The AIRCRAFT YEAR BOOK *For 1948*

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The Aircraft Year Book

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for 1948

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FOREWORD

THE CHANGE IN THE AIRCRAFT YEAR BOOK

The Aircraft Year Book has been published by the national trade association of the aircraft manufacturers in the United States since 1919. At the time of its first issue, and for many years thereafter, there was no other source to which the serious student of aviation affairs could turn for basic statistics, a record of legislative and governmental activities in aviation, outstanding records, or the introduction of new aircraft, engines, accessories, and other scientific developments. Thus the Aircraft Year Book has been and will remain an invaluable repository of the history of American aviation during one of its critical periods.

In the last several years the conditions which necessitated publication of the Aircraft Year Book as a comprehensive encyclopedia of the year in aviation have changed from those prevalent in the 1920's. Commercial publishers now prepare and issue comprehensive directories of all branches of the industry and of all types of equipment. The important and now well-established trade journals regularly chronicle the important developments in aviation. In addition, several issue annual reviews or directories summarizing technological and legislative developments and reproducing the important statistics of the period. It so happens that the growth of the services made available by the commercial publishers coincided with the post-war contraction in the aircraft industry which has necessitated reductions in the budget of the Aircraft Industries Association. In view of these developments, the Association arrived at the decision that publication of the Aircraft Year Book in the format and with the contents typical of its production by Lanciar Publishers was no longer essential.

On the other hand, the year 1948 was one of the most remarkable of the past two decades in the field of national aviation policy. Several outstanding documents of lasting importance to all phases of aviation were published during the year. To preserve these in permanent bound form, the Association decided to devote the entire Year Book for 1948 to reproduction of the full text of these materials. Meanwhile, detailed studies are underway to determine the future of the Aircraft Year Book.

The documents included in this volume are:

1. The report of the President's Air Policy Commission, "Survival in the Air Age."

2. The report of the Congressional Aviation Policy Board, "National Aviation Policy."

3. "Elements of American Air Power," statements submitted by 17 aircraft companies to the President's Air Policy Commission.

In addition to reproduction of the full text of these documents, which truly constitute a landmark in aviation history, there are also included in the Aircraft Year Book for 1948 summaries of the important statistics and legislative developments of the year.

The Congressional history of 1947-8 and particularly the adoption of the Supplemental National Defense Appropriation Act of 1948, providing increased appropriations for aircraft procurement, marked a turning point in the post-war history of American Air Power. The disastrous disintegration of American air power after V-J Day in 1945 was halted by the report of the President's Air

Policy Commission (January 1, 1948) and by that of the Congressional Aviation Policy Board (March 1, 1948) and the ensuing adoption of the appropriation measure. Unfortunately, much remains to be done to make certain that the specific recommendations of the Congressional Board, which are so essential to national security and to the economic welfare of American aviation, are actually put into effect by action of Congress or by governmental directive. For this reason the years 1949 and 1950 assume an importance commensurate to that of 1948 in the revival of American air power. As this is written, the critical international situation adds an emphasis to this need that cannot easily be ignored.

OLIVER P. ECHOLS,
President,
Aircraft Industries Association

Washington, D. C.
October 1, 1948

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THE AIRCRAFT PRODUCTION EXPANSION PROGRAM

The aircraft production expansion program authorized by the Supplemental National Defense Appropriation Act of 1948, which provided for aircraft procurement for the 1949 fiscal year, stems directly from recommendations of the President's Temporary National Air Policy Commission* and the Joint Congressional Aviation Policy Board.** This law, often called the "70-group bill" when it was under debate, only provided funds for the initial purchase of planes for a 70-group program but did not authorize an air force of that size. This appropriation measure should not be confused with the proposed Clason 70-group Air Force bill which would authorize the planes, personnel, and procurement and establish the composition of a 70-group Air Force. This latter measure is scheduled to be considered by Congress early in 1949.

The program calls for an expansion in production of military aircraft more than tripling the rate of industry output prevailing since VJ-Day. Production of military aircraft in the calendar year 1946 was 1,330 aircraft. In the calendar year 1947 production of military types was slightly more than 1,500 units. During the first quarter of 1948 production of military aircraft amounted to 573 units.

In contrast with these low levels, the Supplemental National Defense Appropriation Act of 1948 as passed by Congress in May authorized the purchase of 2,727 planes for the Air Force and 1,535 for the Navy.

Relative Size of the Program

Because the program bulks large against previous peacetime standards, a few comparisons will enable a better appraisal of the size of the assignment given the aircraft industry and of its impact upon the domestic economy.

In its report issued in January, the Finletter Commission endorsed the recommendations of the Air Coordinating Committee issued in October, 1945, dealing with the minimum annual production required to maintain an aircraft industry capable of rapid expansion in an emergency. This 1945 report of the Air Coordinating Committee gave the following two figures for the minimums that should be maintained:

"**Table I**

Annual Production of Military Airplanes

	Lower Level	**Upper Level**
Number of Airplanes	3,000	5,780
Airframe Weight	30,700,000 lbs.	60,100,000 lbs."

The upper and lower level referred to were defined as follows:

"In determining the upper level of possible military requirements for aircraft, we have assumed the need for a substantial striking force ready at all times to cooperate in the maintenance of world peace. We have conceived of the lower level as a minimum which could be reached only after maintenance of world peace is well assured and a substantial degree of disarmament has taken place."

The new program falls between the upper and lower levels recommended by the Air Coordinating Committee. In total units, 4,262, it is almost exactly half-way

*Text of the President's commission report is the second section of this book.

**Text of the Congressional Board report is the third section of this book.

between the two recommended levels. The airframe weight involved in the program will be closer to the upper level than the lower.

It should be noted, however, that the rates of production called for under the Supplemental National Defense Appropriation Act of 1948 will not be reached for at least 18 months, and perhaps not until two years from July, 1948. Production in units in the calendar year 1948 may be expected to approximate the 2,000 unit level. This production in terms of airframe weight will approximate 20 million to 22 million pounds. It is doubtful if production will exceed 50 million pounds a year until after the fiscal year 1950.

"Planes"

When the current expansion program is compared with that inaugurated during World War II it is relatively small. Production of military aircraft during the last war reached a rate of more than 100,000 units per year in early 1944 before cutbacks became necessary. In terms of airframe weight, production in early 1944 was running well above an annual rate of 1 billion pounds a year. These figures give some indication of the relatively slight drain on the nation's resources of steel, aluminum, and manpower involved in the current expansion program.

Inflationary conditions, of course, tend to make this program bulk larger than is actually the case. The new law provides a total of $2,798 million for new obligations for aircraft procurement. Such a volume, while large for the aircraft industry, actually amounts to only one and one-half percent of the current national production or national income, which is now running at a rate above $200 billion a year.

The steel industry at its current rate of operations can produce all of the steel required in the aircraft expansion program in approximately three hours. However, much of it is special steel calling for highly controlled production. The aluminum required for the program, when the peak rates of operation are attained some 18 months from now, would involve only about 15 to 20 days of annual production of the aluminum industry.

1940-48 Conditions Quite Different

While the aircraft production program is not to be compared in size with that undertaken during World War II, it does face the aircraft industry with a real challenge. This is principally because of the vast difference in economic condition between 1940, when the World War II expansion program got under way, and 1948.

In 1940, the aircraft program was undertaken in an economy that was far from peak levels. Unemployment was relatively heavy. Industrial capacity lay idle. Materials were easily available. There had been no inflation of costs. Labor conditions were stable.

In 1940, although new planes were coming from the drawing boards, they were designed for conventional engines. These engines were approaching peak development of more than 20 years. Speeds still were in the range below the speed of sound range, and compressibility was not too serious a factor. A start on plant expansion and organization of design teams had been made possible by British and French orders of the proceding year. There had been no disintegration of plant labor forces, engineering design teams or management groups by events such as the demobilization after V-J Day. The industry, while not rich, had not suffered serious financial losses in the preceding two years.

World War II Experience

1939 output: Military 2,141; Total 5,856.

Monthly output in May 1940 when Franklin D. Roosevelt asked 50,000 planes—450.

Monthly output one year later—1,339 planes.

Time from May 16, 1940, until 50,000 a year rate reached — *27 months.* Monthly output in August 1942—4,274 planes. Output was 47,836 in 1942.

Time to reach 100,000 a year rate from May 16, 1940—42 months. Output in October 1943—8,360 planes. From date 50,000 a year rate reached—*15 months.*

Production in 1944 (peak year)—96,318 (revised).

In 1948, the economy is virtually saturated with orders and backlogs for civilian goods and for equipment, foods and supplies for Europe. There is little unemployment, particularly in the fields from which the aircraft industry must draw its skilled labor. There is no guarantee that employment in the aircraft industry will be at all stable, as contrasted to conditions in other industries. Industrial capacity in the aircraft industry itself is sufficient for the new program, but capacity in industries which must supply the aircraft industry with much of its parts and accessories is heavily engaged in civilan production. Materials, many of them vital and essential, are in scarce supply. There has been an inflation of costs, and labor conditions in an era of national inflation are not stable.

In 1948, the bulk of new planes coming from the drawing boards are being powered with new types of engines—jets and gas turbine. These engines are just beginning in their development cycle. Speeds have shot up into the sonic range and strength, maneuverability, and stability problems all must be reassessed for each new plane. Aircraft companies have been operating below the economic production level, and expansion will bring forth many problems. Plant labor forces, engineering teams and in some cases, management groups, have been dispersed by post-war demobilization. The industry has suffered severe financial losses over a two-year period.

The Time Factor

The amount of time required to bring about an expansion in aircraft production is far beyond what the general public believes can be done. The problem can be illustrated by another reference back to World War II experience. At this time the nation was mobilizing for war and all resources could be concentrated upon the problem of expanding aircraft production. Despite this concentration, 27 months passed from the time the 50,000 planes a year program was announced on May 16, 1940, until that output rate was reached in August, 1942. Yet, some expansion was already under way in 1940 because of the orders that had been previously placed by the French and the British.

As has been pointed out above, expansion will be somewhat more difficult now because of the current boom in the domestic economy. Because of this, the best estimates are that at least 18 months will elapse before the peak production rate authorized by the Supplemental National Defense Appropriation Act of 1948 is reached.

Costs of 5-Year Program

According to Lt. General Edwin W. Rawlings, Air Comptroller, in testimony before a House Appropriations subcommittee, on March 19, the Air Force plan for modernization of the 70 groups differs from the Finletter* report only in the date of completion. Under the five year Air Force plan, the 70 group program would be completed by the end of fiscal year 1953 with modernization of the war reserve to be completed about fiscal year 1955 or 1956. Under the Finletter recommendations, modernization was to have been completed by January 1, 1953. The amounts of cash or contract authorization for aircraft procurement tentatively considered as necessary under the plan being formulated within the Air Force are (in millions):

Fiscal year 1949	2,037	Fiscal year 1952	3,200
Fiscal year 1950	2,738	Fiscal year 1953	3,200
Fiscal year 1951	3,303	Level off	3,200

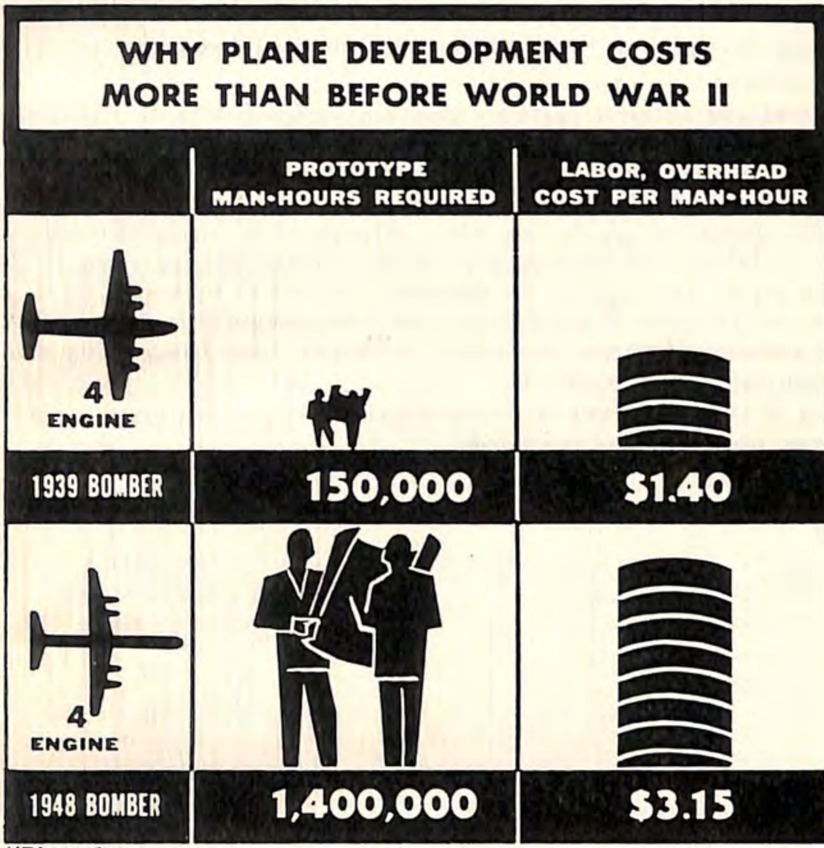
Design Time

The time involved in designing and building aircraft and in preparing them for mass production in 1948 as compared with World War II models designed and produced prior to 1942 has increased nearly 10 times. As an example, the prototype of the B-17 required 150,000 engineering manhours, the prototype B-29 required 1,400,000 engineering manhours and the prototype B-50 approximately the same as the B-29, as a result of the utilization of B-29 know-how and parts.

Some of the problems which increase the complexity and time involved in producing modern aircraft are the result of the increased altitude operating range and speed range. Altitudes have increased roughly from 30,000 to 50,000 feet for tac-

*Chairman of the President's Temporary National Air Policy Commission.

tical aircraft and the speed range from 300 miles per hour to 600 plus miles per hour. These two factors alone have promoted problems in basic aircraft structural design as well as accessory and control equipment. As an example, new concepts in the design of aircraft hydraulic and electrical systems must be developed to enable the systems to withstand the lower temperatures in the higher atmosphere. The matter of engine cooling at higher altitudes has become more complex. Extremely thin wing construction presents problems of design and fabrication. The development of taper sheet aluminum and new types of extrusions for such wing sections of high speed aircraft is a definite developmental problem. The increased complexity of design problems in subsonic and supersonic aircraft have increased the flight test time required to prove the dependability of new designs. This applies also to increased complexity of control and accessory equipment which must be flight tested in total airplane configuration to prove its serviceability for military use.



"Planes"

Aircraft Ordnance

Increased design and production time is also the result of need for more accurate control of military aircraft ordnance equipment and for more precise navigational equipment. As examples, remote gunfire control systems must be adapted to and coordinated with the high speed operation of jet fighters. The radar countermeasure and identification equipment must be extended to greater ranges and higher altitudes for effectiveness. Research must be undertaken to obtain lower weights and greater reliability of such equipment. Radio and control equipment must be redesigned or redeveloped to overcome the low temperature and pressure effects of high altitude as well as the increased acceleration loads of the higher speeds.

Jet and Gas Turbine Power

Use of jet and gas turbine power plants for military aircraft has presented numerous problems tending to increase production time and expense. New high temperature alloy materials and ceramics must be developed for combustion chambers and turbine blades, etc. Such high density and high temperature alloy materials and use of ceramics also result in fabrication problems. New tooling methods are required for forming turbine blades. New problems in design of rotor bearings confront engineers. Such bearings must withstand rotational speeds and powers 10 times greater than reciprocating engines. Such engines must also be capable of withstanding greatly increased stresses for high speed maneuvers. Turbo-prop installations require new designs in propeller reduction gearing to transmit the extremely high turbine speeds and power. Engine controls must be designed to coordinate con-functioning of various engine compounds such as fuel system temperature control and variable jet nozzle.

There are also problems in new design concepts for internal and external cooling of power plants.

Component and airframe parts are generally designed with the objective of providing the greatest performance and dependability possible. Such parts, however, often require complete redesign before they can be mass produced in order to avoid a critical shortage of material or manufacturing facilities. For example, substitutes must be developed for application where columbium or cobalt materials are used and some parts must be redesigned to utilize existing forging capacity for mass production parts. The capacity for accessory and control equipment in aircraft has also increased problems of maintenance and interchangeability. Parts must be designed or redesigned in mass production to increase interchangeability and reduce maintenance and supply problems.

Between 50 and 60 percent of the appropriations go into airframes, the balance into engines, propellers and accessories.

COMPARISON OF APPROPRIATIONS FOR AIRCRAFT PROCUREMENT

U. S. AIR FORCE — In millions of dollars

	Fiscal 1947	Revised Fiscal 1948	Fiscal 1949 as passed Congress
Procurement airplanes	375.4	588.4	1,962.0
Materiel Army	7.2	10.6	10.0
Missiles	N.A.	13.0	10.3
Industry planning	11.7	4.5	4.5
Salaries, etc.	N.A.	N.A.	12.8
Airborne equipment	N.A.	N.A.	45.5
			2,045.1
Cash to pay previous authorizations			250.0
			2,295.1

U. S. NAVY

	Fiscal 1947	Revised Fiscal 1948	Fiscal 1949 as passed Congress
Procurement piloted	307.7	323.5	738.7
Procurement pilotless	5.6	10.1	9.3
Equipment for Service Schools	N.A.	N.A.	1.0
Industry planning	N.A.	6.0	4.0
			753.0
Cash to liquidate previous contracts			150.0
			903.0

Total appropriated for 1949 fiscal year

New obligations (of which contract authorization is $2,275,000,000)	$2,798,100,000
Cash to pay previous authorization	400,000,000
	$3,198,100,000

N.A.—not available.

Number of Planes Provided by Appropriations

	Air Force	Navy Aviation	Total
Original Budget 1/6/48	978	1,025	2,003
Supplemental Request 4/8/48	693	510	1,203
House Addition	1,056	-----	1,056
	2,727	1,535	4,262

Details of Above

Air Force: 1,575 jet fighters; 243 bombers; 909 transports, utility, etc.; total 2,727.

Navy: 807 fighters; 515 attack; 113 patrol; 20 transports; 80 helicopters; total 1,535.

Source: Air Force release May 6, 1948. Testimony by John L. Sullivan, Secretary of Navy, April 27, 1948.

Note: Secretary Forrestal had approved commitments of approximately 80-90% of these authorizations by July 1, 1948.

The Air Information Division of the Department of the Air Force issued the following release on June 10, 1948, detailing the aircraft procurement program then authorized by Secretary Forrestal. Text of the release follows:

"The $1,345,165,000 approved by the Secretary of Defense, for the procurement of aircraft by the USAF will permit the awarding of contracts to aircraft manufacturers for 243 bombers, 1,405 fighters and 553 transport, training and air sea rescue aircraft.

"A detailed breakdown of the 2,201 total by manufacturer, type of aircraft and number of aircraft to be procured is as follows:

"Manufacturer	**Type**	**No. of Aircraft**
"Boeing	B-50D	132
"Boeing	B-50C	30
"North American	B-45C	51
"Northrop	B-49	30
"Republic	F-84C	409
"Lockheed	F-80C	457
"North American	F-86A	333
"North American	F-86C	118
"Curtiss	F-87	58
"Curtiss	RF-87A	30
"Fairchild	C-119B	99
"Douglas	C-124A	28
"Grumman	SA-16A	32
"North American	T-28	266
"Lockheed	TF-80	128

"The Air Force is not prepared at this time to give final figures on the dollar value involved in individual types of aircraft being procured."

The Department of the Navy issued a similar release on the same day. Text of this release follows:

"MEMORANDUM TO THE PRESS:

"Procurement of 1,165 Naval aircraft has been planned under the $653,635,000 authorized for that purpose by the Secretary of Defense from Congressional appropriations.

"In response to queries, the breakdown of this aircraft procurement program by model, manufacturer and quantity follows:

"Fighters	**Manufacturer**	**Model**	**Quantity**
	McDonnell	F2H	179
	Grumman	F9F	317
	Douglas	F3D	28
	Chance Vought	F6U	33
	Chance Vought	F7U	19
		Total Fighters	576
"Attack	Douglas	AD	356
	Grumman	AF	23
	Martin	AM	47
		Total Attack	426
"Patrol	Lockheed	P2V	82
		Total Patrol	82

"Transport	Fairchild	R4Q	8
	Undetermined	VR(HL)	2
	Grumman	JR2F	6
		Total Transport	16
"Helicopters	Sikorsky	HJS	19
	Sikorsky	HO3S	18
		Total Helicopter	37
		Undetermined	28
		Grand total procurement	1,165"

FIRST LINE

AIR FORCE PROGRAM BY TYPES

(Excludes Air National Guard and Air Reserve)

First-line aircraft inventory requirement, fiscal year 1949—full 70 group, 22 squadrons, 3,000-pilot-training program.

Type of Aircraft	Required Inventory	Replacement Requirement Operational[1]	OBS[2]	Total
Heavy bombers	988	90	122	212
Light and medium bombers	436	69	82	151
Fighters:				
Pen and interceptor	1,898	531	418	949
Tactical reconnaissance	165	56	36	82
All-weather	125	16	34	50
Transports:				
Light	56	4	8	12
Medium	463	38	69	167
Heavy	417	10	55	65
Amphibian	67	25	5	30
Liaison	310	61	34	95
Helicopters	105	28	21	49
Trainers:				
Primary basic	1,107	76	124	200
Advanced single engine	336	94	15	109
Advanced twin engine	396	63	30	93
TOTAL FIRST LINE	6,869	1,151	1,053	2,204[3]

[1]Operational rate (attrition): Percentage of total requirement (or inventory) which is assumed to be lost to the using agency due to actual operational loss, wreck, missing, etc. This rate is calculated from experience.

[2]Obsolescence rate: Percentage of total requirements (or inventory) which is assumed to be lost from first-line inventory due to the aircraft which are not lost operationally becoming obsolescent after a certain period of time. This rate includes aircraft being retired from inventory, becoming militarily obsolete, and being retired to fill requirements for which obsolescent aircraft are suitable.

[3]This figure does not include aircraft procurement necessary to support the Air National Guard and the Air Reserve Training Programs. Their requirements have been met to date through assignment of aircraft from storage.

Source: Speech by Representative C. E. Merrow, Congressional Record, December 15, 1947.

Naval Aviation: Composition by Type

The figures which follow are divisions into operating units and by types of the Navy's plan of the 14,500 planes required to make it possible for the Navy to carry out its assigned mission. Under conditions of peace it would be possible to achieve this strength within five years.

The requirement of 14,500 aircraft has been approved by the Joint Chiefs of Staff for the Navy on the same basis as the seventy group plan of the Air Force. The Navy now has operating 5,793 planes and an inventory requirement of about 11,000.

Total USN Operating	8,015
Total USNR Operating	2,672
Grand Total Operating	10,687
Logistic Support	3,787
Total Planes HTA	14,474
Total lighter-than-air	32

Breakdown by Operating Combat Units

NAVY	**Groups**	**Aircract**
USN		
Attack Carrier Air Groups	24	1,860
ASW Carrier Air Squadrons	16	352
TOTAL	40	2,212
USNR		
Attack Carrier Air Groups	8	682
ASW Carrier Air Squadrons	8	176
TOTAL	16	808
TOTAL CARRIER AIR GROUPS	56	3,020
Patrol Squadrons USN	40	400
Patrol Squadrons USNR	12	120
TOTAL PATROL SQUADRONS	52	520
MARINE CORPS		
Carrier Groups (Amphibious) USMC	6	144
Air Groups (Support) USMC	27	540
TOTAL	33	684
Air Groups (Support) USMCR	7	168
TOTAL MARINE CORPS	40	852

Breakdown by Types (Operating)

COMBAT		NON-COMBAT	
Fighters	3,990	Transport, Heavy land	94
Attack	1,972	Transport, Medium land	307
Patrol (Heavy land)	292	Utility, Multi-engined	512
Patrol (Medium land)	306	Utility, Single-engined	129
Patrol (Medium Sea)	194	Training, Multi-engined	715
Patrol (Amphibian)	65	Training, Single-engined	1,922
		Helicopters, Observation	189
TOTAL COMBAT	6,819	TOTAL NON-COMBAT	3,868

Total Operating Aircraft, Heavier-than-air	10,687
Logistic Support (in transit, overhaul, etc.)	3,787
Total Heavier-than-Aircraft	14,474
Total Lighter-than-Aircraft	32

Source: U. S. Navy, as supplied Representative C. E. Merrow.

Aircraft Profits and the Renegotiation Act of 1948

Section 3 of the Supplemental National Defense Appropriation Act as approved May 21, 1948, is titled "The Renegotiation Act of 1948." It stipulates that "all contracts in excess of $1,000 entered into under the authority of this Act, obligating funds appropriated hereby, obligating funds consolidated by this Act with funds appropriated hereby, or entered into through contract authorizations herein granted, and all subcontracts thereunder in excess of $1,000 shall contain" a standard renegotiation article as defined in the law.

This clause is to be administered by the Secretary of National Defense. He is given the rights to audit the books and records of any contractor or subcontractor subject to this section. He is also given the right to make exceptions or exemptions to the law "in his discretion."

The aircraft industry historically is geared to a modest rate of return. Its rate of profits throughout the recent war were lower than those reported by any other major supplier of war material. This is shown by the following table taken from the National City Bank Letter for April, 1948, and showing the rate of profits per dollar of sales for certain leading industries.

Profits Per Dollar of Sales

Industries	1936	1937	1944	1945	1946	1947
Iron and steel	5.9	7.5	2.6	3.0	5.6	6.2
Machinery	11.2	9.1	3.2	3.6	5.9	7.1
Autos and trucks	12.5	9.5	3.1	4.5	3.6	6.5
Aircraft and parts	7.7	7.6	1.2	1.2	0.5	—2.5
Total all manufacturing companies	7.6	7.4	3.3	3.9	6.0	7.1

Source: National City Bank Letter for April, 1948.

The Renegotiation Act of 1948 may pose some serious supplier problems for the prime aircraft contractors. A great many of suppliers of accessories, components for aircraft and engines, electronic equipment of all types, navigation and other instruments, nuts and bolts, etc., are heavily occupied with the production for the civilian market. Any volume of business coming to such concerns as a result of the aircraft expansion program just authorized will constitute a very small portion of their total production and sales. In view of this situation, rather serious problems of operation and bookkeeping are raised by the requirement that all contracts of $1,000 and more awarded under the 1948 act shall be subject to renegotiation provided that the total of contracts received is $100,000 during any fiscal year.

It should be remembered that this Renegotiation Act of 1948 is in addition to the profit limitation features of the Vinson-Trammell Act, which limits profits on all contracts for military and naval aircraft or component parts. The administrative problems of both the Vinson-Trammell Act and the Renegotiation Act of 1948 rather than the profit limitation features of these two statutes will undoubtedly cause some real supplier problems to the aircraft manufacturing industry.

It is, of course, possible that the Secretary of Defense in whatever regulations he may issue to carry out the Renegotiation Act of 1948, may recognize and make allowance for some of these situations.

The inclusion of the "draft -industry" section in the Selective Service Act of 1948, empowering the Secretary of Defense to place compulsory orders for defense equipment, has an obvious direct bearing on these problems.

NUMBER AND VALUE OF AIRCRAFT PRODUCED
1909 - 1948

Year	*Units*			*Total Value (millions)*
	Civil	*Military*	*TOTAL*	
1910[a,b]	—	1	1	—
1910[a,b]	—	—	—	—
1911[a,b]	—	11	11	—
1912[a,b]	29[c]	16	45	—
1913	29[c]	14	43	—
1914	34[c]	15	49	$ 0.8[i]
1915	152[c]	26	178	—
1916	269[c]	142	411	—
1917	135[c]	2,013	2,148	—
1918	29[d]	13,991	14,020	—
1919	98[d]	682	780	14.4[i]
1920	72[d]	256	328	—
1921	48[c]	389	437	6.6[i]
1922	37[c]	226	263	—
1923	56[d]	687	743	12.9[i]
1924	60[d]	317	377	—
1925	268	447	789[e]	12.5[i]
1926	604	532	1,186[e]	—
1927	1,565	621	1,995[e]	21.2[i]
1928	3,542	1,219	4,761	—
1929	5,357	677	6,034	71.2[i]
1930	1,937	747	2,684	—
1931	1,582	812	2,394	40.3[i]
1932	549	593	1,142	—
1933	591	466	1,057	26.5[i]
1934	772	437	1,209	—
1935	1,109	459	1,568	45.3[i]
1936	1,559	1,141	2,700	—
1937	2,281	949	3,230	149.7[i]
1938	1,823[f]	1,800	3,623[f]	—
1939	3,175[f]	2,141	5,856[f]	279.5[i]
1940	6,785[f]	6,019	12,804[f]	342.0[j,k]
1941	6,844[f]	19,433	26,277[f]	1,697.0[j]
1942	985[f]	47,836	48,821[f]	5,497.0[j]
1943	—	85,898	85,898	11,917.0[j]
1944	—	96,318	96,318	15,654.0[j]
1945	2,047	47,714	49,761	7,998.0[j,l]
1946	34,874	1,330[g]	36,204	489.7[g,m]
1947	15,616	2,102[h]	17,718	1,014.8[h,m,n]
1948 (6 mos.)	4,038	1,106	5,144	N.A.

N.A. Not available.

[a] Excludes deliveries to users other than the government.

[b] Excludes spares delivered, remodeling jobs and intergovernment deliveries.

[c] Exported.

[d] Total exports and domestic civil.

[e] Because of different sources civil and military do not add up to totals shown.

[f] Excludes production of civil aircraft exported.

(*Continued on following page*)

[g] Excludes experimental aircraft and aircraft classified as secret or confidential by the armed forces; also helicopters, liaison, pilotless aircraft.

[h] Excludes non-man-carrying aircraft.

[i] Value of products, including engines, propellers, etc.

[j] Value of military airframes, engines, propellers, airplane spare parts, at August 1943 unit costs.

[k] July-December 1940.

[l] January-August 1945.

[m] Complete aircraft and parts and engines and parts.

[n] Value of civil is manufacturer's net billing price. Value of military is payments from U. S. Military (payments do not necessarily cover aircraft delivered during period).

SOURCES:

Units

1909–1912:	Aircraft Industries Association, "Aviation Facts and Figures, 1945," p. 7, table 2-2.
1913–1924:	Civil Aeronautics Administration, "CAA Statistical Handbook of Civil Aviation," 1945, p. 121.
1925–1939:	Aircraft Industries Association, "Aviation Facts and Figures, 1945," p. 8, table 2-4.
1940–1942:	Civil: Aircraft Industries Association, "Aviation Facts and Figures, 1945," p. 8, table 2-4.
1940–1945:	Military: Civil Aeronautics Administration, "U. S. Military Aircraft Acceptances 1940-1945, Aircraft, Engine and Propeller Production," p. 5.
1945:	Civil: Civil Aeronautics Administration.
1946–1948:	Bureau of the Census, Facts for Industry, Series M42A.

Value

1914–1939:	Aircraft Industries Association, "Aviation Facts and Figures, 1945," p. 7, table 2-3.
1940–1945:	Civil Aeronautics Administration, Information and Statistics Service.
1946–1947:	Bureau of the Census, Facts for Industry, Series M42A.

NUMBER AND VALUE OF ENGINES PRODUCED
1917-1948

Year	Units			Total Value Excluding Spares (millions)
	Civil	*Military*	*TOTAL*	
1917-1919	N.A.	44,453	N.A.	N.A.
1926	N.A.	842	N.A.	N.A.
1927	N.A.	1,397	N.A.	N.A.
1928	632	2,620	3,252	$ 13.4
1929	5,517	1,861	7,378	26.5
1930	1,925	1,841	3,766	17.1
1931	1,976	1,800	3,776	14.5
1932	813	1,085	1,898	9.3
1933	1,120	860	1,980	9.7
1934	2,048	688	2,736	15.5
1935	1,974	991	2,965	12.7
1936	2,433	1,804	4,237	22.1
1937	4,095	1,989	6,084	30.1
1938	N.A.	N.A.	N.A.	N.A.
1939	N.A.	N.A.	11,172	74.3
1940[a]	N.A.	22,667	N.A.	101.0[c]
1941[a]	N.A.	58,181	N.A.	436.0[c]
1942[a]	N.A.	138,089	N.A.	1,314.0[c]
1943[a]	N.A.	227,116	N.A.	2,226.0[c]
1944[a]	N.A.	256,911	N.A.	3,075.0[c]
1945[a]	N.A.	109,650	N.A.	1,624.0[c]
1946	40,822	2,585[b]	43,407	126.9[b]
1947	16,370	4,808	21,178	246.4[d]
1948 (6 mos.)	6,605	2,241[e]	8,846[e]	N.A.

N.A. Not available.

[a] Excludes aircraft engines produced for other than aircraft use.

[b] Excludes experimental engines, engines classified by the armed forces as secret or confidential, engines for non man-carrying, pilotless aircraft, jet assist mechanisms.

[c] Military production only, at August 1943 unit costs.

[d] Value of civil engines is manufacturer's net billing price. Value of military engines is payment received from the military services (does not necessarily cover the value of engines delivered during the period).

[e] Preliminary.

SOURCES:

Units:

1917–1939: Aircraft Industries Association, "Aviation Facts and Figures, 1945," p. 10, table 2-8.

1940–1945: Civil Aeronautics Administration, "U. S. Military Aircraft Acceptances 1940-1945, Aircraft, Engine and Propeller Production," p. 7.

1946–1948: Bureau of the Census, Facts for Industry, Series M42A and M42C.

Value:

1928–1939: Aircraft Industries Association, "Aviation Facts and Figures, 1945," p. 10, table 2-8.

1940–1945: Civil Aeronautics Administration, Information and Statistics Service.

1946–1947: Bureau of the Census, Facts for Industry, Series M42A and M42C.

EMPLOYMENT IN THE AIRCRAFT INDUSTRY, 1919-1948

Year	*Total Number of Employees*[a]	*Wage*[a] *Earners*	*Year*	*Total Number of Employees*[a]	*Wage Earners or Production Workers*[a]
1919	4,188[b]	3,543[b]	1939	63,993	48,638
1921	1,950[b]	1,395[b]	1940	122,609[c]	N.A.
1923	3,488[b]	2,901[b]	1941	291,782[c]	N.A.
1925	3,357[b]	2,701[b]	1942	693,082[c]	N.A.
1927	5,486[b]	4,422[b]	1943	1,203,842[c]	N.A.
1929	18,620[b]	14,710[b]	1944	1,176,593[c]	N.A.
1931	N.A.	9,870[b]	1945	655,191[c]	N.A.
1933	9,626[b]	7,816[b]	1946	191,864[d e]	130,003[e g]
1935	14,931[b]	11,384[b]	1947	185,073[d]	133,186[g]
1937	31,720	24,003	1948	178,717[d f]	128,997[g]

N.A. Not available.
[a] Average for year, except 1948.
[b] Excludes engines.
[c] Prime contractors only.
[d] Total plant employees in aircraft and engine manufacturing plants.
[e] Average for the year for complete aircraft manufacturing plants plus December employment for engine manufacturing plants.
[f] Average for January-June 1948.
[g] Production and related workers in aircraft and engine manufacturing plants.

SOURCES:
1919–1939: Bureau of the Census, Census of Manufacturers.
1940–1945: Aircraft Industries Association "Aviation Facts and Figures 1945," p. 20, table 3-3, and Aircraft Industries Association Statistical Memorandum—1, March 7, 1946.
1946–1948: Bureau of the Census, Facts for Industry Series M42A.

HOURS AND EARNINGS IN THE AIRCRAFT AND AIRCRAFT ENGINE INDUSTRY, 1939-1948

Year and Month	*Average Weekly Hours*		*Average Weekly Earnings*		*Average Hourly Earnings*	
	Aircraft and Parts Excluding Engines	*Aircraft Engines*	*Aircraft and Parts Excluding Engines*	*Aircraft Engines*	*Aircraft and Parts Excluding Engines*	*Aircraft Engines*
	(*hours*)		(*dollars*)		(*cents*)	
1939	41.5	44.1	$30.34	$36.58	74.5	83.5
1940	43.2	45.8	31.40	38.50	74.3	84.0
1941	45.3	46.9	37.75	47.04	84.0	103.3
1942	47.0	48.7	46.21	59.03	98.7	121.2
1943	46.4	47.4	49.76	59.81	107.2	126.2
1944	47.1	46.6	54.50	61.14	115.9	131.2
1945	45.7	44.5	54.37	57.93	119.1	130.1
1946	40.6	41.2	52.24	54.78	128.8	133.0
1947	39.8	39.9	54.11	56.28	136.0	140.9
1948, Jan.	39.4	40.6	55.53	59.30	140.8	146.1
Feb.	39.9	40.1	56.13	58.29	140.6	145.2
Mar.	40.1	40.6	56.71	59.53	141.4	146.7
Apr.	40.6	40.5	57.75	60.33	142.1	149.1
May	40.4	40.9	57.74	61.02	142.8	149.4
June	40.4	40.6	57.99	62.14	143.6	153.2
July	39.9	40.6	57.80	64.79	144.7	159.4

Source: Bureau of Labor Statistics.

DOMESTIC AIRLINES OPERATIONS
1926-1947

Year	*Aircraft in Service*	*Route Mileage Operated*	*Revenue Passengers Carried*	*Total Revenue and Nonrevenue Passenger Miles Flown*	*Total Mail, Express, Freight Ton Miles*	*Total Revenue and Nonrevenue Passenger Load Factor (%)*	*Operators*	*Personnel*
				(thousands)		%		
1926	N.A.	N.A.	5,782[a b]	N.A.	N.A.	N.A.	13	N.A.
1927	N.A.	N.A.	8,679[a b]	N.A.	N.A.	N.A.	18	N.A.
1928	268	N.A.	48,312[a b]	N.A.	N.A.	N.A.	34	1,496[g]
1929	442	N.A.	161,933[a b]	N.A.	N.A.	N.A.	38	1,958
1930	497	30,293	384,506[a b]	85,125	N.A.	N.A.	43	2,778
1931	490	30,857	472,438[a b]	106,952	N.A.	N.A.	39	4,314
1932	456	28,956	476,041[a b]	127,433	N.A.	41.98	32	4,020
1933	418	28,283	502,218[a b]	174,820	N.A.	46.77	25	4,369
1934	423	28,609	475,461[a b]	189,806	2,237[f]	51.61	24	4,201
1935	363	29,190	678,549[b]	316,336	5,230	54.76	26	5,945
1936	280	29,797	931,683[b]	438,989	7,607	63.97	24	7,079
1937	291	32,006	985,084[b]	481,116	8,861	57.54	22	7,586
1938	260[c]	34,879[c]	1,197,100[b]	560,660	9,632	58.93	16[c]	9,008[c]
1939	276[d]	36,654[d]	1,704,762[b]	755,118	11,324	62.14	18[d]	10,639[d]
1940	369	42,757	2,802,781[b]	1,157,900	13,594	63.72	19	15,984
1941	370	45,163	3,848,882[b]	1,506,303	18,377	64.32	19	19,223
1942	186	41,596	3,136,755	1,501,279	33,064	76.45	19	26,910
1943	204	42,537	3,019,736	1,670,935	51,201	89.98	19	29,654
1944	288	47,384	4,045,965	2,211,905	68,132	90.77	19	31,198
1945	421	48,516[e]	6,576,252	3,408,290	87,290[e]	89.33	20	50,313
1946	674	53,981[e]	12,213,445	6,068,315	71,564[e]	80.31	24	69,182
1947	810	62,224[e]	12,890,208	6,307,690	97,764[e]	67.29	28	58,998

N.A. Not available.

[a] No data available breaking down revenue and nonrevenue passengers 1926-1934.

[b] Includes some duplication of passengers carried on more than one line on a single trip.

[c] Excludes Colonial and Marine airlines.

[d] Excludes Marine airline.

[e] Does not include regular mail carried under special contract and foreign mail (mail that does not bear United States postage).

[f] Does not include 224,236 mail ton miles flown by the U. S. Army.

[g] Includes employees of Pan American Airways.

Source: Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1948.

U. S. INTERNATIONAL AIRLINES OPERATIONS
1928-1947

Year	*Aircraft in Service*	*Route Mileage Operated*	*Revenue Passengers Carried*	*Passenger Miles Flown (thousands)*	*Mail, Express Freight Ton Miles (thousands)*	*Operators*	*Personnel*
1928	57	N.A.	1,401[a]	N.A.	N.A.	1	[b]
1929	83	N.A.	11,472[a]	N.A.	N.A.	4	387
1930	103	19,256	32,999[a]	18,622	N.A.	3	697
1931	100	19,543	59,224[a]	14,171	N.A.	3	1,353
1932	108	19,574	71,519[a]	20,754	N.A.	3	1,590
1933	86	19,404	74,394[a]	24,956	N.A.	3	1,926
1934	99	22,192	96,804[a]	36,844	N.A.	2	2,276
1935	101	31,261	111,296[a]	46,035	N.A.	2	2,407
1936	94	31,990	87,723[a]	41,829	N.A.	2	2,916
1937	92	31,979	112,324[a]	53,742	N.A.	2	4,000
1938	73	34,968	109,265	53,799	N.A.	2	4,266
1939	84	43,455	129,028	78,271	N.A.	2	5,275
1940	68	52,322	162,617	104,495	N.A.	3	6,067
1941	83	N.A.	228,524	165,950	N.A.	3	7,235
1942	68	N.A.	269,345	240,314	N.A.	3	12,803
1943	70	27,211	279,402	254,374	5,088	3	9,625
1944	70	29,708	341,496	322,123	6,207	3	11,409
1945	97	38,885	475,558	462,180	8,718	4	17,968
1946	147	66,419	1,041,283	1,130,196	15,090	9	27,372
1947	154	95,503	1,359,410	1,870,306	32,891	12	26,154

N.A. Not available.
[a] Total revenue and nonrevenue passengers carried. No breakdown available.
[b] Included in domestic air carrier operations.
Source: Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1948.

AIRCRAFT IN USE ON SCHEDULED AIRLINES
June 1948

Manufacturer	*Aircraft Designation*	*Domestic Airlines*	*U. S. International Airlines (Foreign certificate only)*	*TOTAL*
Douglas	DC 6	93	5	98
	DC 4	187	80	267
	DC 3	442	65	507
Lockheed	649	13	----	13
	749	----	13	13
	L 49	22	21	43
	18	12	----	12
	10A	4	----	4
Martin	202	23	----	23
Consolidated Vultee	240	20	----	20
Boeing	307	5	----	5
Miscellaneous	SR 10	7	----	7
	D18S	6	1	7
	S 51	4	----	4
TOTAL		838	185	1,023

Source: Air Transport Association, Scheduled Air Carrier Maintenance Division, July 16, 1948.

PERSONAL PLANE PRODUCTION, 1933-1948

Year	*Units*	*Value*
		(thousands)
1933[a]	467	$ 1,405
1934[a]	618	2,125
1935[a]	917	2,525
1936[a]	1,423	3,454
1937[a]	2,042	4,516
1938[b]	1,711	3,764[d]
1939[b]	3,555	7,821[d]
1940[b]	6,472	14,238[d]
1941[b]	6,597	14,513[d]
1942[b]	923	2,031[d]
1943	....	....
1944	....	....
1945[c]	1,946	N.A.
1946	33,254	92,524[e]
1947	15,515	52,469[e]
1948 (6 mos.)	3,866	14,938[e]

Note: 1933-1942 values exclude engines. From 1945 on values include engines.

[a] Airframes, excluding engines, valued under $6,000.

[b] Airframe value under $6,000 or of less than 4,000 pounds gross weight.

[c] Under 4,000 pounds gross weight.

[d] Estimated at $2200 per airframe.

[e] Manufacturer's net billing price. Data for companies reporting to Personal Aircraft Council.

SOURCES:

Units

1933–1942: Aircraft Industries Association "Aviation Facts and Figures, 1945," p. 77, table 7-6.

1945–1948: Aircraft Industries Association, Personal Aircraft Council (excludes shipments to U. S. Military Customers).

Value

1933–1937: Geisse and Williams "Postwar Outlook for Private Flying," p. 91.

1938–1942: Aircraft Industries Association—see Footnote d.

1946–1948: Aircraft Industries Association, Personal Aircraft Council.

TOTAL U. S. CIVIL AIRCRAFT IN OPERATION, 1927-1947

December 31	*Aircraft*	*December 31*	*Aircraft*
1927	2,740	1938	11,159
1928	5,104	1939	13,772
1929	9,922	1940	17,928
1930	9,818	1941	26,013
1931	10,680	1942	27,170
1932	10,324	1943	27,180
1933	9,284	1944	27,919
1934	8,322	1945	37,789
1935	9,072	1946	81,002[a]
1936	9,229	1947	94,821[a]
1937	10,836		

[a] Gliders are included.

Source: Civil Aeronautics Administration: CAA Statistical Handbook of Civil Aviation, 1948.

CIVIL AIRCRAFT, BY STATES

State	*Jan. 1, 1948*	*Jan. 1, 1947*
Alabama	998	908
Arizona	1,164	885
Arkansas	1,078	899
California	10,221	8,456
Colorado	1,313	1,088
Connecticut	755	635
Delaware	247	215
District of Columbia	933	986
Florida	2,907	2,572
Georgia	1,538	1,346
Idaho	718	545
Illinois	4,503	3,705
Indiana	2,718	2,269
Iowa	2,190	1,734
Kansas	2,719	2,410
Kentucky	835	686
Louisiana	984	760
Maine	605	491
Maryland	1,184	1,468
Massachusetts	1,454	1,255
Michigan	4,695	3,779
Minnesota	2,073	1,798
Mississippi	720	612
Missouri	2,404	2,171
Montana	845	656
Nebraska	1,534	1,139
Nevada	422	383
New Hampshire	304	244
New Jersey	1,650	1,393
New Mexico	785	617
New York	4,797	4,107
North Carolina	1,817	1,579
North Dakota	851	579
Ohio	4,789	4,448
Oklahoma	2,368	1,862
Oregon	1,619	1,227
Pennsylvania	4,393	3,838
Rhode Island	199	181
South Carolina	836	760
South Dakota	746	585
Tennessee	1,306	1,216
Texas	8,347	7,789
Utah	542	468
Vermont	187	144
Virginia	1,437	1,220
Washington	2,043	1,616
West Virginia	660	567
Wisconsin	2,013	1,731
Wyoming	428	326
Outside the United States	947	654
TOTAL	94,821	81,002

Source: CAA Journal April 15, 1948.

UNITED STATES AIR FORCE

PERSONNEL as of July 1, 1948	
TOTAL PERSONNEL	388,000
of which	
Officers	49,000
Rated officers (pilots, bombardiers, navigators)	25,000
Pilots	20,000
AIRCRAFT on hand as of January 1, 1948	
Active planes	
Combat	5,500
Non-combat	6,000
Storage	
Combat	7,500
Non-combat	4,500
TOTAL AIRCRAFT	23,500

Source: Air Force; Public Relations.

U. S. NAVY—BUREAU OF AERONAUTICS

PERSONNEL as of June 1, 1948	
TOTAL PERSONNEL	76,800
of which	
Officers	11,800
Pilots	10,000
AIRCRAFT as of June 1, 1948	
Operational Active	
Fleet combat airplanes	2,100
Fleet combat support airplanes (transports, utility, etc.)	1,200
Aircraft assigned to shore establishments for training, etc.	1,800
Naval Air Reserve	2,000
Non-operational (storage)	2,800
ANR—assembly, repair, in the process of being moved from contractor to Navy	4,500
TOTAL AIRCRAFT	14,400

Source: Navy Department; Public Relations.

UNITED STATES EXPORTS OF AERONAUTIC PRODUCTS,[a] 1912-1946

Year[b]	*Aircraft[c]*		*Engines*		*Parts & Accessories Thousands*	*Parachutes & Parts Thousands*	*Total Value Thousands*
	No.	*Value Thousands*	*No.*	*Value Thousands*			
1912	29	$ 106	Not reported prior		—	Not	$ 106
1913	29	82	to 1922; probably		$ 26	reported	108
1914	34	189	included with		37	until	226
1915	152	958	"other internal-		583	1932	1,541
1916	269	2,158	combustion		4,844		7,002
1917	135	1,002	engines" or		3,134		4,136
1918	20	206	"parts" of		8,878		9,084
1918 second half	41	562	aircraft.		9,140		9,702
1919	44	215	—	—	3,249	—	3,464
1920	65	598	—	—	555	—	1,153
1921	48	315	—	—	158	—	473
1922	37	157	147	$ 73	265	—	495
1923	48	309	80	66	59	—	434
1924	59	413	146	220	165	—	798
1925	80	511	73	171	102	—	784
1926	50	303	297	574	150	—	1,027
1927	63	849	84	485	570	—	1,904
1928	162	1,760	179	665	1,240	—	3,665
1929	348	5,485	322	1,383	2,258	—	9,126
1930	321	4,820	376	1,635	2,363	—	8,818
1931	140	1,813	307	1,432	1,623	—	4,868
1932	280	4,359	2,356[d]	1,518	1,756	$ 313	7,946
1933	406	5,392	2,903[d]	1,452	2,249	87	9,180
1934	490	8,195	1,009	4,459	4,861	148	17,663
1935	333	6,599	568	2,459	5,070	163	14,291
1936	527	11,602	933	5,182	6,061	298	23,143
1937	631	21,085	1,048	5,946	12,105	268	39,404
1938	876	37,978	1,309	7,900	21,949	401	68,228
1939	1,221	67,112	1,880	14,120	35,799	775	117,806
1940	3,531	196,265	4,986	49,874	64,663	1,069	311,871
1941[e]	6,011	422,764	8,144	81,693	121,757	715	626,929
1942[e]	10,500	884,766	14,603	160,575	311,537	467	1,357,345
1943[e]	13,897	1,217,038	21,803	243,650	680,109	1,815	2,142,612
1944[e]	24,405	1,646,169	25,751	335,081	830,220	6,701	2,818,171
1945[e]	7,290	650,108	9,351	126,210	427,241	1,264	1,204,823
1946[f]	2,406	65,294	2,490	11,851	37,389	784	115,318

[a] No breakdown available between new and secondhand exports.

[b] Fiscal years (ending June 30) prior to 1919; later data for calendar years.

[c] Complete aircraft including engines, propellers, etc.

[d] Russia bought 2,010 for $261,344 in 1932 and 2,576 for $255,400 in 1933.

[e] Includes lend-lease shipments.

[f] Includes lend-lease and UNRRA shipments.

SOURCES:

1912–1943: Department of Commerce "Foreign Commerce and Navigation of the United States" annually.

1944–1945: Department of Commerce; Bureau of Foreign and Domestic Commerce, Machinery and Motive Products Unit.

1946: Bureau of the Census; Report FT 410, "United States Exports of Domestic and Foreign Merchandise, Commodity by Country of Destination, Calendar Year 1946."

U. S. EXPORTS OF AIRCRAFT, AIRCRAFT ENGINES AND PARTS AND COMPONENTS

	Jan.-June 1948		1947	
	Units	*Value Thousands*	*Units*	*Value Thousands*
AIRCRAFT	1,309	$38,223.7	3,163	$ 74,501.4
Military				
Bombers—Land Type	39	507.0	38	457.5
Fighters—Land Type	3	20.5	19	130.0
Fighters—Carrier Type	----	----	28	280.0
Trainers of Military Design	411	2,047.9	563	5,131.8
Civil				
New				
Passenger Transports 3,000-15,000 lbs.	17	1,155.3	36	2,155.4
" " 15,000-30,000 lbs.	1	285.0	11	2,598.1
" " Over 30,000 lbs.	30	21,355.6	43	32,308.7
Utility, Personal, Liaison				
Not over 3 places	282	805.9	1,058	2,835.8
4 places and over	187	1,260.1	638	3,614.7
Used and Surplus				
Cargo Transports all sizes	98	3,310.8	74	4,305.5
Passenger Transports all sizes	113	6,093.5	336	18,735.8
Utility, personal, liaison	105	377.2	246	709.2
Rotary Wing	20	994.4	35	1,214.4
Gliders	1	0.5	36	21.0
Airships and Balloons	----	----	2	3.5
Miscellaneous Aircraft	2	10.0	----	----
ENGINES	2,093	7,753.8	4,138	18,075.0
Reciprocating				
Liquid Cooled	76	117.8	23	471.8
Aircooled				
New	546	4,018.0	----	----
0-74 hp	240	136.5	354	187.8
75-249 hp	104	83.8	197	283.3
250-999 hp	100	436.6	153	627.5
1,000-2,499 hp	46	1,041.6	534	6,309.6
2,500 hp and over	56	2,319.5	127	4,261.5
Used (all types)	1,471	3,618.0	2,750	5,933.5
PARTS AND COMPONENTS (of aircraft except engines)		38,612.6		82,946.3
TOTAL VALUE		84,590.1		$175,522.7

Source: Bureau of the Census, Report FT 410 "United States Exports of Domestic and Foreign Merchandise, Commodity by Country of Destination," calendar year 1947, monthly reports January-May 1948.

U. S. AIRPORTS ON MARCH 1, 1948
(Data covers existing airports recorded with CAA)

State	Type of Operation					
	TOTAL	*Commercial*	*Municipal*	*CAA Intermediate*	*Military*[a]	*All Others*[b]
TOTAL	**5,904**	**2,937**	**1,838**	**171**	**451**	**507**
Ala.	98	44	29	2	17	6
Ariz.	163	38	30	6	48	41
Ark.	87	48	25	1	1	12
Calif.	427	202	115	10	54	46
Colo.	104	34	42	2	8	18
Conn.	33	23	10	0	0	0
Del.	21	16	2	0	1	2
D. C.	3	0	0	0	2	1
Fla.	195	47	80	3	59	6
Ga.	134	49	47	4	13	21
Idaho	109	16	53	4	2	34
Ill.	168	124	26	4	5	9
Ind.	168	124	29	2	7	6
Iowa	163	107	45	4	1	6
Kansas	194	85	71	3	22	13
Ky.	64	48	9	2	3	2
La.	92	28	27	4	8	25
Maine	74	43	23	0	3	5
Md.	53	31	5	0	7	10
Mass.	78	51	21	0	4	2
Mich.	229	111	107	0	5	6
Minn.	118	56	61	0	0	1
Miss.	100	43	38	4	5	10
Mo.	129	81	33	5	7	3
Mont.	99	15	56	11	1	16
Nebr.	109	48	42	5	9	5
Nev.	54	21	15	5	5	8
N. H.	34	19	12	0	1	2
N. J.	85	63	11	0	5	6
N. Mex.	110	38	29	11	9	23
N. Y.	257	186	45	2	8	16
N. C.	152	101	31	1	14	5
N. Dak.	69	28	35	6	0	0
Ohio	198	149	35	6	4	4
Okla.	161	72	76	2	5	6
Ore.	111	41	43	5	1	21
Pa.	218	167	40	3	5	3
R. I.	11	7	2	0	2	0
S. C.	72	23	35	2	6	6
S. Dak.	67	26	38	1	1	1
Tenn.	72	37	22	6	3	4
Texas	487	193	144	21	58	71
Utah	47	7	26	9	3	2
Vt.	17	9	8	0	0	0
Va.	113	71	20	3	14	5

(*Continued on following page*)

U. S. AIRPORTS ON MARCH 1 (*Continued*)

State	*Type of Operation*					
	TOTAL	*Commercial*	*Municipal*	*CAA Intermediate*	*Military*[a]	*All Others*[b]
Wash.	139	56	56	3	13	11
W. Va.	55	36	14	2	0	3
Wisc.	109	61	45	2	1	0
Wyo.	54	14	30	5	1	4

[a] Indicates Army, Navy, Army-operated and Navy-operated (latter two are municipal or commercial airports taken over by Army or Navy).

[b] Includes private and miscellaneous Government airports.

Source: CAA Journal, April 15, 1948.

AIRPORT AND LANDING FIELDS
1927-1947

Calendar year	TOTAL	*Commercial*	*Municipal*	*CAA Intermediate*	*All others*	*Lighted total*
1927	1,036	263	240	134	399[a]	N.A.
1928	1,364	365	368	210	421[a]	N.A.
1929	1,550	495	453	285	317[a]	N.A.
1930	1,782	564	550	354	314[a]	640
1931	2,093	829	780	404	80	680
1932	2,117	869	777	352	119	701
1933	2,188	938	827	265	158	626
1934	2,297	872	980	259	186	664
1935	2,368	822	1,041	291	214	698
1936	2,342	774	1,037	296	235	705
1937	2,299	727	1,053	283	236	720
1938	2,374	760	1,092	267	255	719
1939	2,280	801	963	266	250	735
1940	2,331	860	1,031	289	151	776
1941	2,484	930	1,086	283	185	662
1942	2,809	1,069	1,129	273	338	700
1943	2,769	801	914	240	814	859
1944	3,427	1,027	1,067	229	1,104	964
1945	4,026	1,509	1,220	216	1,081	1,007
1946	4,490	1,929	1,424	201	936	1,019
1947	5,759	2,849	1,818	178	914	1,447

N.A. Not available.

[a] Includes auxiliary marked fields, later classified as to ownership, commercial or municipal.

Source: Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1948.

SURVIVAL IN THE AIR AGE

A Report by the President's Air Policy Commission

Washington • January 1, 1948

LETTER OF TRANSMITTAL

DECEMBER 30, 1947.

DEAR MR. PRESIDENT: We have the honor to transmit the report on national aviation policy as directed by your letter of July 18, 1947, establishing the undersigned Air Policy Commission.

During the 5-month period since the appointment of the Commission we have consulted on all phases of aviation with the best-qualified Government and private sources. The members of the Commission are in unanimous agreement on the conclusions expressed.

Respectfully,

THOMAS K. FINLETTER, *Chairman.*

GEORGE P. BAKER, *Vice Chairman.*

PALMER HOYT, *Member.*

JOHN A. MCCONE, *Member.*

ARTHUR D. WHITESIDE, *Member.*

PRESIDENT'S LETTER APPOINTING THE COMMISSION

JULY 18, 1947.

DEAR MR. ———————: The rapid development of aviation in recent years has made many of our former concepts out of date. At the same time, there exists a danger that our national security may be jeopardized and our economic welfare diminished through a lowered aircraft production and a failure of the aircraft industry to keep abreast of modern methods, with consequent retarding of the development of air transportation. There is an urgent need at this time for an evaluation of the course which the United States should follow in order to obtain, for itself and the world, the greatest possible benefits from aviation.

It is for these reasons that, upon the recommendation of the Secretaries of State, War, Navy, and Commerce and of the Air Coordinating Committee, I am creating a temporary Air Policy Commission to make an objective inquiry into national aviation policies and problems, and to assist me in formulating an integrated national aviation policy. Because of your knowledge of our national needs and our industrial capabilities, as well as your public-spirited concern for the national welfare, I ask you to serve on this Commission.

The Air Policy Commission should study, among other pertinent aspects of the problem, such questions as the current and future needs of American aviation, including commercial air transportation and the utilization of aircraft by the armed services; the nature, type, and extent of aircraft and air transportation industries that are desirable or essential to our national security and welfare; methods of encouraging needed developments in the aviation and air transportation industry; and improved organization and procedures of the Government that will assist it in handling aviation matters efficiently and in the public interest.

The final recommendations of the Commission must, however, go beyond the limits of any one phase of aviation. They should be so broad in scope and purpose that they will assist in revising old policies and in framing new ones, and will serve as a guide for formulating a carefully considered national air policy.

Because of the urgency of the problem, I request the Commission to complete its studies in time to submit its final recommendations to me by January 1, 1948. In its work, the Commission will have the full cooperation of all agencies of the Government, including the Air Coordinating Committee, which has been making detailed studies of aviation policies and problems.

Although the Commission will organize its own regular staff and secretariat, the Secretary of Commerce will provide any special staff assistance which may be needed, as well as office headquarters and routine administrative services.

Sincerely yours,

HARRY S. TRUMAN.

CONTENTS

LIST OF WITNESSES HEARD BY THE PRESIDENT'S AIR POLICY COMMISSION IN FORMAL PUBLIC AND EXECUTIVE SESSIONS

Aiken, Paul—Second Assistant Postmaster General.

Aitchison, Clyde—Chairman, Interstate Commerce Commission.

Akerman, John D.—Professor of Engineering, University of Minnesota.

Alison, John R.—Assistant Secretary of Commerce for Aeronautics.

Allen, C. B.—Washington correspondent, New York Herald Tribune (formerly member, Air Safety Board).

Allen, William M.—President, Boeing Aircraft Co.

Anderson, William L.—National Association of State Aviation Officials.

Appleby, Paul—Dean, Maxwell School, Syracuse University.

Baldwin, Hanson—The New York Times.

Balfour, Maxwell W.—Aeronautical Training Society.

Bassett, Preston R.—President, Sperry Gyroscope Co., Inc.

Batchelor, James W.—Aviation Attorney, United Pilots and Mechanics Association.

Behncke, David—President, Airline Pilots Association.

Bell, Lawrence D.—President, Bell Aircraft Corp.

Berle, Adolph—Columbia University (formerly Assistant Secretary of State).

Berliner, Henry A.—Chairman of the Board, Engineering and Research Corporation of America.

Bertrandias, Victor C.—Vice President, Douglas Aircraft.

Betts, Alan—Consultant, Aircraft Industries Association.

Branch, Harllee—Member, Civil Aeronautics Board.

Braniff, T. E.—President, Braniff Airways.

Brent, J. L.—President, Pacific Overseas Airlines.

Brophy, Gerald—Aviation Attorney, Chadbourne, Wallace, Parke & Whiteside.

Brown, John Nicholas—Assistant Secretary of the Navy for Air.

Brownell, George A.—Davis, Polk, Wardwell, Sunderland and Krenal.

Brownlow, Louis—Public Administration Clearing House.

Buckley, Charles B.—Manager, Aircraft Division of Weber Showcase & Fixture Co.

Buckley, James—Director of Airport Development, New York Port Authority.

Burden, William A. M.—Former Assistant Secretary of Commerce for Aeronautics.

Burgess, Robert S.—Deputy Second Assistant Postmaster General, Air Postal Transport, Post Office Department.

Bush, Dr. Vannevar—Chairman, Research and Development Board.

Callery, Francis—Victor Emanuel & Co.

Clevering, Richard B.—Allison Divison, General Motors Corp.

Cohu, LaMotte—President, Transcontinental & Western Airlines, Inc.

Compton, Dr. Karl T.—President, Massachusetts Institute of Technology.

Coy, Wayne—Vice President, Radio Station WINX and WINX-FM.

Damon, Ralph—President, American Airlines, Inc.

Darr, Harold S.—President, Monarch Airlines.

Davison, General F. Trubee—Former Assistant Secretary of War for Air; Director, Museum of National History.

de Florez, Dr. Luis—Independent Consultant, Doubleday Publishing Co.

de Seversky, Major Alexander—Aviation Author.

Dean, Allen—President, Air Freight Forwarder Association (since dissolved).

Dinu, Madeline C.—National Association of State Aviation Officials.

Douglas, Donald—President, Douglas Aircraft Corp.

Dryden, Hugh L.—Director of Research, National Advisory Committee for Aeronautics.

Dyer, J.—President, Florida Airways.

Echols, Maj. Gen. Oliver P.—President, Aircraft Industries Association of America.

Eisenhower, General Dwight D.—Chief of Staff, U. S. Army.

Emmerich, Herbert—Director, Public Administration Clearing House.

Ferguson, Malcolm P.—President, Bendix Aviation.

Flavin, Thomas A.—Judicial Officer, Department of Agriculture.

Fletcher, R. V.—Special Counsel, Association of American Railroads.

Ford, Tirey L.—Chairman, Sea-Air Committee.

Forrestal, James—Secretary of National Defense.

Foster, William C.—Under Secretary of Commerce.

Garside, Joseph—President, E. W. Wiggins Airways, Inc.; Chairman, Council of Local Airlines.

Gates, Artemus—Formerly Assistant Secretary of the Navy for Air.

Gillen, John J.—Deputy Assistant Postmaster General, International Postal Transport, Post Office Department.

Glacy, G. F.—Comptroller, Boston & Maine Railroad.

Glass, Fred M.—President, Air Cargo, Inc.

Gross, Robert E.—President, Lockheed Aircraft Corp.

Gurley, F. G.—President, The Atchison, Topeka & Santa Fe Railway Co.

Hardin, Col. Thomas O.—Air Transport Command (formerly Chairman, Air Safety Board).

Harriman, W. Averell—Secretary of Commerce.

Hartranft, J. B.—President, Aircraft Owners and Pilots Association.

Hazen, R. M.—Director of Engineering, Allison Division of General Motors.

Hensel, H. Struve—Counsel, The Air Freight Association (formerly Assistant Secretary of the Navy for Air).

Hicks, Gwin—Vice President, Empire Airlines.

Hinckley, Robert H.—American Broadcasting Co.

Hoffman, Clifford—National Flying Farmers Association.

Horner, H. M.—President, United Aircraft Corp.

Howard, Beverly—President, Hawthorne Flying Service; President, National Aviation Trades Association.

Hunsaker, Jerome C.—Chairman, National Advisory Committee for Aeronautics.

Hunt, Ralph V.—Vice President, Douglas Aircraft Co.

James, R. B.—Attorney, Chicago, Burlington & Quincy Railroad.

Kennan, George F.—Director, Policy Planning Staff, Department of State.

Kindelberger, J. H.—President, North American Aviation.

Klak, John J.—General Counsel, Independent Air Carriers Conference.

Kline, Robert E.—Counsel, Sea-Air Committee.

Kuter, Maj. Gen. Laurence S.—United States Representative, International Civil Aviation Organization.

Laddon, I. M.—Executive Vice President, Consolidated-Vultee Aircraft.

Land, Vice Adm. Emory S., U. S. N. (Ret.)—President, Air Transport Association of America.

Landis, James M.—Chairman, Civil Aeronautics Board.

Law, Hervey—General Superintendent of Airports, New York Port Authority.

Lee, Josh—Member, Civil Aeronautics Board.

Lewis, William C.—Director, Air Reserve Association of the United States.

Litchfield, Paul W.—Chairman of the Board, Goodyear Tire & Rubber Co.

Lombard, Dr. Albert E.—Consolidated-Vultee Aircraft.

Lovett, Robert—Under Secretary of State.

McDonald, David J.—Secretary-Treasurer, United Steel Workers of America.

Mahoney, E. J.—Director, International Postal Transport, Post Office Department.

Marshall, George C.—Secretary of State.

Martin, Glenn L.—President, Glenn L. Martin Co.

Martin, Roy—Under Second Assistant Postmaster General.

Merriam, Lewis—Vice President, The Brookings Institution.

Merritt, K. N.—Vice President, Railway Express Agency.

Mooney, James—President, Willys-Overland Motors, Inc.

Moseley, C. C.—Cal Aero Technical Institute.

Munro, C. Bedell—Former President, Capital Airlines, Inc.

Munter, Herbert—Vice President, West Coast Airlines.

Murray, Roger—Vice President, Bankers Trust Co.

Nelson, Donald—President, Society of Motion Picture Producers of America (formerly Chairman, War Production Board).

Nimitz, Fleet Admiral Chester W., U. S. N.

Northrop, John K.—President, Northrop Aircraft, Inc.

Norton, Garrison—Assistant Secretary of State; Chairman, Air Coordinating Committee.

Patterson, Robert—Patterson, Belknap and Webb (formerly Secretary of War).

Patterson, W. A.—President, United Air Lines.

Peale, Mundy I.—President, Republic Aircraft Corp.

Phillips, Mallory—Director, Domestic Air Postal Transport, Post Office Department.

Piasecki, Frank N.—President, Piasecki Helicopter Co.

Pogue, L. Welch—Chairman of the Board, National Aeronautics Association.

Pois, Joseph—Assistant to the President, Signode Steel Strapping Co.

Putnam, Carleton—President, Chicago and Southern Airlines.

Ray, James C.—Vice President, Southwest Airways.

Raymond, A. E.—Vice President-Engineering, Douglas Aircraft Corp.

Rentzel, D. W.—President, Aeronautical Radio, Inc.

Richardson, Rear Admiral L. B., U. S. N. (Ret.)—Vice President, Curtiss-Wright Corp., Airplane Division.

Rickenbacker, E. V.—President, Eastern Airlines, Inc.

Robinson, R. G.—Assistant Director of Research, National Advisory Committee for Aeronautics.

Roig, Harold J.—President, Pan American Grace Airways.

Rosendahl, Rear Admiral C. E., U. S. N. (Ret.).

Rosenheim, Howard H.—International Register Co.

Royall, Kenneth—Secretary of the Army.

Schildhauer, C. H.—Captain, U. S. N. (Ret.); U. S. Flying Boats, Inc.

Schroeder, Lester—National Association of State Aviation Officials.

Sikorsky, Igor I.—Director of Engineering, Sikorsky Division of United Aircraft.

Slater, John—Chairman of the Board, American Overseas Airlines, Inc.

Slick, Earl F.—President, The Air Freight Association.

Smith, C. R.—Chairman of the Board and Chief Executive Officer, American Airlines, Inc.

Smith, William W.—Chairman, Maritime Commission.

Snyder, George W., Jr.—President, Challenger Airlines.

Solomon, S. J.—President, Atlantic Airlines.

Spaatz, General Carl—Chief of Staff, U. S. Army Air Force.

Stunkel, Regan C.—President, Aviation Maintenance Corp.

Sullivan, John Dwight—Secretary, National Air Council.

Sullivan, John L.—Secretary of the Navy.

Swirbul, Yeon A.—President, Grumman Aircraft Corp.

Symington, W. Stuart—Secretary of the Air Force.
Tibbets, Kenneth W.—President, National Credit Corp.
Trippe, Juan T.—President, Pan American Airways System.
Van Zandt, Parker—Aviation Consultant.
Victory, John F.—Executive Secretary, National Advisory Committee for Aeronautics.
Wallace, Dwane L.—President, Cessna Aircraft Company.
Ward, J. Carlton, Jr.—President, Fairchild Engine & Airplane Corp.
Webb, James E.—Director, The Bureau of the Budget.
Webb, R. A.—General Agent, Illinois Central Railroad.
Webster, Edward M.—Commissioner, Federal Communications Commission.
Wetmore, Alexander M.—Chairman, National Air Museum.
Willis, Charles F., Jr.—President, Willis Air Service.
Wright, Burdette—Vice President, Curtiss-Wright Corp.
Wright, T. P.—Administrator, Civil Aeronautics Administration.

SECTION I

AIR POWER AND THE NATIONAL SECURITY

Foreign Policy—The United Nations, Disarmament, and Self-Defense

The letter of the President of July 18, 1947, establishing the Commission instructs it to make an "objective inquiry into national aviation policies and problems" and to assist the President in "formulating an integrated national aviation policy."

The Commission is directed to study, among other aspects of the problem, the "current and future needs of American aviation, including commercial air transportation, and the utilization of aircraft by the armed services; the nature, type, and extent of the aircraft and air transportation industries that are desirable or essential to our national security and welfare." The President states that there is a "danger that our national security may be jeopardized and our economic welfare diminished through a lowered aircraft production and a failure of the aircraft industry to keep abreast of modern methods, with consequent retarding of the development of air transportation."

We are instructed to make the broadest kind of survey. "The final recommendations of the Commission must, however, go beyond the limits of any one phase of aviation," the President's letter states. "They should be so broad in scope and purpose that they will assist in revising old policies and in framing new ones, and will serve as a guide for formulating a carefully considered national air policy."

* * * * *

The President's instructions thus require us to recommend an integrated national air policy which (1) will protect the Nation's security to the greatest extent practicable and (2) will foster its economic and social interests.

We take up first the problem of the national security.

We believe that the United States will be secure in an absolute sense only if the institution of war itself is abolished under a regime of law. There was a time when the United States could tolerate with safety a world in which war was the final way of settling disputes among nations. For even if war came the United States could be reasonably sure not only of winning it but even of keeping enemy forces away from its shores. Our geographical position, our Navy, our industrial capacity, our manpower, and the armies, navies, and air forces of nations allied or associated with us, protected us against direct attack in the two World Wars through which we have just passed. But, with the recent revolution in applied science for destruction which is still going on, these safeguards are no longer enough.

Our national security must be redefined in relation to the facts of modern war. Our security includes, as always, winning any war we may get into; but now it includes more than that. It includes not losing the first campaign of the war if the loss would mean that the country would be invaded and occupied. It includes not having our cities destroyed and our population decimated in the process of winning the first campaign. And it further includes not having our way of life, and particularly our civil liberties, taken from us in preparing for war. Our national security, when we define it in this way, can be assured only by the elimination of war itself.

World peace and the security of the United States thus are now the same thing. World peace, however, is not yet in sight. We will not be rid of war until the nations arrive at the great agreement to live together in peace and to this end give to the United Nations organization the legal and physical powers under a regime of law to keep the peace. As yet there is almost no sign that this agreement will be made within the future with which this Commission has to deal. Such an agreement would need a unanimity of peaceful purpose among the great powers which does not exist. It also would require a willingness on their part to break with the traditions of the past and to put their faith in a system of law rather than in their ability to take care of their own national selves with their own national armaments; and this apparently they are not yet ready to do.

The hope that the United Nations will be given the authority to prevent war is therefore not one on which we can base our policy of security. The United Nations has solid achievements to its credit in the work of its specialized agencies and also, to a limited extent, in the settling of political disputes. But even the most optimistic view of the record and prospects of the United Nations does not assure us that the United Nations will develop in time the necessary authority and power to prevent another great war.

Throughout this report we have limited ourselves to those matters which, if they happen when we are reliably told they will, require the United States to do something about them immediately. There is, however, one long-term policy which we believe should be mentioned.

We believe that the United Nations can never develop as a permanent instrument of universal peace except on a foundation of free communication throughout the world. Such freedom of communication must include freedom of travel, freedom of intercourse by mail, telegraph, cable, and radio, and equal availability of news and public information.

At present there are fixed and impenetrable barriers to freedom of communication. The gathering and transmission of news is subservient to the purposes of state in a large part of the world, with the result that the peoples are not able to reach judgments based on common sets of facts. There is accordingly no common compulsion to eliminate war despite the development of weapons so deadly and efficient as to shock the imagination.

We believe that the understanding necessary for permanent world peace cannot be achieved except on the basis of freedom of travel and communication, the universal availability of news, and the elimination of censorship. In the long run only an informed world can be free and only a free world can be secure.

We urge the United Nations and the United States of America to take all possible steps to enlarge and strengthen the present international network of freedom as an essential basis for world peace and national disarmament.

* * * * *

The provisions of the United Nations Charter for the reduction and regulation of armaments have not been fulfilled, and unilateral disarmament by the United States is out of the question. There are those who believe that peace can never come about by force and that the United States should show the way to peace by disarming. This is not the opinion of this Commission. We believe that it is the policy of the people of this country—and that this policy is right—that before the United States will give up any of its weapons, it will insist that there be set up a foolproof system of security which will assure it that no nation can take advantage of it in its disarmed state. And since the only foolproof system which would give this protection is one which would make war impossible under a system of world law and since the nations have not yet been able to agree to set up this system, unilateral disarmament is not now a possible policy for the United States.

For these reasons the United States must have a double-barrelled policy abroad. It must work to achieve world peace through support and development of the United Nations. At the same time it must prepare to defend itself for the possibility that war may come. Not being able to count on the creation, within the future for which it now has to prepare, of a world settlement which would give it absolute security under law, it must seek the next best thing—that is, relative security under the protection of its own arms.

Where does relative security lie in a world in which all nations are free to arm as they please and in which war is the final resort for the settlement of international disputes? Reluctantly this Commission has come to the conclusion that this relative security is to be found only in a policy of arming the United States so strongly (1) that other nations will hesitate to attack us or our vital national interests because of the violence of the counterattack they would have to face, and (2) that if we are attacked we will be able to smash the assault at the earliest possible moment. The alternative policy—of having inadequate arms in a world in which war must be reckoned with as the final solution of international differences—would be foolhardy. Nothing would be more likely to provoke aggression than the spectacle of an unarmed or inadequately armed United States. This country, therefore, if it is to have even relative security, must be ready for war. Moreover, it must be ready for modern war. It must be ready not for World War II but for a possible World War III.

To realize this double-barrelled policy will be as difficult a task as this country has ever taken on. Nothing less than a reversal of our traditional attitudes toward armaments and national sovereignty can make it succeed.

Our policy of relative security will compel us to maintain a force in being in peacetime greater than any self-governing people has ever kept. Our policy of seeking world order under law is even more difficult. If it is to be successful we will have to reverse all our notions of our sovereign independence and, equally difficult, persuade others to do likewise.

It may be that we shall not go all-out on either part of our double-purpose policy; that we shall compromise with both and achieve neither. If we do compromise in this way, we shall continue to live in a world in which war is an accepted institution and is therefore inevitable, and we shall be unprepared to defend ourselves in that war.

The Approach of the Commission to a Program of National Defense

Our report discusses in considerable detail the preparedness program which we believe is now required if we are to have the relative security to which we have referred. But before we deal with this program we will state our general approach to this matter of preparation in time of peace for the possibility of war.

1. The Commission does not subscribe to the proposition that armaments are a guarantee of peace. History does not assure us that a strong armament policy by a peacefully inclined nation is certain to frighten off aggressor governments. An authoritarian government bent on aggression may calculate that it can arm better and faster than the nations it has chosen as its victims, and that if it hits hard enough and with no warning, it can conquer. Indeed, an authoritarian government may seek war for war's sake or to divert attention from its internal troubles, even though it may not be certain that it will win.

Nevertheless, the Commission believes that a strong United States will be a force for peace. Our armaments will not guarantee that peace absolutely. But the chances of avoiding a war will be greatly increased if this country has the available force to strike back and to defeat anyone who breaks the peace, A strong United States will be welcomed by all peace-loving nations. The countries who want to live under regimes of freedom will see in our armaments not a threat but an assurance.

2. It is difficult for a representative democracy to keep up with an authori-

tarian state in an armament race in peacetime. It can, however, be done. We gained supremacy of the seas by the weight of our naval armament. We can be supreme in the air by the weight of our air power. The United States can build a Military Establishment which will keep up with any nation and be a powerful force for peace.

In our opinion this Military Establishment must be built around the air arm. Of course an adequate Navy and Ground Force must be maintained. But it is the Air Force and naval aviation on which we must mainly rely. Our military security must be based on air power.

3. Maintenance of a proper air establishment will require heavy appropriations. Not only must the equipment be of the finest quality that science can devise and money provide, but there must be enough of it, in being and ready for immediate use. Research and development must be increased. For a second-best air force, when war takes place, is almost as bad as none.

Already the payments which have to be made every year on account of past wars and current preparations for possible future wars are draining away a large part of the money and energy of the country that should be applied to better things—things that could add to the wealth of the country and the intellectual and physical well-being of its people. The taxpayer's money goes mainly for war. The Bureau of the Budget has informed us that about 80 percent of the budget for the current fiscal year ending June 30, 1948, is for payments for past wars or for our present Military Establishment. Indeed, the figures show that since 1915 about 85 percent of our total Federal budgets have been spent for war or preparation or payment for war.

And yet, as will be seen, this Commission has been compelled to report that the evidence is overwhelming that even this amount is not enough and that (1) the Federal Government should increase substantially its expenditures for the Air Force and naval aviation in the years 1948 and 1949, and (2) that expenditures may be needed in later fiscal years up to the end of 1952 substantially in excess of the 1948 and 1949 figures. The expenditures which we recommend, however, would be small in comparison with the cost of another war.

The Commission has reached its recommendations for increased military expenditures with the utmost reluctance. Every dollar spent for military establishments is a dollar to be grudged. Large military expenditures will help to keep taxes high and will drain away from the people a large part of the product of their labor. For these reasons we have not accepted military estimates without submitting them to critical analysis and we have required that all estimates meet the test of strict necessity under the broad principles as to the strategic needs of the country which are set out in this report.

On the other hand we believe that self-preservation comes ahead of economy. No concession should be made from the principle that our Military Establishment must be adequate for the defense of the country. Substantial savings within the Military Establishment are possible, and later in this report we make recommendations on this subject. But in making these savings the adequacy of our forces must not be impaired. Economies, desirable as they are, must not be made if making them would jeopardize our safety.

4. We believe that the recent unification of the services under the Secretary of Defense will result in greater efficiency in the spending of the security dollar.

The National Security Act of 1947 puts the duty squarely on the Joint Chiefs of Staff, subject to the President and the Secretary of Defense, (1) to prepare the over-all strategic and logistic plans to support the foreign policy of the United States and to protect the country, and (2) to review the major material and personnel requirements of the Services in accordance with these strategic and logistic plans.

By establishing constantly revised strategic and logistic plans and by relating expenditures strictly to these plans it should be possible to eliminate many expenses not sufficiently directly related to our strategic purposes, and consequently to have a force capable of carrying out the purposes without expenditures which would seriously strain the economy.

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The New Strategic Concept of the Defense of the United States

We have said that we believe that the defense of the United States must be based on air power. We have reached this conclusion as a result of prolonged discussions with the Armed Services and with many private citizens who have appeared before us. We believe that it is the overwhelming view of those most qualified to know that the country must have a new strategic concept for its defense and that the core of this concept is air power.

We need a much stronger air establishment than we now have. The reason for this is that we can no longer follow our traditional procedure of relying entirely on the Navy as our force in being in peacetime. Heretofore the United States has been able to make most of its preparations for war after war began. In World Wars I and II the oceans lay between us and the enemy. Protected by the Navy, and by the land, sea, and air forces of our Allies, we were able to convert our great industrial machine and our manpower for war after war had begun. No enemy action interfered with us as we got our factories going. Our army was trained in peaceful areas. Our cities were untouched. In World Wars I and II not a single enemy weapon except a few Japanese balloons and a few shells from submarines touched the United States mainland, and sabotage was but a minor nuisance.

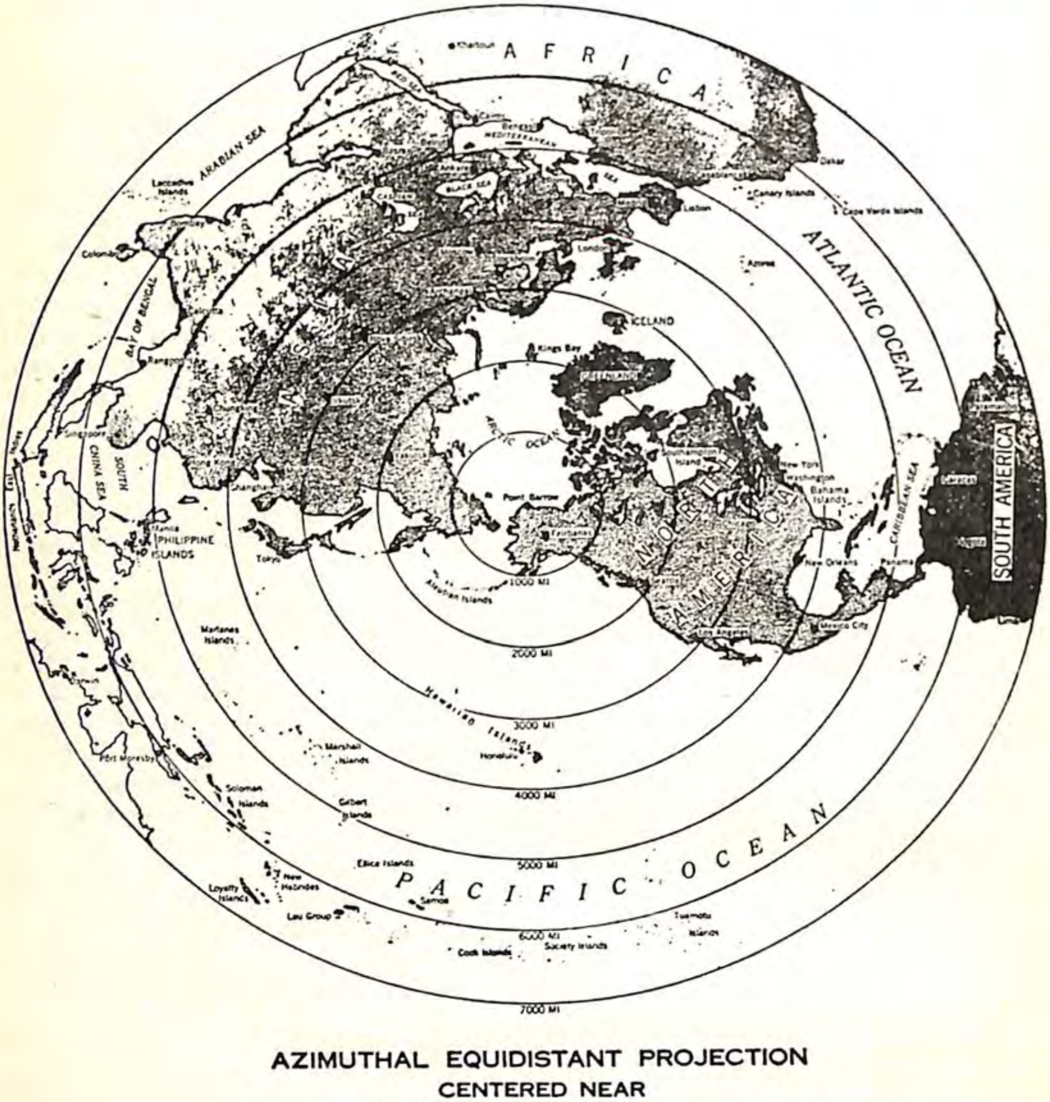
This will not be the case in a future war. Our surface fleet can have and does have a supremacy of the seas which is so nearly complete that it can guarantee the safety of our cities and our factories from surface attack by water. This supremacy should be maintained. To do so is possible in a world in which no challenging naval power exists today or can possibly exist for many years to come. The only immediate naval danger—and against this we must always be on guard—is the development of new submarine techniques on the part of a possible enemy.

But there is a new element through which this country may be attacked—the air. And the new weapons which can be delivered through the air make it vital that we protect ourselves from attack by way of this new element. An air attack could be so terrible that we must at once create the best conceivable defense against it. This means an air force in being, strong, well equipped and modern, not only capable of meeting the attack when it comes but, even more important, capable of dealing a crushing counteroffensive blow on the aggressor.

Atomic weapons will not long remain our monopoly. And there are other weapons of comparable destructiveness. Mankind has not indulged in biological warfare on a large scale so far; but the biological sciences are evolving so rapidly that it is impossible to predict the future. The nations might be foolish enough to try it out. Biological warfare might become a serious factor in another war and we must be alert to every aspect of defense against this kind of attack. And sabotage—heretofore a relatively unimportant means of warfare—is in the process of becoming a serious menace. The preplacement of atomic and biological weapons may soon become a major military problem.

This means that the traditional peacetime strategy of the United States must be changed radically. We can no longer count on having our cities and the rest of our mainland untouched in a future war. On the contrary, we must count on our homeland becoming increasingly vulnerable as the weapons increase in destructiveness and the means of delivering them are improved. And we must assume that if future aggressors will have learned anything from World Wars I and II it will be that they must never let United States industrial power get under way; they must destroy it at the outset if they are to win.

The strategy to meet these new conditions is obviously that which we have described above—to have in peacetime a force in being which will protect to the greatest extent possible our air space as well as our water approaches and hold



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out to anyone who thinks of attacking us the prospect of a counterattack of the utmost violence. The hope, of course, is that the existence of such a force will do more than win a war; the hope is that by serving notice that war with the United States would be a most unprofitable business we may persuade the nations to work for peace instead of war.

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Let us examine the premise inherent in this new strategy that we must not only have a strong Military Establishment immediately but also must start now to build the even stronger force which will come into full maturity at some date in the near future.

To have an opinion about this we must examine some preliminary questions. When must we assume that other nations will have atomic or other comparable weapons in quantity sufficient to make a sustained attack on the United States? When will other nations have the planes and missiles to deliver such weapons against the United States homeland? How long will it take us to build up the force which we must have when we have to live in a world in which other nations have these weapons and can deliver them against us? What force do we need immdiately, even before other nations have atomic weapons and the means of delivering them?

First, as to atomic weapons. If present official estimates are right we have not yet reached the point where other nations have atomic weapons in quantity. On the other hand, according to these same estimates we must make our military plans on the assumption that they will reach this point soon. No one can forecast definitely the date, and therefore we must arrive at a time, for planning purposes, beyond which it would not be safe to assume that the United States will be immune from atomic attack. In dealing with a subject on which there is so much difference of opinion, and in which the stakes are so high, we must allow a margin of insurance for the certain error inherent in any estimate.

We emphasize the wide range of the opinions on this question. We have been told by highly qualified persons that other nations may have atomic weapons now. We have been told by equally qualified persons that they will not have them in quantity for 15 years. We cannot rely entirely, therefore, on any one opinion, no matter how expert. Our estimate is based on our composite appraisal of a large number of estimates and of the facts on which they are based. We also have had the benefit of a similiar study made by the President's Advisory Commission on Universal Training which used the estimate that other powers would have atomic weapons sometime between 1951 and 1957.

Our conclusion is that we should make our strategic plans for the defense of the United States on the following assumptions:

(1) It is impossible to know certainly when other nations will have atomic weapons, but it is proper to assume, for our present planning purposes, that other nations are not now producing such weapons in quantity. The Commission realizes the heavy responsibility of making this statement. We do it only after receiving much authoritative evidence in support of this view. We point out once more, however, the uncertainty of the whole subject and the fallibility of expert evidence in these matters. We emphasize the high importance of our continuing every effort possible to be fully informed on this subject.

(2) It is known that other nations are working diligently on the problem of atomic energy; that they have available to them some of the raw materials, the quantity naturally being indeterminate; and that they possess scientific minds capable of solving the many intricate and complex problems involved.

(3) If an effective system for reviews of the strategic situation and for the adapting of our procurement and research and development policies to our strategic needs is established, it would be safe to assume, in making our plans for the next 2 years, that possibly hostile powers will not be producing atomic weapons in substantial quantities before the end of 1952. We point out that this does not assume that such powers may not have a few atomic weapons prior to that date. We point out also that this estimate places this date more than a year and a half further into the future than the earliest date fixed by the President's Advisory Commission on Universal Training.

(4) It would be an unreasonable risk, and therefore, a reckless course, to rely on other nations not having atomic weapons in quantity by the end of 1952.

(5) It would be an unreasonable risk to assume that this country will surely

have warning of the manufacture of atomic weapons by others. It may be that we will know when other nations have succeeded in manufacturing atomic weapons. But it would not be wise to rely on this. We may learn of the existence of atomic weapons in the hands of other countries only when they are used against us.

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Biological weapons are undoubtedly being studied in all parts of the world. They differ from atomic and conventional weapons in that their most destructive effect is not on impact but by slow or epidemic spreading. That extremely violent bacteria and viruses exist is common knowledge. The problem in their military use is effective dissemination. They may be delivered by the air, or by preplacement by enemy agents. So delivered or placed they would create great damage to humans, animals, and crops. In any all-out attack on the United States the possibility that they may be used should not be overlooked. The danger from these weapons is, however, not only in time of war. They can be distributed in our cities and among our crops and herds in advance, say a year or so, of a planned attack or as part of a campaign to weaken us, without any intention of following up with a conventional military attack. Our plans to anticipate and prevent such sabotage, insofar as this can be done, must be intensified.

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In focusing our attention on the weapons of mass destruction we must not minimize the other, more conventional weapons. These are comparable in destructive power, when used in large quantity, to atomic bombs, as the cities of Germany and Japan testify. And it is certain that conventional weapons will be developed in the next few years so that their destructive power will be even greater than in World War II.

Nevertheless, it is the mass-destruction weapons which now exist and almost surely will be developed within the next few years which radically change the strategic needs of the United States. An enemy has to have air superiority, a great industrial production and a very large fleet of aircraft if it is to overwhelm a country by using conventional weapons only. But an enemy can inflict enormous damage with the mass-destruction weapons even if he does not have air superiority. The possession by an enemy of these weapons, in quantity, changes all the rules and requires a different strategy by a nation which may be attacked.

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The possession by a possible enemy of the mass-destruction weapons is, of course, not all that he must have before he attacks the United States. He must also be able to deliver these weapons against us. He must have the planes and missiles capable of making a sustained assault on our mainland.

At the moment no possible enemy could make such an assault. The United States has control of the surface area of the Atlantic and Pacific Oceans and therefore is not subject to surface attack by water. The only attacks of importance which could now be made on the United States mainland would be by air, by the preplacement of weapons by enemy agents, or by attack from submarines. We do not believe that such attacks now, equipped as they would be (we may assume) only with nonatomic weapons, could destroy our ability to retaliate and to gear ourselves up for an all-out counterattack on the enemy.

No other nation now has or is likely to have in the immediate future the piloted aircraft capable of getting air supremacy over the United States mainland. There are now in existence bombing planes (and other nations have them) capable of one-way raids from bases 4,000 miles away. And one-way raids must be reckoned with—as the Japanese suicide attacks show. These bombing planes are, however, relatively slow compared with the supersonic planes of the future. They are therefore subject to interception by the faster moving jet fighters, and in other ways. But they will not be intercepted except by an alert and ready force in being; and even then experience shows that the technique of interception takes a considerable time before it gets under way. The first attacks would show a much lower rate of interception than the later attacks.

An attack on the United States by piloted aircraft in the immediate future would not therefore give an enemy air superiority over our mainland; although it could inflict a serious damage on our industry and our cities before our defenses could be developed. But without such air supremacy and without atomic weapons, it is not likely that an enemy could so disrupt our country that we would be unable to repeat the formula of World Wars I and II and build up our war industry and our Army, Navy, and Air Force after war had begun.

Nor is it possible for an enemy now to deliver an assault on the United States mainland with guided missiles which would be so serious as to prevent our preparing to win after the fighting started. By the term "guided missiles" we mean any uninhabited airplane of the conventional kind or any winged or unwinged projectile which is guided in its flight. At one extreme of guided missiles is the superatmospheric, supersonic missile (an improved German V-2) which balances itself by internal mechanisms and is guided by various internal and external devices. At the other extreme is an airplane of the conventional type loaded with bombs and directed electronically toward its target (the recent trans-Atlantic C-54 flight is an example). The guided winged missile moving through the atmosphere at subsonic speeds (of which the German buzz bomb was an early type with short range) is merely a specially designed uninhabited airplane.

Guided missiles of the German V-2 type travelling at supersonic speeds are now impossible to intercept; they are, however, as yet of relatively short range. Guided missiles of the subsonic type also are still of limited range. The problem of guidance, which is the obstacle to range, has not yet been solved.

Neither of these two means of delivery—the piloted aircraft or the guided missile—is a vital threat to this country in its present form. Nor is the only remaining possible method of delivery, sabotage—that is the preplacement of weapons by enemy agents in this country—a vital threat at this time. The Commission has been concerned about the possibility of the preplacement of certain of the mass destruction weapons—such as disease weapons located in city reservoirs, and there is no doubt that this form of sabotage is a possibility and could create serious damage. But if we are alert a sabotage campaign would probably not disrupt the country; and this is the point we are presently considering. The United States, in the opinion of this Commission, could now undergo the ordeal of an attack delivered by the presently available piloted or unpiloted aircraft and by sabotage, and under the heavy handicaps which such an attack could create, still be able to follow our traditional course of building up our war machine after war has begun.

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So far we have spoken only of the means of delivery as they now are. The current scientific revolution is however working on the means of delivery at the same time as it is working to make the weapons to be delivered more destructive. There is a race between the two. When either reaches its next stage of development, the threat to the United States will be great.

If other nations develop the means of direct assault on the United States by supersonic piloted aircraft, the threat to this country will be serious, even though these vehicles are not equipped with atomic or comparable weapons. Similarly, if other nations develop atomic weapons in quantity, or some other weapon of comparable destructiveness, the threat to this country will be great even though these nations have only the present means of delivery at their disposition. The addition of supersonic transpolar or transoceanic guided missiles would intensify the damage that could be done by an atomic attack. Should all these developments exist at the same time, the situation would be very grave indeed.

When will these things happen? If they are so remote that there is nothing we should do in relation to them now, they are not within the terms of reference of this Commission.

We see nothing in the present situation to justify fear that the development of supersonic transpolar or transoceanic piloted aircraft or guided missiles by any possible enemy will threaten our air supremacy and our homeland within the immediate future. Evidence has been given before this Commission that such supersonic aircraft will not be developed into the mass-production stage for several years and that long-range supersonic missiles will not be available in operational form for from 10 to 25 years. Evidence has also been given before this Commission that subsonic guided missiles with a 5,000-mile range and capable of being directed toward a sizable target such as a city can be developed into the mass-production stage within 5 years; but these subsonic missiles would be subject to a high rate of interception. All these estimates—both as to the supersonic aircraft and guided missiles and as to subsonic guided missiles—are at best informed guesses. This is a fast-moving branch of science, and any estimate may be upset by some unforeseen development or by some unforeseen obstacle. The estimates of the best scientists must not be accepted as laying down an accurate timetable.

The conclusions which the Commission has reached as to the development by other nations of the means of delivering a direct attack on the United States by transpolar or transoceanic aircraft or missiles are these: (1) It is probable that other nations will develop atomic weapons before they develop supersonic bombers in quantity with a striking range of 5,000 miles, or supersonic, accurate, guided missiles with a 5,000-mile range. (2) Nevertheless, it would be unwise to assume, in the planning of our defense establishment, that other nations will not have the planes and missiles capable of delivering a sustained attack on the United States mainland by the same date we have assumed they may have atomic weapons in quantity—namely, by the end of 1952. If they want them enough they can surely have them at some date; just when will be determined by the amount of effort they put into getting them. (3) It is not certain that the United States will be the first to develop such aircraft or missiles. On the contrary, the Germans were ahead of us in these matters at the war's end and other nations may well be even with or ahead of us now. (4) The United States must press most energetically and immediately its basic and applied research and development programs in aerodynamics, power plants, electronics, and related fields with a view toward the development at the earliest possible date of the most effective piloted aircraft and guided missiles and the defenses against them.

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The conclusions of the Commission thus fix as the target date by which we should have an air arm in being capable of dealing with a possible atomic attack on this country at January 1, 1953. For convenience we will refer to this date as A-day.

We believe that A-day divides the future into two clear phases for strategic purposes. The first phase is that which begins now and extends to A-day. We call this Phase I. The second phase is that which will exist on and after A-day. We call this Phase II.

The next question is whether we must begin now to build the force we must have on and after A-day. How long will it take to build this force? Do we have to start building it now?

There is no doubt about it. The force we need by the end of 1952 must possess the complicated defensive equipment of modern electronics and modern defensive fighter planes and ground defensive weapons. A radar early warning system must be part of our defense; but such a system, if designed to give complete and continuous coverage, would be extraordinarily expensive. Worse yet, it might divert us—as the Maginot Line diverted France—from the best defense against atomic attack, the counteroffensive striking force in being.

We also must have in being and ready for immediate action a counteroffensive force built around a fleet of bombers, accompanying planes, and long-range missiles which will serve notice on any nation which may think of attacking us that if it does, it will see its factories and cities destroyed and its war machine crushed. The strength of the counteroffensive force must be such that it will be able to make an aggressor pay a devastating price for attacking us. It must, if possible, be so strong that it will be able to silence the attack on the United States mainland and give us the time again to build up our industrial machine and our manpower to go on to win the war.

Such a force does not grow overnight. It takes 4 to 7 years to develop a new plane from the engineering board to production. It takes longer than that to develop many of the weapons which will be used in any future war. No airplane was used by the United States in World War II which had not been designed before we entered the war. Only improvements were made after Pearl Harbor; there was no change in fundamental design in any plane which saw war service. An air force will probably fight a war which does not last a long time with the general types of equipment it has on hand when the war begins.

The method of gradual build-up, that is, a build-up in a line or curve of progression from the force we now have to the force we must have on A-day, is the most effective and cheapest way of getting the force we need. To delay beginning the construction of this force, to hope to make a sudden jump to the A-day force in a year or so is unrealistic. An air force cannot be built that quickly. Moreover, to delay in starting the build-up would leave us without the force we need right now. We have no breathing space in which we do not need air power.

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We therefore consider the kind of air establishment we need during Phase I. What is the likelihood of war during this Phase? Can we say that during this Phase the chances of war are slight or that, if war does come, we can build up after hostilities begin and, therefore, do not need immediately a strong force?

On first impression it might seem that a major war during this Phase I is unlikely; and this opinion has been expressed to this Commission by high military authorities. The argument is persuasive. Our monopoly of the atomic bomb may make any aggression-minded nation wait until it also has the atomic bomb before it takes on the United States. Moreover, the unrepaired devastation and the fatigue from World War II is a powerful force working for a breathing period from war. There usually is such a breathing period in the unending procession of wars throughout history. Great wars usually happen after the nations have recovered from their wounds and a new generation has forgotten the horror of the previous battles.

However, we cannot be sure. The world situation is dangerous, and our foreign policy is not running away from the danger. This is not to criticize our foreign policy. A nation in the position in which the United States finds itself today has no choice but to follow policies which may lead to friction with other nations.

There is, moreover, such a thing as blundering into a war. World Wars I and II were planned by Germany and happened more or less when the Germans planned them. A persuasive case can be made that great wars are wars of aggression which take place when the aggressor wants them to. Sometimes, though, events get out of hand and war happens when neither side wants it. The present may be such a time. Unless the incompatibility of East and West can be overcome and the energy of the world turned toward the building of peace rather than toward preparing for destruction, a war may break out which neither side wants.

We must therefore be prepared for war during this Phase I. Moreover, we must not think that the atom bomb alone will win a war. If we get into war during

Phase I we cannot drop atomic bombs and sit back. What we need during this Phase is an integrated Military Establishment, (1) capable of an atomic attack, (2) stronger in air power than that of any other country, and (3) capable of a sustained and powerful air counteroffensive, either directly or by the way of intermediate bases.

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What is the kind of force which we need during Phase II? We have reviewed this question carefully with the services.

The strategy for Phase II is determined largely by the kind of attack which is likely to be made if war occurs during that phase. The attack which we must anticipate determines the kind of force which will be needed to meet it. The first thing to consider therefore is the nature of the assault which could be made by an enemy equipped with atomic or comparable weapons, and possessing the aircraft and missiles capable of delivering them against the United States mainland. As to this, our conclusions are as follows:

1. We must assume, in making our plans, that there will be a direct attack on the United States mainland in any major war in which the United States will become engaged on and after January 1, 1953. It may be that the war will not open with this direct assault. It may be that the fighting will start at some point in the world where our forces will come in contact with those of other nations. It may be that the fighting will be localized at that point, on the model of the practice war between Germany and Russia in the Spanish Civil War. But this is not likely; and certainly we must not count on it. We must assume, in making our plans, that if the enemy can do it he will make a direct air assault on the United States mainland regardless how or where the first shooting starts.

2. It must be assumed that there may be no warning of attack. We must assume that the force we will bring into being by the end of 1952 will be the force which will have to handle the attack. We will get no further warning than that which we already have.

3. An attack by an enemy equipped with atomic weapons would be of a violence which is difficult for us to imagine. The first bombardment assault by an enemy equipped with mass destruction weapons would probably have as its objective the destruction of our capacity for resistance and counterattack. No one who appeared before us has suggested that we could turn back completely such an attack. Indeed, if we were not fully prepared, a mass destruction attack might be followed by invasion by air-borne land troops for the purpose of taking advantage of the first confusion to seize strategic points in the United States and to destroy utterly the country's resistance. It might be that the attack would be less ambitious if the enemy again made the mistake of allowing us time to gear up our industrial capacity and our manpower. But in preparing our defenses and our counter measures we must anticipate the most violent assault of which the enemy is capable. We must not rely on his making major errors of strategy.

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It is apparent that the Air Establishment which we need is substantially different for the two phases. During Phase I we may assume that we will be free from an attack which would prevent our building up for war after war begins. But an attack during Phase II might be such as to cripple at the very outset our capacity to resist and to build up after hostilities start. For this reason, the force which is needed on and after the beginning of Phase II must be a force of considerably more power than during Phase I.

In neither phase can we have in being a counteroffensive force capable of winning the war outright in the first counterblow. We cannot support in peace a force capable of dominating the enemy's mainland. That would require a nation in arms—a nation as dedicated to war as the United States was at the peak of World War II. What we must have and can support is a reasonably strong defensive establishment to minimize the enemy's blow, but above all a counter-offensive air force in being which will be so powerful that if an aggressor does attack, we will be able to retaliate with the utmost violence and to seize and hold the advanced positions from which we can divert the destruction from our homeland to his.

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We now consider the recommendations of the armed services as to the air establishment which is needed during Phase I and Phase II.

The Requirements of the Air Establishment—Recommendations of the Commission

The Air Force

We have received from representatives of the Air Force and the Navy exhaustive presentations of the war missions to be carried out by each of the services for the conduct of their missions. We have analyzed these strategic plans and requirements and have reached the following conclusions:

The Air Force as presently composed is inadequate. It is inadequate not only at the present time when we are relatively free of the dangers of sustained attack on our homeland, but is hopelessly wanting in respect of the future Phase II when a serious danger of atomic attack will exist.

The present Air Force consists of 337,000 uniformed and about 125,000 civilian personnel. It is equipped with a total of 10,800 aircraft in active status, including about 580 heavy bombers and 2,300 fighters. Backing up this force is a reserve of about 12,800 World War II aircraft usable at any time during the next 2 or 3 years to replace losses of planes due to current peacetime attrition or, in the event of war, caused by combat losses.

Our present Air Force is divided into 55 groups. Each group is trained for specific missions such as strategic bombing, tactical reconnaissance, fighter escort, interception, and troop carrier and transport.

From evidence received from the Secretary of the Air Force, its Chief of Staff, and many of its ranking generals as well as informed authorities outside of the military establishment, we conclude that the 55-group force, if engaged in action in this present Phase I, could not carry out the missions assigned to it because it is lacking in the essential air units for effective combat action. It would be even less capable of carrying out the missions which would face it in Phase II conditions. Even more alarming is the statement by the Air Force that the funds presently available will not permit the maintenance of the present inadequate Air Force and that if appropriations are not increased the establishment must be cut back to approximately 40 groups with reductions starting in July 1948.

None of this must be permitted. There is a minimum force in being below which we must not go if we are to protect our country and its vital interests.

We have concluded that the minimum force necessary at the present time is an Air Force composed of 12,400 modern planes, organized into 70 combat groups, and 22 special squadrons, supplemented by 27 National Guard groups and 34 groups of Air Reserve. All these forces, with the exception of the Air Reserve, must be equipped, trained, and ready for immediate action in the event of war. We should build to this force as rapidly as possible and once it is achieved, never permit it to drop below this level. Nor should we permit it to become impotent and ineffective because of failure to keep it modernized with the very best planes and equipment available.

At first we seriously questioned the need of an Air Force of these proportions because it was obvious that building it and supporting it would involve a substantial increase in expenditures. However, as we studied the strategic and tactical needs of the Air Force we came to the conclusion that:

(1) The 70 groups would include the very minimum number of interceptor fighters necessary for our home defenses; and their effectiveness would be almost entirely dependent upon having a satisfactory radar early-warning system and adequate ground and air defensive missiles. We emphasize again, however, that no plans for defense should be made in derogation of the striking counter offensive air arm in being.

(2) The 70 groups would provide only 700 very heavy bombers for the strategic bombing of enemy targets. This force of bombers seems minute as compared with the 14,000 bombers of the United States Air Force and the Royal Air Force committed to combat in the European theater during the war. Only by using the very best equipment and the latest techniques will so small a force be able to carry an effective war to the enemy.

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Once committed to combat, losses of planes and personnel are very high. From experience in the European and Pacific theaters, we know that many operating groups lose 25 percent of their equipment every month of actual combat. Losses must be replaced immediately. At the outbreak of a war, industry cannot expand in time to make up combat losses in the first year. Unless, therefore, there are planes in reserve, combat forces would diminish rapidly after the beginning of hostilities and we would be left without a fighting Air Force after a few months of war.

The solution of this problem is one of the most serious tasks faced by the Air Force and the aircraft industry. Plans for the rapid expansion of industry will help, but no evidence presented to us indicates that any plan can be devised which will insure the production of planes by industry in time to replace combat losses in the first year of a war. Moreover there is the grave danger that enemy attack may so disrupt our industrial production that all forecasts of plane manufacture after war begins will prove to be unrealistic. Therefore, a reserve of aircraft in storage must always be maintained. This reserve is expensive to procure and costly to keep modernized. Planes in storage become obsolescent and must be replaced.

At the present time, we are reasonably well off because World War II surplus planes are still usable. Fortunately the Air Force retained a substantial number of planes as a reserve and sold or otherwise disposed of only those planes considered unusable. This reserve is gradually being used up. It must be replenished before the end of 1952. Estimates by the Air Force show that 8,100 new planes must be procured for this reserve between January 1, 1950, and January 1, 1953. The 8,100 figure for reserve planes is reached by establishing the deficiency between losses, computed on the basis of past experience, and replacement forecast under a theoretical mobilization plan. Since both losses and replacements are estimates, later studies may cause a revision in the recommended 8,100 plane reserve.

In summary, the problems of the Air Force are threefold: (1) The force in being must be increased from its present level to a minimum regular establishment of 70 groups (6,869 front line aircraft), an Air National Guard of 27 groups (3,212 front line aircraft) and an adequately equipped 34 group Air Reserve. (2) The level of procurement of new aircraft must be high enough to keep this force modern at all times. And (3) an adequate reserve, now estimated at 8,100 aircraft, must be created and maintained in a proper state of modernization.

We must start now on such a program and complete it before the end of 1952.

The Navy Air Arm

We also have examined and analyzed the requirements of the Navy and its plans for the performance of its war missions both now and in the future. In one important regard the role of the Navy will differ in the future from that of the past. It will not be called upon to engage an enemy surface Navy since none exists and it is questionable whether any will be built by a foreign power within the next decade. This changed condition alters the mission of the Navy and the type of equipment it must use in the future, but it does not eliminate the need for a Navy.

In case of war the Air Force and the Ground Forces now could not operate effectively from the continental United States in a sustained attack against distant enemy centers. Rather they would have to occupy and conduct their offensive action from advanced bases strategically located and sufficiently close to the enemy's homeland. In addition they would have to prevent the enemy from occupying bases from which to conduct offensive operations against us. Only in this way could we carry the war to the enemy during Phase I. If we were to try to operate from our homeland without seizing advanced bases the enemy would carry the war to us, and our cities and people would suffer as England and Germany and Japan did in World War II.

Furthermore, it must be recognized that while the means of waging transoceanic warfare will some day certainly be perfected, the long-range aircraft and guided missiles needed for sustained operations are not yet here, and until they are transoceanic warfare will be limited to the occasional rather than the continuous effort.

The task of securing advanced bases rests on all three services, with the Navy having a large share of the responsibility for establishing the troops and air forces on shore. Until the shore based establishment can become effective, carrier aviation must be relied upon. The problem of keeping open the supply lines to these bases through submarine-infested waters also is one of the important missions of the Navy. Moreover, this country, rich as it is in natural resources, is dependent on many distant sources of essential raw materials without which our ability to produce in wartime and to fight would be seriously affected. Most of these materials are transported over the seas, and securing and defending these sources of supply and maintaining the vital overseas supply lines is a Navy task.

The active Navy is now organized into two fleets—the Pacific Fleet and the Atlantic Fleet. Each is composed of several carriers and its supporting ships. The new strategy of the Navy is air power. The carrier has become the major ship—the battleship now is of only secondary importance.

In order to equip properly the carriers in operation and to conduct other air activities considered the responsibility of the Navy, one of the most important of which is protection against modern submarines, the Navy requires 5,793 front-line planes, plus about 5,100 in support.

The Navy now has the planes necessary to equip its active carriers and its supporting air operations. The Navy, however, needs funds for the procurement of new replacement aircraft. Like the Air Force, the Navy wisely placed a large number of World War II planes in reserve and since VJ-day has been replacing its operational losses of active planes by withdrawals from this storage. Knowing the reserve would be of value for only a few years because planes in storage become obsolescent, the Navy has followed the commendable policy of limiting procurement of new planes and making maximum withdrawals from reserves. This policy will soon exhaust the storage planes, and therefore we must increase our rate of procurement of new planes or face the danger of seeing our great carriers tied to the docks because of lack of planes.

The Unification Act and the Joint Chiefs of Staff

The strategic plans and requirements which we have been discussing were received by us from representatives of the Air Force and the Navy. These are independent statements of each of the services and give no effect to the consolidation of functions and savings which must be made to result from the National Security Act of 1947.

It is the responsibility of the Secretary of Defense acting under the President to see to it that the Joint Chiefs of Staff prepare integrated strategic plans for the defense of the country in such a way that the plans can be carried out with the minimum of personnel and equipment and a maximum of effectiveness.

We requested the Secretary of Defense to furnish us the requirements of the Air Force and the Naval Air Establishment as they should be now and at various specified future periods. The Secretary of Defense has been unable to comply with this request. The completion of the necessary studies and the integration of the three services without which our strategic plans will not be efficient and economical will require much time. Figures, of course, can be prepared quickly but they would be little more than a verification of the independent and separate requirements of the Air Force and the naval air arm as presented to us by the respective services. The real task—which cannot be done quickly—is to consolidate and integrate the functions of our total military establishment and to increase the dollar efficiency of every segment of it.

The Joint Chiefs of Staff are carrying on their analyses of requirements and their work to create an integrated and economical peacetime force in both Phase I and Phase II. In addition, of course, they must develop the wartime requirements of our consolidated military establishment. These requirements must be worked out with two clear objectives in mind. We must have a military establishment capable of defending the country: any recommendation that comes from the Joint Chiefs of Staff should never go below this minimum requirement. And the cost of such an establishment must be built on the most economical basis possible.

The military establishment we must have will put a heavy strain on the economy of the country. The recommendations of the Joint Chiefs of Staff must require the most rigorous efficiency in operations and in the consolidation of strategic functions. The Unification Act was passed to achieve these two purposes.

Most of the witnesses who appeared before us have pointed out the need for stronger military forces, with particular emphasis on the Air Establishment. But little has been said as to the cost.

The cost of the Military Establishment as reflected in this report shows beyond any doubt the critical need of carrying out the intent of the Unification Act to the greatest extent possible and at the earliest possible moment. We believe that there is an enormous opportunity for savings, and that as these savings are effected, the forces essential for our security can be maintained in being within the safe limits of our financial resources.

But to attain these economies vested interests must be set aside, traditional divisions of appropriations must be ignored, and every unnecessary activity must be abandoned if the war of the future no longer requires them. We are concerned by the fact that a majority of the Joint Chiefs of Staff, who represent three separate Services, may find it difficult to achieve these results. A heavy responsibility rests upon the Secretary of Defense to exercise fearless and independent judgment to see to it that integration means more than a mere consolidation of the requirements of each of the individual branches of the services.

We view with great anxiety the pressures from many sides directed towards the maintenance of yesterday's establishment to fight tomorrow's war; of unwillingness to discard the old and take on the new; of a determination to advance the interest of a segment at the sacrifice of the body as a whole. All this is understandable. For it comes in large part from loyalty of each Service to its traditions.

But we can no longer afford the waste it involves. Hope rests only with the ability of the Secretary of Defense under the President to discharge effectively the authority vested in him with one objective in mind—the maximum in security for the minimum cost. It is imperative that this be done; for unless it is we will not have a military establishment capable of defending the country.

Recommendations of the Commission for Immediate Appropriations for the Air Establishment

We are informed by the Bureau of the Budget that for the current year the Military Establishment is supported by budget expenditures of $10,098,000,000 (exclusive of terminal leave, stock piling and certain miscellaneous items). Of this amount, according to Budget figures, $4,037,000,000 are for the Navy including naval air, $2,850,000,000 are for the Air Force and $3,211,000,000 for the Army. Out of the total budget of $10,098,000,000, $4,050,000,000 is for the Air Force and naval aviation (exclusive of the cost of construction and operation of carriers).

We are impressed with the need for a proper balance between the three services and have concluded that such a balance does not exist now because of the relative and absolute inadequacy of the Air Force Establishment. As we have said, the Air Force is inadequate for current conditions and is hopelessly deficient for Phase II conditions; and the Navy air arm will soon be lacking in equipment.

We make no recommendations for change in the appropriations for the Army and the surface Navy, but confine ourselves to recommendations for the maintenance of naval aviation and an immediate build up beginning January 1, 1948, of the Air Force. The appropriations which should be made for the Army and the surface Navy of the future, whether higher or lower than the present levels, should be determined by Congress after it has received from the President his recommendations as to the total integrated Military Establishment the country needs, based on analyses by the Joint Chiefs of Staff as to this integrated Military Establishment prepared by them under the direction of the Secretary of Defense.

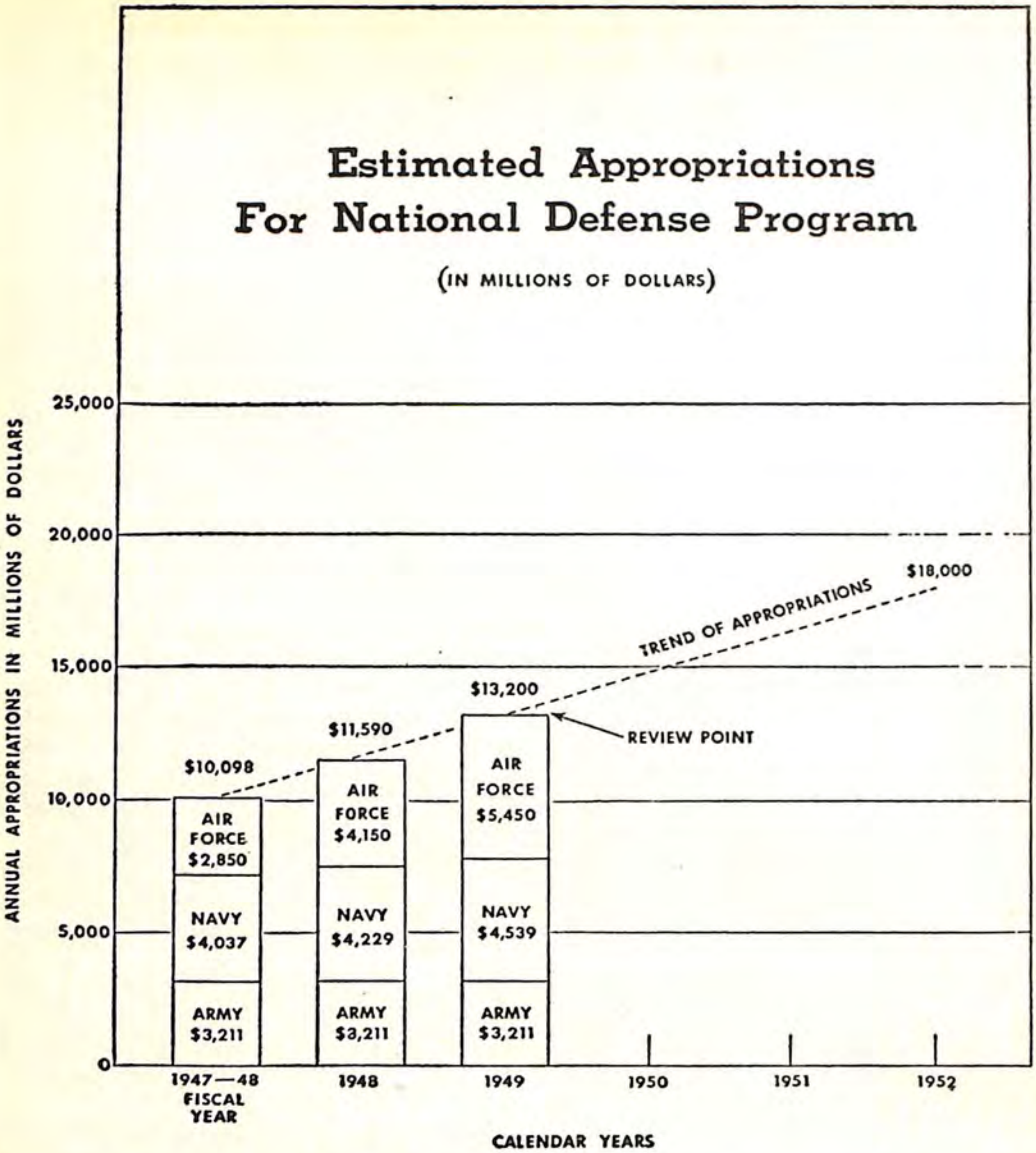
* * * * *

The increase in the Air Force must be started at once and be completed by the end of the year 1952. The 70 groups should be organized, equipped, and ready for service by January 1, 1950. An adequate reserve of planes, now estimated at 8,100, should be in being by the end of 1952. Uniformed personnel must be brought to the 401,000 figure now planned by the Air Force.

The chart shows the rate of build up of the 70 group force during the calendar years 1948 and 1949, as well as an indication of the trend of increase in the Air Force which should be made during the years 1950, 1951, and 1952 if the 70 group force plus the 8,100 plane reserve is to be in being by the end of 1952.

Our recommendations are for the calendar years 1948 and 1949 only. For the calendar year 1948 we recommend an increase in appropriations for the Air Force in the amount of $1,300,000,000 and a further increase of $1,300,000,000 for the calendar year 1949. We call especial attention to our recommendation later in this report that there be a complete review of the Military Establishment as of January 1, 1950. This review (which is marked on the chart with the words "Review Point") should control the direction of expenditures for the years 1950 and subsequently.

We recommend that, as part of the appropriations for the Air Force for 1948 and 1949, there be included $350,000,000 more for the procurement of aircraft in the calendar year 1948 than the present rate of such procurement ($550,000,000 for the current fiscal year); and that there be included for the calendar year 1949 $660,000,000 more for the procurement of aircraft than would be procured in 1948 under our recommendation. These dollar figures would require the purchase



of about 9,000,000 pounds of air frame more in 1948 than the present rate of Air Force procurement; and about 16,000,000 pounds of air frame more in 1949 than in 1948.

The building of the reserve of new planes, now estimated at 8,100, need not begin until January 1, 1950. Reserves of World War II planes in substantially adequate amounts are available for the years 1948 and 1949. We recommend however that in the calendar year 1949 there be allocated, out of the appropriation for that year, $300,000,000 of contracts to begin the build-up of the 8,100 plane reserve. These contracts, placed in 1949, would produce planes only in the years subsequent to 1949.

Because of this deferring of the build-up of the 8,100 plane reserve program, it is likely that the increase in expenditures for the Air Force in 1948 and 1949 will be less than in the third, fourth, and fifth years. The power of the Air Force will progressively increase, reaching the full 70 group strength with modernized reserves only at the end of 1952. We believe that this is the most economical way of building the Air Force we need and at the same time satisfies, within the limits of a calculated risk, the strategic requirements of the country for the present and the future with which we are dealing.

This procedure will have the added advantage of permitting a review as of January 1, 1950, of the reserve plane requirement by the Joint Chiefs of Staff and by the Commissions suggested later in this report.

Some savings through internal economies in the Air Force may be expected in 1948 and 1949. If we assume that such savings may be as much as 10 percent of the total cost of the Air Force, they would be of the order of $285,000,000, based on the expenditures for the current fiscal year. Such savings, in our opinion, should not be used to cut our recommended Air Force appropriations for 1948 and 1949 but should be converted into a like dollar amount of contracts for the building of the 8,100 plane reserve.

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The Navy must immediately increase the annual rate of contracting for the procurement of aircraft (now at the rate of $338,000,000 per year) in order to equip properly the present fleet with the modern aircraft needed as World War II reserves are exhausted. To accomplish this result contracts for new aircraft should be in the amount of $530,000,000 for the calendar year 1948 (an increase of $192,000,000 over the current rate) and $840,000,000 for the calendar year 1949 (a further increase of $310,000,000 over the 1948 figure). These dollar figures would require the purchase of about 4,000,000 pounds of air frame more in 1948 than the present rate of naval air procurement; and about 6,000,000 pounds of air frame more in 1949 than in 1948.

Any savings which may occur in the naval establishment in 1948 and 1949 should be applied to the reduction of the total naval budget, and should not affect our recommendation for the increased purchase of aircraft during these years.

We have received strong arguments that the air arm of the Navy should be increased from its present level to 8,000 first-line planes in being and 6,500 planes in support. Since any such increase would be part of a program of expansion of the Navy as a whole, we feel that a decision on this subject should be deferred until the Joint Chiefs of Staff has completed their strategic plans and their statement of integrated requirements and then should be made only if the security of the country demands the expansion of the naval establishment.

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As appears from the above chart the present budget of the Air Force is at the rate of $2,850,000,000. The recommendations of the Commission call for Air Force appropriations in the calendar year 1948 of $4,150,000,000 and for Air Force appropriations in 1949 of $5,450,000,000.

The present budget of the Navy is at the rate of $4,037,000,000. The additional procurement of aircraft (assuming that the appropriations for the rest of the naval establishment remain the same) would increase this figure to $4,229,000,000 for the calendar year 1948 and $4,539,000,000 for the calendar year 1949.

The present total military budget is at the rate of $10,098,000,000. The recommendations of the Commission would increase the total military budget for the calendar year 1948 (assuming that there are no changes in appropriations for the Army, the surface Navy, or the expenses of naval aviation other than for the purchase of aircraft) to $11,590,000,000 and would call for a total military budget in the calendar year 1949 of $13,200,000,000.

There will be, it is hoped, savings in our total Military Establishment resulting from the unification of the services under the direction of the Secretary of Defense as contemplated by the National Security Act of 1947. But we do not believe that any integration of our military operations under the National Security Act will lessen the need for the 70 group Air Force in being or for the replacement of existing naval aircraft. The likelihood of these savings should not therefore be considered as a reason for reducing the appropriations recommended in this report for the years 1948 and 1949.

The estimated trend of expenditures for the air establishment for the years 1950, 1951, and 1952, is shown in the above chart. This estimate is only an indication of the cost of the air establishment towards which we may have to build. It is likely that the reviews which we recommend later in this report will change the direction of these estimates, either increasing them or decreasing them. We believe that unless conditions change substantially for the better, the 1950 review will increase the size of the establishment rather than decrease it.

But in any case, until the world situation improves, substantial expenditures for the military establishment must be considered a fixed item in the Federal budget. It is regrettable that these expenditures have to be made, especially at a time when we must make heavy commitments for economic rehabilitation abroad. But we cannot escape the clearly demonstrated necessity for a military establishment adequate to protect the country and its vital interests.

Military and Commercial Transport Services

The Air Force and the Navy each has its own transport service which was organized in World War II. The Air Force service is the Air Transport Command (ATC); the Navy service is the Naval Air Transport Service, referred to as NATS. In addition, the Marine Corps has a combat air transport service which is occasionally used as an auxiliary to NATS. The position of NATS was recognized in the National Security Act of 1947, which states that naval aviation shall consist in part of air transport essential for naval operations.

Each of these transport services is a sizeable operation. ATC has a fleet of 366 aircraft with about 22,000 military and civilian personnel and has flown an average of about 10,000,000 ton-miles per month this year. NATS has a fleet of 84 aircraft with about 6,300 military and civilian personnel and has flown an average of about 8,000,000 ton-miles per month this year. For the fiscal year 1947 the two services together carried about the same amount of freight as all United States certificated commercial carriers combined, and about one-eighth as much passenger traffic. The cost of NATS for the fiscal year 1947 has been estimated as about $45,000,000; that of the ATC has not been estimated but it is undoubtedly much higher.

ATC now conducts regularly scheduled operations over 66,138 miles of routes; NATS over 41,918 miles. Many of these services are duplicating.

A directive has recently been issued which prevents NATS and ATC from carrying any but military traffic on routes where commercial services are available.

The purpose of the ATC and NATS services is to have in being in the event of a war a personnel and cargo lift to the rear areas of the war theaters. Service into the areas of combat is provided by the Troop Carrier Command and the Marine Transport Command. ATC and NATS take over where the Troop Carrier Command leaves off.

ATC and NATS appropriations are handled within the regular Air Force and Navy budgets.

ATC and NATS cannot handle all the personnel and cargo lift to the rear areas in case of war. They plan to take over, as they did in World War II, as much of the civilian lines, domestic and international, as circumstances permit. The question thus is whether the present ATC-NATS planes and personnel plus the commercial line planes and personnel are sufficient for the future strategic needs of the country in case of war.

In any war within the future with which we are dealing the logistic supply to our advanced combat area must be largely by water. There are not enough planes to handle more than a fraction of the huge supplies which must be transported. However, certain personnel and cargo, especially in the early days of a war, must be transported quickly by air. Tentative estimates by the Military Establishment show that ATC and NATS at their present size plus the present commercial aircraft would be far short of what will be needed. For this we must increase our commercial fleet. We recommend later in this report certain policies for this purpose.

We also recommend the consolidation of ATC and NATS into one Military Air Transport Service to handle all scheduled military transport services for the Army, the Navy, and the Air Force.

We make one further recommendation on this subject. Advantage should be taken of our World War II experience in working out in advance the required coordination between the armed services and the commercial air lines. Contract arrangements specifying the equipment and services to be furnished to the Military Air Transport Service by the air lines should be made now with the commercial carriers.

Mobilization Planning

It is not enough to have an Air Force in being on the day war begins. Mobilization plans must be made in peacetime to enable us to expand our production of airplanes and other equipment as rapidly as possible after war begins. This subject is dealt with in section II below, in our discussion of the aircraft industry.

Plans must also be made in peacetime for the rapid mobilization of our manpower in event of war. In the case of our Air Establishment this problem centers on the so-called civilian "components" of the Air Force and naval aviation. In the case of the Air Force the civilian components are the National Guard and the Air Force Reserve. In the case of the Navy, they are the Organized Reserve and the Volunteer Reserve.

The problem is to have enough trained personnel to man and handle the planes which are in storage and those which will be built after war begins.

We have examined this question but are not prepared to make specific recommendations with respect to the air components. There is no point in developing a training program until the plans to provide the planes are farther advanced. If the recommendations of the Commission for the increase in the Air Establishment are put into effect, it will be necessary to develop corresponding plans for the training of pilots and ground crews to man these planes. When the Industrial Mobilization Plan has been farther advanced, estimates must be made as to the number of planes to become available under this plan; and corresponding plans for the training of personnel must be developed.

The Secretary of Defense has appointed a committee within the Military Establishment to study this question which presents problems of long historical background and great difficulty. The problem assumes importance because the Air Force is depending upon 27 National Guard groups as part of its first line forces. The report of the committee established by the Secretary of Defense and the necessary action to insure satisfactory and economical functioning of the civilian components are therefore of the highest importance.

Periodic Reviews of the Military Establishment

We recommend that there be periodic reviews of the Military Establishment of the United States in the light of the then international situation and the military strength of other nations.

We must at all costs avoid a hit or miss armaments program. We must not believe that any program which may be adopted now will solve once and for all the problem of national defense. Our plans for the Military Establishment must be constantly revised. The strength and techniques of other nations are changing rapidly in the current scientific revolution. Our Military Establishment must change with them—not behind them but ahead of them. Moreover, we can get the integrated fighting force we need only if continual reviews see to it that this force is produced at the least possible cost to the taxpayer. Unless there are such reviews, duplications and ineffective use of the security dollar are inevitable.

There now are arrangements for such reviews by the highest officials of government.

The National Security Act of 1947 places the responsibility for the maintenance of our defense forces on the Secretary of Defense, under the President and within the limits of the funds made available by Congress. The Secretary of Defense has available to him a structure for the manufacture of the over-all strategic plan. The National Security Council, composed of the Secretary of State, the Secretary of Defense, the Secretaries of the Army, Navy, and Air Force, has the duty, under the President, of integrating our foreign policy and our military power—that is of seeing to it that we have a military force strong enough in the light of our international policies and of international conditions. With this top-level advice the Secretary of Defense has the responsibility for arranging that the Joint Chiefs of Staff prepare and keep constantly revised the strategic plans of the country. The Secretary of Defense relates the plans of the Joint Chiefs of Staff to the possible by checking their proposals with the National Security Resources Board to see if the material and human resources of the country are enough to fulfill the plans which the Joint Chiefs of Staff propose—and adjustments are made accordingly. The plans are then referred back to the National Security Council through the Secretary of Defense for further checking and instructions; and this process starts all over again in order that the strategic plans will be always up to date.

This is a sound procedure. We believe, however, that the arrangement lacks an essential element—the direct participation by the people of the country in the preparation of the plans.

Some national policies touch the people so intimately and so seriously that the ordinary processes of government are inadequate. Under our system of representative government, national policies usually are made by the Executive and the Congress, with the role of the public an indirect one. Some policies, however, cannot be made by the elected representatives alone. The making of war is one such policy. The preparation in peace for the defense of the country in the atomic age is another.

This Commission does not believe that we will ever have an adequate Military Establishment unless the people of the country know fully what the international military and political situation is, what kind of a military force is necessary if we are to be ready for that situation, and how much it will cost to have this force. With these facts before them they may choose, with full knowledge of what they are doing, whether they will or will not pay the bill. We believe they will want to pay it—provided they feel sure that what they are getting is as free as possible from duplicating or other useless expenditures and is absolutely necessary for their safety.

We make the following recommendations:

1. That the National Security Act of 1947 be amended to provide that the President appoint on June 15th in each second year, or more frequently if he sees fit, and subject to confirmation by the Senate, a commission of five citizens with no connection with government who shall review the Military Establishment of the country and its adequacy in the light of the then international military and political situation and shall submit a report of their findings and recommendations to the President by the following January.

This Commission should be composed of different persons on each occasion. Their report should deal among other things with the efficiency with which the procurement and other policies of the Military Establishment are being carried on. The purpose must be not only to have what is necessary but also to have it at the minimum cost to the United States taxpayer.

2. That the report of this commission of citizens be made public by the President. Military security does not require secrecy in this matter. It may require secrecy in some details. But it does not require secrecy as to the broad outlines of the military strength of foreign powers and the steps which should be taken to be ready to meet that strength if it is used against us. Not to tell the people the military facts they are facing would not only deny to them what they are entitled to know, but also would make it impossible to have an adequate preparedness program.

We believe that our policies as to military secrecy in relation to our Military Establishment require overhauling. Details of our new air equipment and technical information as to our applied research and development which should be kept secret are often released to the press. This detailed information as to our airplanes and other air equipment is of no interest to the American public but it is of interest to nations competing with us in the current race for power. On the other hand the people of the country are not kept fully informed of the dangers of the military situation they are facing and of the preparation they ought to make to defend themselves against these dangers. These facts are known by all foreign governments, but there is now no procedure in our Government for systematically informing our people about them.

We recommend a reversal of both present policies. Less information should be given out as to the technical facts of our air establishment. More information should be given out as to the broad lines of the military situation which confronts the country and of the Military Establishment needed to handle this situation. The best way to give the people this information is to have these reviews of the state of our Military Establishment made public.

SECTION II

AIRCRAFT MANUFACTURING INDUSTRY

Basic Considerations for National Security

A strong aircraft industry is an essential element in the Nation's air power. Our air establishment would be useless unless backed by a manufacturing industry skillful in technological application, efficient in production, capable of rapid expansion, and strong in basic financial structure.

On the basis of the evidence, the over-all aircraft industry of the United States now meets only the first of these specifications. A parade of witnesses has testified as to its current productive weakness as an industry, its general lack of preparation for rapid expansion, and its general financial instability. How to remedy those deficiencies is a matter that has engaged the Commission's close attention.

As a point of departure, it is necessary to calculate the minimum level at which the industry must be held to provide a safe base for expansion in an emergency. Our own studies, together with figures supplied by the industry and the military services, tend to confirm the general range of requirements set by the Air Coordinating Committee in its report of October 22, 1945.

Two levels were set by the Air Coordinating Committee. The lower level was an estimate that the aircraft industry required military purchases in the amount of 30,000,000 pounds of airframe weight annually. This was considered "as a minimum which could be reached only after maintenance of world peace is well assured and a substantial degree of disarmament has taken place." The Air Coordinating Committee also proposed an alternate level of about 60,000,000 pounds of airframe for the event that world conditions were such that * * * "we have * * * need for a substantial striking force ready at all times to cooperate in the maintenance of world peace." The military requirements listed in section I would lead to a steady build-up throughout this range over the next few years.

This Commission believes that military requirements for 30,000,000 to 40,000,000 pounds annually, in addition to demands for commercial and private planes, would provide a sound basis for expansion in an emergency.

No artificial stimulation to achieve this result appears to be necessary. If the program outlined in section I is carried out, the necessary base for expansion of the aircraft industry will exist. The rate of procurement recommended in section I would increase the present military procurement (which is now at the rate of about 21,000,000 pounds annually) by contracts for an additional 13,000,000 pounds during the calendar year 1948, and for 22,000,000 pounds in 1949 more than in 1948.

This, of course, is not a permanent solution. It satisfies only the demands of the immediately foreseeable future. If the threat of war diminishes, or if war becomes imminent, new levels of military demand (lower or higher) must be calculated and maintained. As is recommended throughout this report, periodic reviews of the military needs must be made, and plans and programs adjusted to fit conditions as they change.

It was widely predicted before the end of World War II that rising demand for commercial aircraft, both transport and personal, would tide a number of companies over the postwar adjustments of 1946 and 1947. For various reasons, some of which are dealt with elsewhere in this report, these hopes have not been justified. Although conditions may change in the future, it is certain that current commercial demands alone will not carry us through the present crisis. Whether we like it or not, the health of the aircraft industry, for the next few years, at least, is dependent largely upon financial support from Government in the form of orders for military aircraft.

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To justify that support, the aircraft industry of the United States must be capable of turning out superior war weapons. The importance of adequate aeronautical research programs cannot be overemphasized. This phase of the problem is discussed in section III of this report.

At the time the Morrow Board convened (1925) the design of a successful military aircraft depended largely upon the efforts of a single man—the final product was almost wholly a reflection of one individual's ideas. Today, every design is the end point of many contributions by many individuals. The concept of the engineering team is almost universally accepted. Group engineering know-how is one of the most valuable assets carried forward by aircraft manufacturers out of the World War II period. If, for any reason, too many of the war-trained teams are dispersed, we are in danger of losing this hard-won knowledge and experience.

But the aircraft industry must do more than design aircraft of top performance. It must also design them for efficient production in quantities to meet the needs of the armed services. Since World War II, military aircraft have become much more complicated. The net result has been to increase the number of their component parts and to complicate their final assembly. The most efficient aircraft in the world, no matter how brilliant its performance, is of little value to the national defense unless it can be manufactured quickly in large quantities.

The team concept is not limited to research and design. Production planning and production control groups are equally necessary, but it is more difficult to keep such teams together in peacetime. When production drops off to mere jobbing levels, their functions simply disappear. Means must be found to keep alive the special skills that have been evolved in these particular fields during the war years. If they are allowed to be dissipated, time and effort will be needed to replace them in a future emergency.

The techniques of aircraft manufacture vary widely with changes in the volume of orders. It is uneconomical to do extensive special tooling, either for manufacture or assembly, to turn out a few units. If, on the other hand, thousands of similar airplanes are required, the expenditure of relatively large sums for special jigs, fixtures, and tools is justified. Between the two extremes are wide areas in which the exercise of good judgment is the only controlling factor. The only way such judgment can be generated is through actual production experience. How to provide the aircraft manufacturer with orders in sufficient quantity in peacetime to develop that kind of experience and to justify planning and tooling to a reasonable level for emergency expansion is one of the most important questions facing the services.

In a freely competitive economy the number of companies manufacturing a particular product levels off at a point determined by the ordinary laws of economics. In the case of the aircraft industry, however, it would be dangerous to rely only on the operation of these laws. The demand factor fluctuates too violently from peace to war. If a reasonable degree of expansibility is to be maintained for periods of emergency, it is necessary to exercise some industry-wide control in the interests of national security. It may even be desirable to keep a few marginal manufacturers in business who might be forced out if the normal laws of supply and demand were allowed to operate.

Based on considerations of maximum security, it is essential to maintain at least two sources of supply for similar products. It has long been the practice for the procurement agencies of the Army and Navy to keep alive at least two separate producers of each type of aircraft, as well as two or more separate sources for each of the major components. We believe that this policy is sound and should be continued. It develops automatically a degree of manufacturing dispersal which might otherwise not exist. In a field in which the technology is changing rapidly, competition between design and development groups results in continuously improved products, and price competition between suppliers results in lower unit costs.

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The financial difficulties which harass the aircraft industry today stem from many causes. Uncertain Government policies account for many of them. Some reflect faulty judgment by management. Others have come about from particular circumstances which have surrounded this peculiar industry in the postwar period of readjustment. Some of them are:

(1) A product that is, almost indivisibly, a weapon of war and a carrier of commerce;

(2) A market with but one major customer, the Government, which purchases 80 to 90 percent of its entire output;

(3) A violently fluctuating demand, due to uncertainty of requirements of its major customer;

(4) A lack of the production continuity which is vitally important in sustaining a trained work force and in keeping production costs to a minimum;

(5) A rapidly changing technology which causes a high rate of design obsolescense and abnormally high engineering costs;

(6) An extremely long design-manufacturing cycle;

(7) An organization in excess of present requirements.

The financial strength of any individual company or of the industry cannot be measured by the amount of sales, the extent of working capital, or the total floor space of its plants. It depends upon profitable operation. A profitable organization will attract capital and credit. It will be able to employ and retain the most capable engineers and craftsmen. The concern which consistently loses money will deteriorate, its financial position will weaken, and the quality of its product will suffer as its best employees drift away in search of better opportunities.

The Government cannot guarantee profits. Government can and should, however, create an atmosphere as conducive as possible to profitable operations in the aircraft manufacturing business. This can be done by longer-range planning, adequate volume, and the abandonment of uneconomic procurement practices. Under these circumstances, it will be the task of each manufacturing company to work out its own salvation.

The State of the Aircraft Manufacturing Industry

The aircraft manufacturing industry covers all those manufacturers whose products are included in finished aircraft, military or civil. The normal airplane consists of the airframe (fuselage, wings, tail surfaces, landing gear); the propulsion system (engines, turbo-jet units, rocket motors, propellers); instruments (control, navigational, recording); communication equipment; accessories (pumps, generators, landing lights); and furnishings (seats, fire-extinguishers, and miscellaneous fixtures).

The airframe manufacturer is responsible for the final product. He designs and builds the basic structure and installs the numerous components. He also test-flies the airplane before delivery to the customer and is responsible for its satisfactory performance.

The price of the airplane to the commercial customer usually includes the cost of all components. The aircraft manufacturer purchases them from their producers just as he does his raw materials. In aircraft for the military services, however, the airframe manufacturer bases his price on the cost of the airframe and of installing in it the various components. The Government usually buys the engines, propellers, instruments, and accessories separately. These are delivered to the airframe manufacturer as Government furnished equipment (GFE).

About half of the cost of the finished military aircraft is represented by the cost of the airframe and its assembly plus the cost of installing the GFE. The other half is the cost of the GFE. Thus, of a billion-dollar aircraft procurement program, about $500,000,000 goes to the airframe companies and the balance is spread among the hundreds of companies that build engines, propellers, radios, instruments, lights, heaters, and other gear.

Patent cross licensing.—All the principal manufacturers of aircraft are members of the Manufacturers Aircraft Association, through which they license each other and the Government on all their aircraft patents. Over 90 percent of such patents are licensed without fee. On others, small royalties per airplane are paid. There is, accordingly, complete freedom among the MAI membership to adopt, and incorporate in new aircraft, features developed by other companies. Design patents are offered for license on a percentage royalty basis.

Composition of the industry.—The aircraft manufacturing industry may be roughly divided into (*a*) the 15 major companies or groups which produce the majority of the airframes, engines, and propellers for the military services and for the airlines and other users of transport aircraft; (*b*) the nine major manufacturers of personal and small commercial aircraft; (*c*) and numerous additional small companies making personal and other aircraft. The divisions are not sharply defined as some personal airplanes and helicopters are made by certain of the 15 major companies, while some of the personal plane manufacturers also make transports and military liaison airplanes.

The 15 major airframe companies are:

1. Bell Aircraft Corp.
2. Boeing Airplane Co.
3. Consolidated Vultee Aircraft Corp.[1]
4. Curtiss-Wright Corp.[2]
5. Douglas Aircraft Co., Inc.
6. Fairchild Engine & Airplane Corp.
7. Grumman Aircraft Engineering Corp.
8. Lockheed Aircraft Corp.
9. The Glenn L. Martin Co.
10. McDonnell Aircraft Corp.
11. North American Aviation, Inc.
12. Northrop Aircraft, Inc.
13. Republic Aviation Corp.
14. Ryan Aeronautical Co.
15. United Aircraft Corp.[3]

The nine major makers of personal and small commercial planes, most of whom were important producers of small military aircraft and aircraft components during the war, are:

1. Aeronca Aircraft Corp.
2. Beech Aircraft Corp.

[1] Includes the Stinson Division (personal airplanes).
[2] The Curtiss-Wright group includes the Curtiss Air plane Division, Curtiss Propeller Division, and the Wright Aeronautical Corp. (engines).
[3] The United Aircraft Corp. group includes the Chance Vought (aircraft), Sikorsky (helicopters), Hamilton Standard (propellers), and Pratt & Whitney (engines) divisions.

3. Bellanca Aircraft Corp.
4. Cessna Aircraft Co.
5. Engineering & Research Corp.
6. Luscombe Airplane Corp.
7. Piper Aircraft Corp.
8. Taylorcraft, Inc.
9. Texas Engineering & Manufacturing Co.

During the war many of the major aircraft companies operated branch plants remote from their main factories. Other airframe and engine plants were operated by companies not traditionally a part of the aircraft industry. The wartime aviation industry occupied the plants shown on the accompanying map. It will be noted that plants were widely dispersed. Now, nearly all of the branch plants have been relinquished and most of the companies which were temporarily in aviation activities during the war have withdrawn from aviation with the exception of the Allison Division of General Motors, General Electric Co., and the Westinghouse Co., all of whom are active in the turbo-jet field.

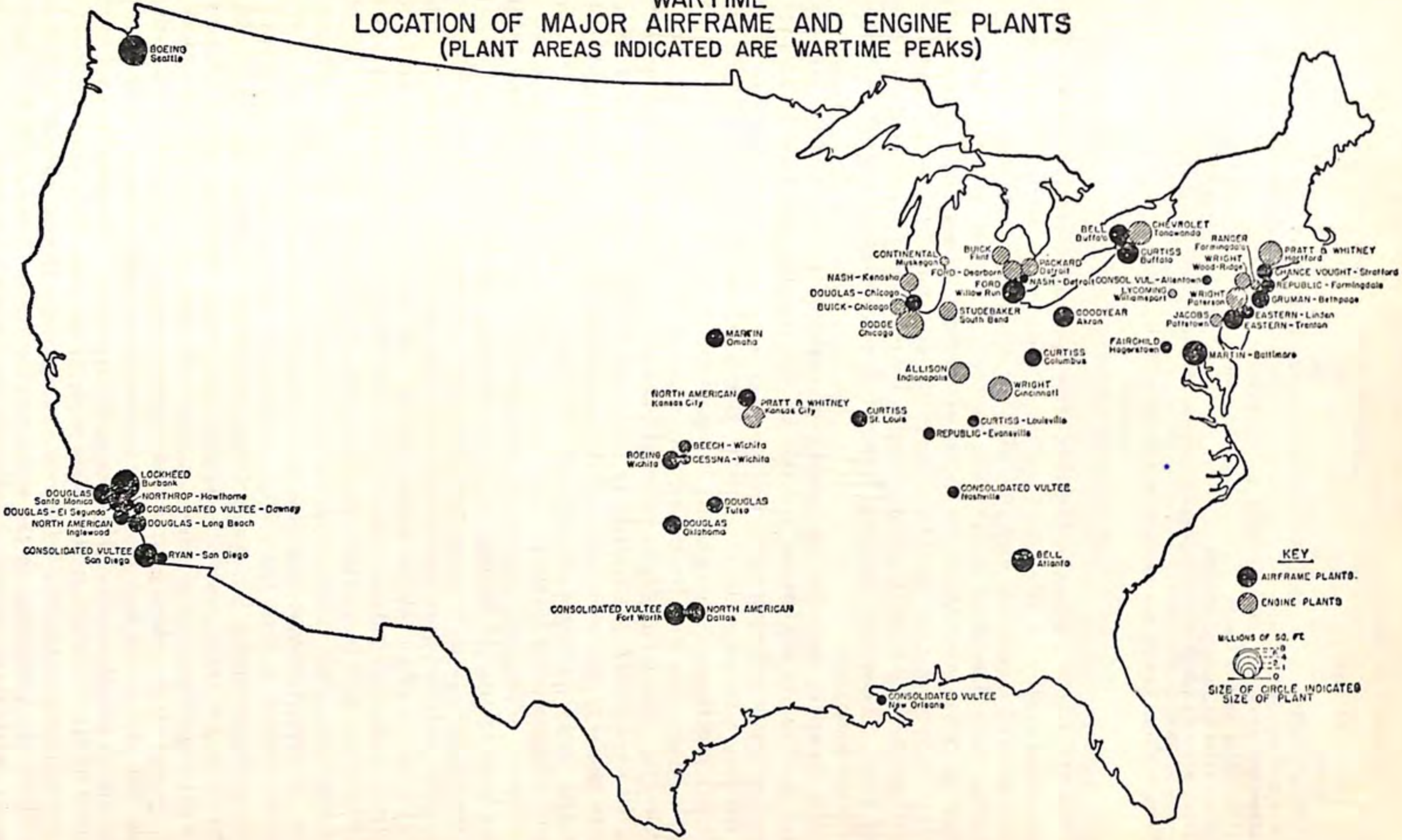
	1939	War peak	1946	1947
Floor area (covered) (in millions of sq. ft.)				
Total for all manufacturers of military and large civil airframes, engines and propellers	13 (Jan. '40)	175	54 (Dec.)[4]	53 (June)[4]
Airframe prime contractors	10 (Jan. '40)	111	41 (Dec.)[4]	40 (June)[4]
Engine prime contractors	3 (Jan. '40)	55	11 (Dec.)[4]	11 (June)[4]
Propeller prime contractors	(1)	9	2 (Dec.)	2 (June)[4]
Employees[2] (in thousands)				
Industry total for both military and civil airframes and engines	76 (Dec.)	1,708	221 (Dec.)	200 (Oct.)
Industry total for military and civil airframes	63 (Dec.)	1,257	184 (Dec.)	164 (Oct.)
Production—Yearly[3] (in millions of airframe pounds)				*1947* (1st 10 Mos.)
Total military and large civil[5]	13	1,101	24	23
Total military	11	1,101	15	10
Total large civil[5]	2*	0	9	13

* Estimated.
[1] Less than 0.5 million sq. ft. (492,000 sq. ft.).
[2] Includes prime contractors and sub-contractors.
[3] Includes spares.
[4] In the 1946 and 1947 year columns, the floor areas shown are for those companies contracting with the military services during these periods, although some of these companies also make commercial aircraft.
[5] Four-place and over.

Facilities and output.—The accompanying table shows the floor areas, number of employees, and airframe production of the major companies for 1939, at the war peak, for 1946 and for the first 10 months of 1947. Included in the figures for airframe weight of large civil airplanes are aircraft of 4-place and over, some of which are the products of the personal plane manufacturers.

Financial condition.—Pertinent financial data on the 15 major companies are presented in the table below. Total sales are shown for the calendar years 1939, 1944, and 1946, and for the first 6 months of 1947. Net profit or loss and the ratio of profit or loss to sales are shown for the years 1939, 1944, and 1946. Net worth, working capital, investment in plant and equipment, and the ratio of sales to each of these, is shown for the years ending on December 31, 1939, 1944, and 1946.

WARTIME
LOCATION OF MAJOR AIRFRAME AND ENGINE PLANTS
(PLANT AREAS INDICATED ARE WARTIME PEAKS)



	1939	1944	1946	1947 (1st 6 mos.)
Sales .... millions of $	244	8,204	711	375
Net profit (or loss) .... do	30	133	(13)	....
Net worth .... do	138	596	640	....
Working capital .... do	64	424	541	....
Plant and equipment .... do	62	105	89	....
Ratio—net profit (or loss) to sales .... percent	12.4	1.6	(1.9)	....
Ratio—sales to net worth .... do	1.8	13.8	1.1	....
Ratio—sales to working capital .... do	3.8	19.4	1.3	....
Ratio—sales to plant and equipment .... do	3.9	77.8	8.0	....

NOTE.—Value figures are rounded to nearest million; ratios were computed on actual figures.

The $13,000,000 net loss in 1946 was after application of nearly $72,000,000 in tax-refund credits. A substantial portion of the loss was attributable to development costs of commercial aircraft and other nonmilitary activities. Other losses resulted from difficulties in curtailing expenses as rapidly as sales declined, expense of rearranging plants for decreased postwar volume and for new models, delays in obtaining raw materials due to postwar shortages, acceleration of production schedules to meet airline demands for new transports in some companies, and heavy development costs and losses on non aeronautical commercial ventures by other companies.

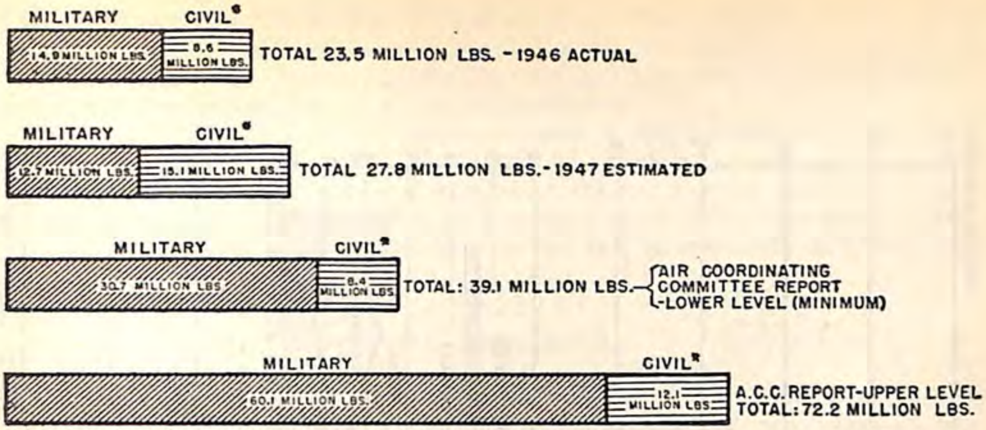
Not shown in the table, but worthy of comment, is the decrease in working capital of nearly $83,000,000 in 1946. Of this amount, $45,000,000 was used to purchase plant and equipment.

Backlogs.—In compiling the backlog figures submitted to us by the 15 major aircraft manufacturing companies, it was apparent that a statement of any composite figure, even with the explanations given, would be confusing and might be misleading. This is largely due to the lack of a uniform basis of accounting methods within the industry, particularly in this respect. While we have recognized and given weight in our recommendations to the backlog figures, it was deemed advisable to omit the publication of the exact total amount of contracts reported to be on the books of the aircraft industry.

Capacity.—The peak capacity of the present aircraft manufacturing industry may be estimated. At the peak of war production, "on-site" air frame output was 9 pounds per square foot per year. The present covered floor area of the major airframe manufacturers now contracting with the military measures 41,000,000 square feet. At 9 pounds per square foot per year, this area should support a peak output (under full wartime conditions of 369,000,000 air frame pounds per year.

Plants now held in reserve have a total area of 21,200,000 square feet. Applying the same ratio, they should support an additional 191,000,000 air frame pounds per year at peak utilization. The potential industry peak capacity under the best conditions attained in 1944, and without allowance for the possible contribution of the companies specializing in personal plane production, is approximately 560,000,000 pounds of air frame (including spares) per year. Available space, even under normal peacetime rates of output is thus more than adequate for the production of the aircraft for which procurement is recommended in section I. Testimony has indicated that plants now producing airplanes are readily convertible to the production of guided missiles. Their capacity to produce poundage of such missiles should be equal to or greater than their capacity in terms of air frame pounds.

Civil aircraft production.—The relative importance of civil aircraft manufacture is illustrated graphically in the accompanying chart. This shows (1) the 1946 output, in air frame pounds, of military airplanes and of large (4-place and over) civil airplanes, (2) the estimated 1947 output figures, (3) the corresponding figures



AIRFRAME PRODUCTION
(*EXCLUDING SMALL PRIVATE PLANES)

for the lower level of the Air Coordinating Committee report of October 22, 1945, and (4) the upper level figures of the ACC report. All weights include spares (estimated for 1946-47) and excluding experimental production. Although the production of small personal aircraft has fallen off sharply, the output of larger civil aircraft continues in substantial volume.

An additional chart has been included to show the total military and civil (4 place and large) airframe weight produced monthly from 1938 to late 1947. For the postwar period, the inset shows the total production divided between the military and the large civil aircraft.

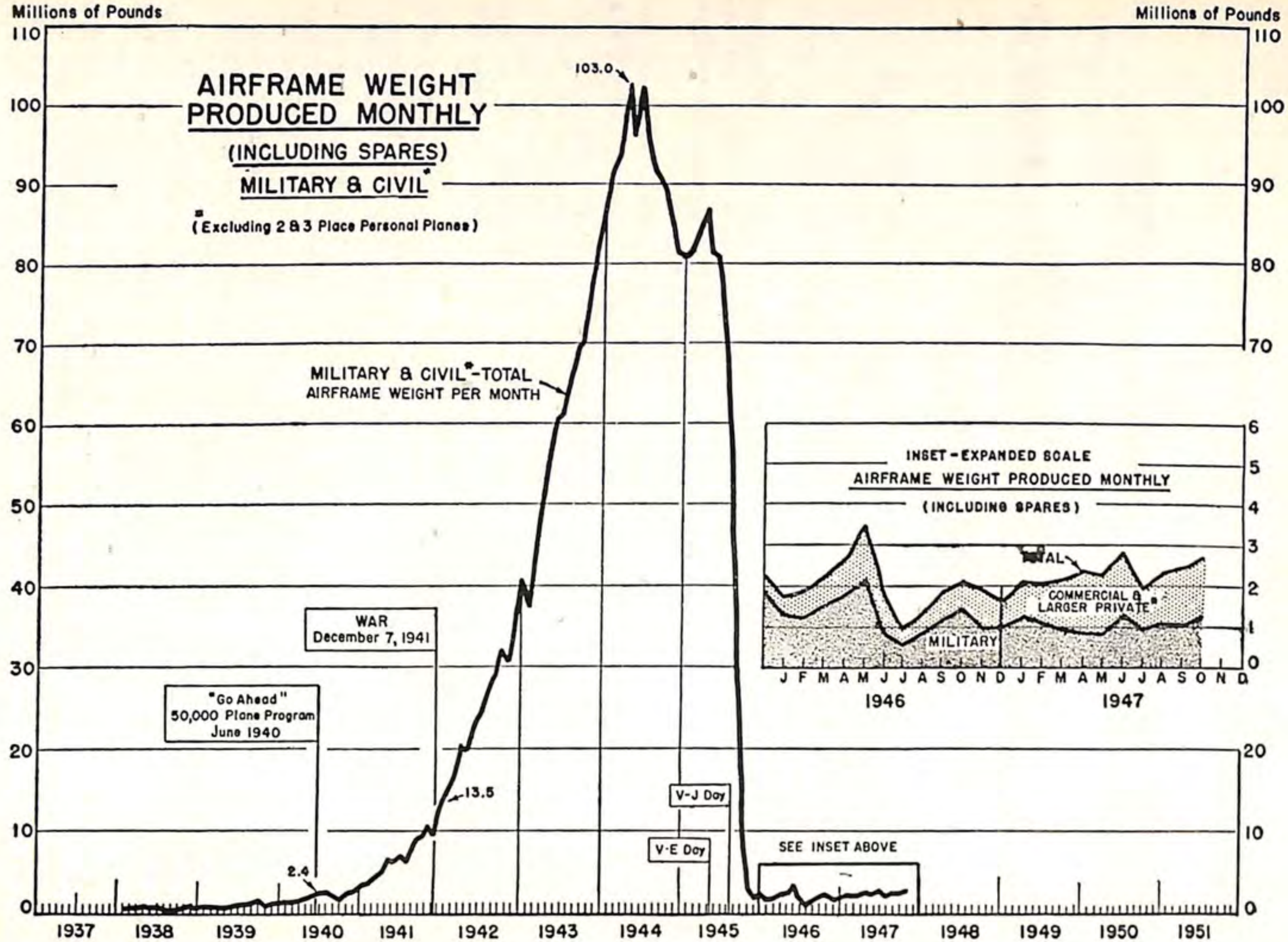
Helicopters.—Two of the major military aircraft manufacturers (Bell and the Sikorsky Division of United Aircraft) produce helicopters for both military and civil users. A number of smaller companies are developing helicopters and one, Piaseki Helicopter Corporation, is producing transport helicopters for the Navy.

Lighter-than-air.—Little or no production of lighter-than-air craft has taken place since the war, although one company, the Goodyear Tire & Rubber Co., remains a source of supply of blimps for the United States Navy and is also fostering new designs of large dirigible types for both military and commercial uses.

Power plants.—Prior to the war, only conventional reciprocating engines were manufactured in the United States. Two large companies, Pratt and Whitney and Wright Aeronautical, supplied the greatest number of large engines for the military and for the larger civil aircraft. Near the end of the war, Allison (which also made reciprocating engines), General Electric and Westinghouse developed new type turbo-jet engines and are currently supplying them in quantity for military aircraft. Pratt and Whitney and Wright Aeronautical are in the process of developing turbo-jet engines while continuing to produce conventional engines for use in current commercial and civil type aircraft.

Instrument and other aircraft equipment.—The aircraft industry also includes numerous companies (or divisions of companies) which develop and manufacture instruments, radio and communication equipment, accessories, and other items required in the modern airplane. This group generally produces for both the military and commercial markets. Their combined importance is indicated by the fact that over 17 percent of the cost of an average military aircraft is represented by Government furnished equipment procured from these companies.

Exports of aircraft, engines, and equipment.—In the year 1946, the United States exported 2,243 civil aircraft valued at $64,206,000 and 59 military aircraft valued at $1,057,000. In numbers, the markets for the civil aircraft were: South America 827, the rest of North America (chiefly Canada and Mexico) 791, Central America and



Millions of Pounds
AIRFRAME WEIGHT PRODUCED MONTHLY
(INCLUDING SPARES)
MILITARY & CIVIL*
* (Excluding 2 & 3 Place Personal Planes)
103.0
MILITARY & CIVIL*-TOTAL AIRFRAME WEIGHT PER MONTH
INSET-EXPANDED SCALE
AIRFRAME WEIGHT PRODUCED MONTHLY
(INCLUDING SPARES)
COMMERCIAL & LARGER PRIVATE*
MILITARY
J F M A M J J A S O N D J F M A M J J A S O N D
1946
1947
WAR
December 7, 1941
"Go Ahead"
50,000 Plane Program
June 1940
2.4
13.5
V-J Day
V-E Day
SEE INSET ABOVE
1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951

the Caribbean Area 169, Europe 195, and the rest of the world, 261. By value, the markets for these civil aircraft were: South America, $15,200,000, the rest of North America, $7,200,000; Central America and the Caribbean area $3,100,000, Europe, $29,300,000, and to the rest of the world, $9,400,000.

The value of the 2,490 aircraft engines exported in 1946 reached $11,900,000 while exported propellers accounted for $1,000,000. The markets for the exported engines were: South America 718, valued at $2,200,000; Central America and the Caribbean area 217, valued at $1,000,000; the rest of North America 602, valued at $1,900,000; Europe 780, volued at $5,800,000; and to the rest of the world 173, valued at $1,100,000.

Recommendations

Most of the problems which beset the aircraft-manufacturing industry in 1946 and 1947 resulted from (*a*) over optimistic development and production of commercial aircraft; (*b*) low-level military procurement and (*c*) the absence of long-range military planning. As we have said, military procurement in accordance with our recommendations in section I of this report will provide sufficient business to maintain the industry in a sound condition—but such business must be wisely distributed.

The services must undertake more extensive planning and control of procurement. We recommend that they be given the legislative authority to do so.

We have pointed out that the industry comprises a number of separate companies. Although competition between these units should be utilized to provide incentive to low costs and low prices, the aircraft-manufacturing industry, being essential to the national defense, cannot be freely competitive to such an extent that vital design teams or production organizations are liquidated. Means must be devised to avoid undue concentration of business in a few companies. This, it is recognized, implies a greater degree of planning and control than the services have heretofore undertaken, or is, in fact, permitted by the peacetime procurement legislation which will again become effective on the expiration of the War Powers Act. Some continuation of those special powers must be allowed if we are to achieve a balanced aircraft industry.

Such planning must be directed toward avoidance of discontinuities in production. As has been stated repeatedly in testimony, such breaks in production result in high costs. Not only do many expenses continue while production is interrupted, but the training of a new labor force on resumption of operations involves a great increase in unit costs.

Long-range planning.—Year-to-year planning of aircraft production, which has been forced upon the services by current budgeting practice, must give way to long-term planning. Evidence submitted to us indicates that the savings on the uninterrupted production of airplanes over a 5-year period, as compared to five annual procurements of the same total number of planes, could run as high as 20 to 25 percent. Such savings result in part from the ordering of materials and parts in larger quantities and to the more extensive tooling warranted by the larger number of airplanes on the single order, but even more from the more effective use of tools and manpower.

Long-range planning does not imply a single frozen procurement program for a period of years, but rather the integration of several concurrent plans, the duration of each of which will depend on its particular character. While many projects can be planned for 5 years, others are of such a nature that they cannot be planned for more than 2, 3, or 4 years ahead. The aggregate of such 2-, 3-, 4-, and 5-year plans will constitute the "plan" for which a budget must be prepared. All of these plans should be reviewed at least annually.

Forward contract authorization.—We recommend that the services plan their aircraft procurement as far in advance as possible and that the Congress provide the legislative base for such planning. We recommend the placing of orders for planes for delivery over a 5-year period whenever possible. We propose that the budget be charged each year with the necessary progress payments and the funds needed to pay for the airplanes accepted in that year. Congress might provide funds for such planned procurement by appropriating funds disbursable in the current year and for 5 or more years ahead. To do so, however, would commit current funds needlessly. We propose, instead, that the Congress make appropriations only of the moneys to be disbursed in the current fiscal year, and provide for the additional years of the procurement program by forward contract authorization, permitting the services to contract for deliveries over the following 5 fiscal years. We recommend that the Congress retain complete control over such procurement through its subsequent annual appropriation of funds to liquidate the forward contract authorizations.

Industrial mobilization planning.—The ability of the aircraft manufacturing industry to expand will control, to a large extent, the magnitude of our strength in a future war. In section I of this report we have concluded that the Air Force will need a storage reserve of 8,100 airplanes to replace combat losses in the early months of war, because industry will not be able to supply the needed planes in time. This reserve would cost, at present standards and prices, from $6 billion to $7 billion and, in addition, would require about $2 billion a year to keep modern. An industrial mobilization plan which can be depended upon to speed production after war starts may reduce the size of the reserve which will be required.

According to the National Security Act of 1947, the coordination of military, industrial and civilian mobilization is the responsibility of the National Security Resources Board. Based on the advice of the Board, the President may direct the Secretary of Defense and the heads of the appropriate civil departments to undertake the planning of military and industrial mobilization. On the military side the Secretary of Defense holds the Secretaries of the Army, the Navy and the Air Force responsible for military and industrial mobilization planning within their respective services. On the civilian side, it is our recommendation outlined in section V of this report that the Secretary of Commerce and the Secretary of Civil Aviation take an active part in mobilization planning.

We urge that the Under Secretaries of the Army, the Navy, and the Air Force give special attention to effecting such planning. We recommend that, at the administrative level, industrial mobilization planning receive attention comparable with that given to research, development, and procurement.

It was urged on the Commission that all procurement and mobilization planning functions of the Air Force should be carried out by civilian personnel rather than by pilot officers whose tours of duty in such activities are likely to be interspersed with other assignments. We believe that it would be extremely difficult, because of Government pay levels and civil service restrictions, to recruit and hold the quality of civilians necessary for this type of work in numbers sufficient to do the job adequately. We recommend, however, that the practice of passing combat officers through such assignments on the assumption that a well-trained officer must have had experience in all branches of the Air Force should be discarded. With its maturity as a full-fledged service under the National Security Act, the Air Force should accept the fact that procurement and mobilization planning call for officers with specialized industrial training who wish to make a life-long career in those fields. Such officers should have the same opportunity for advancement in rank as those in other commands.

We recommend that, in the industrial mobilization planning program, studies be made for all planning necessary to place one model of each basic type of aircraft in production in a reserve plant in an emergency, such planning to include the preparation of shop drawings, operation sheets, bills of material, work orders, and the design of all jigs, fixtures, and special tooling. This planning must also include continual revisions to keep all material up to date.

We believe that top level attention should be given in each aircraft manufacturing organization to industrial mobilization planning in peacetime. Subcontract arrangements should be worked out in advance outside the aircraft industry. Licenses or other agreements for the production of aircraft, power plants, propellers, instruments and accessories by nonaeronautical firms should be entered into, ready for activation in an emergency. The peacetime integration of such companies within the air industrial mobilization plan should expedite any expansion greatly.

We have heard a great deal of criticism of the current condition of industrial mobilization planning. We believe, however, that with the establishment of the responsibilities and procedures above outlined this important work should go forward satisfactorily.

Mobilization authority.—Industrial mobilization planning is futile if the mobilization cannot be carried out accordng to plan when the emergency comes. To give value to such planning it is essential (*a*) that the National Military Establishment reflect such plans annually in a mobilization budget showing the appropriations and forward contract authorization necessary to put this budget into effect should mobilization be initiated in the then current fiscal year; (*b*) that the Congress authorize (but not appropriate for) such mobilization budget annually; (*c*) that the National Security Resources Board set up an Office of War Mobilization, with the necessary subsidiary offices for the control of materials, production facilities, machine tools, and other capital goods, to be held ready for activation upon declaration of a national emergency and mobilization by the President; and (*d*) that in the event of such mobilization the Congress immediately vote the necessary forward contract authorization and appropriation to support the authorized mobilization budget. These first three actions, taken by the National Military Establishment and by the Congress in peacetime, when they can be considered calmly and carefully, will avoid the necessity for a repetition of the hasty and costly improvisations of World War II. We emphasize the importance of this preparation. It is essential, in any future emergency, that all controls and all planned procurement be initiated immediately upon the declaration of an emergency by the President.

Strategic materials.—No mobilization planning can be carried out in the absence of the materials from which the aircraft and other aeronautical equipment are to be constructed. The Strategic and Critical Materials Stock Piling Act (Public Law 520, 79th Cong.) and the National Security Act of 1947 establish the authority and responsibilities of the National Security Resources Board, the Munitions Board, and of the Secretaries of Defense and of the Treasury, in respect to the stock piling of strategic and critical materials. Attention is directed to the importance of maintaining domestic sources of critical and strategic materials as an effective and advantageous alternative to the stock piling of certain imported items and materials.

Procurement policies.—We point out that the procurement policies of the services must be directed to the provision of incentives to (*a*) the design and development of aircraft which are both technically superior and readily productible, (*b*) the production of such aircraft at the lowest possible cost, and (*c*) maintenance of expansibility.

Design and development.—Aircraft are initially designed and developed on contracts which provide for the reimbursement of cost, plus a fixed fee for administration. We believe this type of contract is desirable for such initial procurement because the cost of developing a new airplane cannot be ascertained in advance, and because the contractor should have the greatest possible freedom in making changes both to increase performance and, by improving producibility, to develop an airplane which will be cheaper to build in quantity production.

Under present contracts, all rights for reproduction of a new design become

Government property although the success of the airplane may be due largely to the contractor's particular knowledge and special skills. The retention of some rights by the developing contractor would provide an incentive to superior effort. We recommend that some consideration be given to this point in drafting future legislation.

Producibility.—The importance of superior performance is so obvious that the attention given it has, in the past, tended to obscure the equally important factor of producibility. An airplane must be superior both in performance and in producibility if it is to be an effective military weapon. Of only slightly less importance is the ease of maintenance which, in general, is related to producibility. An aircraft easy to produce is also usually easy to maintain. We recommend that the services put heavy emphasis on producibility in all future aircraft-development contracts.

Low cost production.—The aircraft procurement program we have recommended will cost the American taxpayer a great deal of money. Every effort must be made by the procurement agencies to see that the most effective use is made of that money. All possible incentives must be provided for production at low unit costs and at low prices.

Expansibility.—Lowest cost production will sometimes be incompatible with expansibility, which would be incerased by a greater degree of tooling than is economical for the number of articles being produced. Such additional tooling should be regarded as a part of industrial mobilization planning and its added cost should not be a charge against the production contract.

Design, development, and production continuity.—To be able to plan for reasonable continuity of production, each company should, at any given time, have at least one type in production, one in development, and one in the design-study stage. The type or type of planes to be developed and produced by each company should be determined (*a*) by the needs of the service, and (*b*) by the interest and special skills of the manufacturer. Companies which fail to develop successful aircraft or which fail to produce at competitive cost levels will, of course, eliminate themselves from military business. Conversely, a new group submitting a promising design should be encouraged and given the opportunity to become a producer upon demonstration of its capabilities.

In as far as possible aircraft should be produced by the developing company. More often than not the production airplane differs materially in detail from the original design. Engineering changes resulting from the changing requirements of the services are frequent during all stages of production. They may be complicated, and may exert an important influence on the ultimate performance and the final cost of the aircraft. It is considered essential, therefore, that the company which initiated the design should be responsible for all design changes during the course of production. It is accordingly recommended that as a normal procedure, production contracts be given to the organization which made the original design.

Where such a production order would overload that manufacturer's facilities, however, the contracting service should require him to sub-contract a certain percentage of the new contract (or the equivalent man-hours on a prior contract) elsewhere in the industry. Such a subcontract could involve complete aircraft, or any parts or subassemblies thereof. If the placing of such an order with the developing company would concentrate too much production in a single area, the service should place it elsewhere, arranging with the developing company for any necessary engineering assistance to enable the producing company to build the aircraft economically, and to keep up with any design changes.

Accessory development.—In the procurement of equipment from companies which do not operate exclusively in the aircraft field, it is important to provide incentives for military development. The Attorney General has recently proposed that all rights to patentable inventions made in the course of performing a Government-financed contract be assigned to the Government. The adoption of such a policy would turn research and development brains from Government developments to commercial and industrial developments. Unless instrument and accessory companies are permitted to retain design rights commensurate with the risks taken, they will tend to avoid Government development contracts.

Legislation.—To provide authority for the procurement policies and procedures above recommended, we urge the enactment by Congress of H. R. 1366 and H. R. 5031, both Eightieth Congress.

H. R. 1366. ARMED SERVICES PROCUREMENT ACT

This bill, which was passed by the House of Representatives at the last session of Congress, provides for purchases by negotiation: (*a*) When it is impracticable to secure competition, (*b*) where secrecy should be maintained, (*c*) under other stated conditions and safeguards, and (*d*) of research and development work. The Secretary of Defense is required to report negotiated contracts to Congress.

H. R. 5031. VINSON-TRAMMELL REPEALER

This bill, which repeals part of the provisions of the Vinson-Trammell Act of 1934, as amended, was passed by the House of Representativess at the last session of Congress. It removes the requirement that 10 percent of naval aircraft and engines be made in Government plants, and substitutes the *authorization* that the President or the Secretary of the Navy may use Government aircraft factories for the manufacture of naval aircraft and engines whenever private manufacturing proposals indicate that the Government is being deprived of unrestricted competition, or when private quotations appear unreasonable, or when such use of Government factories appears to be in the public interest. The 10-percent requirement of Government manufacture of aircraft has in fact never been completely operative, due to suspensions both legislative and executive. Should it become fully operative it would work to the disadvantage of the Government, and we believe that it should be repealed.

H. R. 5031 also removes the profit limitation of 10 percent placed on Navy contracts for the construction of ships and the profit limitation of 12 percent placed upon Navy and Air Force contracts for the construction of aircraft. It must be noted, however, that if H. R. 5031 were enacted and the statutory profit limitation on Navy and Air Force contracts adopted, the Services would be required in all cases to assure themselves of the reality of competition, that contracts are entered into at reasonable prices, and that expenditures of Government funds are effectively controlled. It will be difficult, however, to obtain this assurance because of the practice of awarding production contracts to the designing contractor without competition.

We do not recommend the repeal of this statutory profit limitation until a substitute is enacted which, by provision for renegotiation or otherwise, will protect the Government against excessive profits and prices.

Plant dispersion.—At the end of World War II, the aircraft and aircraft engine plants were well dispersed, as shown on the map elsewhere in this section. A large part of our total production of military aircraft is now concentrated in the Los Angeles area, on Long Island, and at Seattle.

It is regrettable that the wartime-plant dispersion was not maintained. Our reserve plants (i.e., Government-owned plants not now in operation) are still well dispersed. If, in response to a mobilization order, reserve plants are brought into production, the total aircraft manufacturing plant pattern would represent an effective geographical dispersal. If, on the other hand, an attack should precede activation of the reserve plants, the industry will offer highly concentrated targets.

We recommend that, in future plant expansion, the services avoid further concentration in these areas as far as possible.

Plant reserve.—The Air Coordinating Committee proposed that a reserve of industrial plant be established and maintained, consisting of 16,000,000 square feet of specialized airframe plant area (19,000,000 square feet if plant dispersion were not maintained) and 10,000,000 square feet of specialized engine plant area. The program for a reserve of specialized plant has been modified to the extent that certain plants have been sold or leased, or are being offered for sale or lease, subject to recapture on 90 days' notice in event of an emergency. Two plants (5,800,000 square feet) have been set aside for the storage of machine tools under the program discussed below. Including these two plants a total of 21,200,000 square feet of specialized airframe plant and 11,700,000 square feet of specialized aircraft engine plant are now available. We recommend that this program be maintained to assure the continuing availability of these plants.

Machine tool reserve.—It was proposed by the Air Coordinating Committee that a reserve of general purpose machine tools be established and maintained, with 65,000 machine tools as a minimum. These reserve tools are being acquired and placed in storage by the Air Force and Navy under Public Law 364 (80th Cong.). We recommend that this program be completed.

Contract overhaul.—A number of substantial civilian organizations are engaged in the overhaul of transport aircraft. This is a specialized type of business quite separate from the manufacture of airplanes. Testimony before us has indicated the economy and other advantages of having modification and overhaul of military aircraft done by such civilian organizations under contrct. This is particularly true when the same types of cargo or transport aircraft can be overhauled in the same shops for both the military services and the civil airlines. The services are not in agreement and stress the need for training their own overhaul personnel in their own shops. We recognize the validity of the argument but recommend that the services weigh carefully the savings possible through contract overhaul, and the possible long-term advantages of building up civilian staffs trained in such work for use in an emergency.

Federal regulation of personal aircraft.—The present detailed requirements for certificating light aircraft of new design are complex, and tend to retard experimental design. The Commission agrees with the Administrator of Civil Aeronautics that it is time to recognize and encourage the moral and legal responsibility of the light aircraft manufacturers for the safety and integrity of their products. The Federal Government should continue to promulgate aircraft design standards in collaboration with established technical groups, research agencies and safety organizations, but compliance with these standards should be the primary responsibilitary of the manufacturer. After careful initial checking for competence, each should be required to certify to the airworthiness, the proper flight characteristics and operational limitations of the production type and to the fact that the airplane has been submitted to an exhaustive performance and service test. The present testing procedure now executed by the CAA should be conducted and sworn to by the manufacturer.

To discourage the entrance of irresponsible or technically ill-equipped firms into the private aircraft industry and to prevent the deterioration of standards among established firms, we recommend that the Government establish simplified but adequate standards of fitness and ability to be met and maintained by each company selling personal aircraft. A manufacturer's certificate based on proven ability should be issued by the Department of Commerce. Periodic spot checks should be made, and the Department should have the power of revocation for just cause. By thus certifying qualified manufacturers they could, in turn, certify all personal airplanes.

Export assistance.—The export of aircraft and aeronautical material provides a volume of business which, by helping to sustain the industry, contributes to the national defense potential and to our economic welfare. The Export-Import Bank should, we believe, be utilized as a financing medium to aid in making sales of aircraft and aeronautical equipment in foreign countries. The Export-Import Bank now requires that the manufacturer assume up to 25 percent of the credit risk. This is beyond the financial means of most of the American aircraft manufacturers at the present time. In view of the national defense advantage, we believe the Bank should be authorized to assume a larger share of the credit risk on export sales of aircraft and aircraft equipment.

Conclusion.—Setting up the National Military Establishment was one of the most important moves in the long struggle to provide the United States with adequate air power. As it settles down into a smooth running organization it can, and must, deal with the many policy problems that have long plagued our aircraft manufacturing industry in peacetime.

A number of those problems have been laid before the Commission in testimony. Our consultants have called our attention to others. We have seen some for ourselves in visiting aircraft and engine factories, and a few of our great research and development centers.

The above recommendations embody our opinion of the minimum requirements of the aircraft industry at the present time. The needs of this important element of our national defense must be dealt with sympathetically by those charged with the security of the United States.

SECTION III

AERONAUTICAL RESEARCH AND DEVELOPMENT[1]

Summary

There is little need to stress the point that intensive research and development in aeronautics are essential to the national defense and to the national welfare. No witness before the Commission presented a contrary view. All agreed that whatever money is spent for the purpose can be looked upon as a vital form of national insurance, a direct contribution toward maintaining our leadership in the air.

Evidence placed before the Commission, however, indicated some need for reappraisal of certain phases of our research programs and policies. During World War II we concentrated on the development of existing types of aircraft for production, and practically abandoned fundamental research in the aeronautical sciences. By VJ-day our reserve of research information was largely exhausted. If we are to have an air establishment of the first quality, we will have to concentrate, as other nations are doing, on our fundamental aeronautical research. Development, that is the making of new aeronautical devices, cannot move ahead faster than our fundamental research.[1]

The established governmental agencies for the conduct and coordination of aeronautical research appear to be doing a good job with the funds at their disposal. Care must constantly be exercised, however, that our research and development programs produce completed articles at frequent intervals that would be immediately useful for a war at any time.

Most witnesses urged the necessity of increased appropriations for the purpose of expanding research activities. In this we concur. We have been convinced that there is urgent need for extending our fundamental knowledge of aerodynamic phenomena in all speed ranges, particularly in the supersonic (above 760 m. p. h. at sea level), as such speeds are of particular importance in the design of high-speed piloted aircraft and of long-range guided missiles. Also, we are seriously deficient in our knowledge of theory and its application in the matter of accurate guidance of missiles to selected targets. Evidence is in the record that we lack the minimum facilities necessary to do an adequate research job in those new areas.

The provision of additional funds, however, will not of itself solve the problem. The most serious shortage is in personnel. Due to the hiatus of the war years in the output of young engineers and scientists, we are short of qualified people. Recognizing this need, the Commission is unanimous in its belief that every possible encouragement should be given to our universities and scientific institutions to train more, and better aeronautical scientists. Undergraduate courses should be strengthened and exceptional students encouraged to continue in advanced work. The proposed establishment of a National Science Foundation with its program of grants and fellowships would help materially. Government contracts for supplemental research granted to educational institutions offer one of the most effective means of providing funds for the purpose. The Commission recommends that this method be developed as far and as fast as is consistent with the results obtained.

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[1]The distinction between the terms "research" and "development" as here used is not always sharp. In general, however, *research* is the seeking for new basic knowledge from which better aircraft, missiles, or other aeronautic devices may be *developed.*

International Competition

For national security, second best military aircraft are simply not good enough. On the commercial side, inefficient or unsafe aircraft and unreliable or inadequate navigational aids cannot be tolerated.

We must keep ahead in the race for military supremacy. And it is a race. Although the great aeronautical laboratories of Germany, Italy, and Japan have been dismantled and destroyed, other strong contenders are now in the field. Britain, France, and Russia are vigorously pushing new aeronautical research programs. The British, in spite of a generally strained economy, have made drastic sacrifices to make available this year some 30,000,000 pounds sterling ($120,000,000) for air research. They are modernizing war-worn equipment and are installing extensive new facilities, among them a National Gas Turbine Establishment at Whetstone, the new Aeronautical Research Center at Bedford, and the new Aeronautical Research Center at Bedford, and the new Telecommunications Establishment at Malvern.

The French, although seriously hampered by postwar fiscal and social problems, are reported to be building a large group of high-speed wind tunnels somewhere in the French Alps. A huge hydro-electric station, developing some 100,000 horsepower, is being installed at the site to provide the necessary power. Other prewar research facilities are being reactivated as fast as general economic conditions permit.

There is published evidence that aeronautical research and development programs on a very large scale are under way in Russia.

Although we have difficulty in obtaining aeronautical information from other countries, they have almost complete access to our own data. We spread our latest advances in the aeronautical arts on the pages of our newspapers and magazines. The Air Force and the Navy appear to be competing publicly for recognition of their individual progress. When a new speed record is set, or a new model of advanced design is pushed out of the shop, its physical dimensions and its performance figures are quoted, and clear photographs showing the general configuration and the details of the new plane are broadcast. Admittedly, there are practical difficulties in keeping a B-36 or a B-47 hidden from public view. Also, it is argued the taxpayer has a right to know what he is getting for his money. But, whatever the difficulties or objections, the Commission believes that continuing and rigid enforcement of wartime security measures with regard to advanced aeronautical development is necessary now. For reasons outlined earlier in this report, it is desirable that our military readiness and our potential strength be known to the world. But we cannot now afford to show all the cards in our hand. The stakes are too high.

Status of U. S. Aeronautical Research and Development

Military aviation in the United States had its beginning with the establishment of the Aviation Section, Signal Corps, in 1907. A few years later (1911) the Navy set up an Aeronautics Group in the Bureau of Navigation, which later became the Bureau of Aeronautics. By 1915 it had become obvious that neither branch of the service could cope adequately with the problem of satisfying a growing need for basic research in aeronautics. To meet that need, Congress authorized (1915) the formation of the National Advisory Committee for Aeronautics, an independent Federal agency. Since that time, the NACA has produced most of the basic aerodynamic and structural data from which the Navy and the Air Force and the aviation industry have developed practically all commercial and military aircraft. It now operates three of the world's largest aeronautical laboratories, (1) at Langley Field, Va.; (2) at Moffett Field, Calif.; and (3) at Cleveland, Ohio. The first two cover aerodynamic, hydrodynamic, structural, and flight research. The latter engages chiefly in power plant studies of all kinds.

On March 21, 1946, a National Aeronautical Research Policy was formulated by the Army Air Forces, the Navy's Bureau of Aeronautics, the Civil Aeronautics Administration, the NACA and the aircraft industry. It was promulgated largely to clarify the relationships of the NACA with the other research and development agencies. Under this policy, the NACA is charged with the responsibility for "research in the aeronautical sciences"; the military services with the responsibility for the "evaluation of military aircraft and equipment and the exploration of possible military applications of research results"; the Civil Aeronautics Administration with the responsibility of "expediting the practical use in civil aeronautics of new ly developed aircraft and equipment"; and the aircraft industry with the responsibility for the "application of research results in the design and development of improved aircraft equipment, both civil and military." In addition, the policy statement sets forth the conditions under which the research facilities of the NACA are to be available to the other groups.

Work done by the Air Force (at Wright Field, Dayton, Muroc Air Base, Calif., and Eglin Field, Fla.) and by the Navy (at Philadelphia Navy Yard, Patuxent River, Md., and at Point Mugu, Calif.) consists largely of the evaluation and testing of aircraft, power plants and their components, and guided missiles. These laboratories draw on the NACA for fundamental data. They collaborate with the aircraft industry in developing practical weapons for military use.

Certain other Government agencies conduct research in fields related to aeronautics. The Civil Aeronautics Administration operates a Technical Development Center at Indianapolis, Ind., for the testing and evaluating of airways equipment and miscellaneous aircraft auxiliaries for commercial use. The United States Weather Bureau and the United States Bureau of Standards are actively engaged in research and development projects with aviation application.

In order to increase research capacity during the war, many universities and engineering schools were awarded aeronautical research projects under Government contract. The results have been excellent. Not only do such projects yield answers to specific research problems, but they have developed a nucleus of trained research personnel that is definitely a national asset. They also provide a needed element of competition on fundamental research problems.

Many of the companies in the aircraft manufacturing industries have installed elaborate facilities for the development and testing of aircraft and components. These laboratories, however, are generally operated for the improvement of particular products, and their findings contribute more than a little to the generally available pool of information.

Since our national security is keyed directly to the state of our aeronautical knowledge, it is only logical that the responsibility for planning and guiding of the Government's over-all development programs (as distinct from research) should be vested in the military. The recently established Research and Development Board within the new National Military Establishment is charged with this responsibility. Through its several technical committees and subcommittees it coordinates the aeronautical programs of the Air Force, Navy, and other agencies with activities in other related scentific fields, authoritatively within the National Military Establishment and on a voluntary basis with respect to external agencies. The establishment of this Board is, in the opinion of the Commission, a proper and sound means of advancing and coordinating this very important work.

The financial support of aeronautical research in the United States has been accepted as a proper responsibility of Government. The work contributes directly to the national defense, and the scale of operations is now so great that no civilian organization could foot the bill. Expenditures for the purposes actually increased in the first postwar year (fiscal 1946) to approximately $450,000,000 roughly

$100,000,000 over the wartime peak. The following fiscal year (1947), appropriations dropped back to some $240,000,000.

For fiscal 1948, the Government is spending about $312,000,000 for aeronautical research and development. This figure represents the total direct effort toward the solution of problems in the aeronautical sciences. Other branches of the physical sciences, however, are making increasing contributions to the field of aeronautics. For example, research in the ceramic industry may lead to improvements in the design of jet turbine blading, or physiological research may yield results that may change the design of pressurized cockpits for high altitude fighters. It is difficult to evaluate the worth of such contributions in dollars, but it is evident that the total amount of money going into aeronautical research is considerably greater than the figures specifically earmarked in the budgets.

The 1948 appropriations for aeronautical research and development in the several agencies is shown in the following table:

Aeronautical Research and Development Expenditures Fiscal Year 1948

Agency	Expenditures	
	Amount	Percent of total
Air Force	$145,316,000	46.6
Bureau of Aeronautics—Navy	75,000,000	24.0
National Advisory Committee for Aeronautics	43,449,000	13.9
Bureau of Ordnance—Navy	30,000,000	9.7
Ordnance Department—Army	11,000,000	3.5
Office of Naval Research	4,952,000	1.6
Civil Aeronautics Administration	1,670,000	.5
Weather Bureau	521,000	.2
Bureau of Standards[1]	[1](838,200)	----
Total	$311,908,000	100.0

[1]Aeronautical research and development projects conducted by the Bureau of Standards are financed by contributions from other agencies of the Government. The amount shown is included in the above items.

The military services, together with the NACA, absorb approximately 99 percent of the entire program. The Air Force alone takes about half.

Aeronautical research and development programs within the aircraft industry are almost entirely supported by the armed forces. Although some very important research is carried out by industry at its own expense, the cost is small when compared with that financed by the Government. The work carried on by the aircraft companies is chiefly development of particular items under contract with the services. If, for example, the services need a ground-to-air missile with certain characteristics, contracts may be let to several aircraft companies to provide a number of design studies. The development—that is, the attaining of the desired result—is left to the ingenuity of the companies.

The armed forces will allocate approximately $168,0000,000 for research and development contracts with the aircraft industry during the fiscal year 1948. In the main, the work performed under such contracts is prototype development—the experimental construction of new aircraft, propulsion units or allied equipment for test purposes only. In some cases, of which the RAND project is an example, the studies are more academic in nature, and no physical article, except a report, is called for under the contract.

Aeronautical research work in educational and scientific institutions is almost entirely supported by the Government. Few universities could sponsor extensive aeronautical projects with their own funds. The total to be allocated by all Government agencies for such work in universities, during the year 1948, is $31,000,000. The NACA's share is $800,000.

Thus, of the total appropriations to the services, approximately $200,000,000 goes for research and development work carried on by the aircraft industry and in educational and scientific institutions under contract to the services. The balance is spent in planning and evaluation by the services in their own facilities.

Suggested Areas for Continued Research

This Commission does not consider it within its province to evaluate specific research projects, nor to recommend detailed programs to be followed by research laboratories. Such matters are clearly within the scope of the National Research and Development Board, the NACA, and the Armed Services. During the course of the testimony, however, a number of suggestions were made concerning additional research projects or dsirable changes in specific current programs. They are listed below. Doubless there are many other which did not come to the Commission's attention. The arrangement is alphabetical, and does not in any way reflect an order of relative importance.

Atomic propulsion.—The possibility of employing atomic energy for the propulsion of aircraft and guided missiles is sufficiently important to warrant vigorous action by the Atomic Energy Commission, the Air Force, the Navy, and the NACA. Some work of a preliminary nature has already been done in this field by the AEC, the Air Force and its NEPA project. Immediate steps should be taken to intensify research effort in this field under a plan which would be supported by all of the above agencies and under which the project would be given the benefit of all the background information in the atomic field actually needed by the recipients for the appropriate performance of their respective functions.

Electronics.—The science of electronics contributes to almost every segment of modern industry. It is an essential tool for aeronautical research. The safe functioning of all commercial and military aircraft depends upon it. It makes a vital contribution to our national security.

At least three very important phases of current aeronautical development involve extensive use of complicated electronic devices—(1) the detection of the approach of enemy aircraft or missiles; (2) the guidance of our own missiles and pilotless aircraft to targets, and (3) the navigational and blind landing requirements of all aircraft. As a result, the Air Force is expending approximately 12 percent of all research and development funds for the current year on electronics— and the Navy's Bureau of Aeronautics, 18 percent.

The funds allocated in fiscal 1948 for electronics development for aeronautics by the two services are as follows:

	Research	Development	Total
Air Force	3,300,000	10,780,000	14,080,000
Bureau of Aeronautics	1,700,000	10,800,000	12,500,000
Total	5,000,000	21,580,000	26,580,000

The Air Force electronics facilities consist chiefly of the Electronics Subdivision at Wright Field; the Watson Laboratories at Eatontown, N. J., the Cambridge Field Station at Cambridge, Mass.; and the Flight Research Units at Middletown, Pa., and Boca Raton, Fla. The Navy's electronic work, conducted principally under the Bureau of Aeronautics and the Office of Naval Research, is carried on at the Naval Research Laboratory at Anacostia. The Bureau of Standards operates the Central Radio Propagation Laboratory at Washington. A committee on electronics of the Research and Development Board is charged with the coordination of these activities.

In addition to the above, the Civil Aeronautics Administration conducts its investigations and evaluations of electronic navigational equipment at its own station at Indianapolis Airport. Also a number of other laboratories throughout the country are conducting a wide range of electronic research. Extensive work is being done in the aeronautical industry, in universities, and in the large electric equipment manufacturing companies such as General Electric, Westinghouse, Bell Telephone Laboratories, RCA, and many others.

It has been suggested to the Commission that the extent and diversity of electronic research calls for better means of coordination than now exist. The question has been raised as to whether or not the results obtained in the various laboratories are being made available in full to researchers in guided missiles, and in the more highly specialized fields of aeronautics. To resolve these problems, the establishment of a new Government agency, a National Advisory Committee for Electronics paralleling the NACA, has been suggested. Its primary function would be coordination, but the plan, as proposed, contemplates also the establishment of research laboratories, including an extensive firing range for free-flight tests of guided missiles.

After studying plans submitted by existing research agencies for new laboratories and new flight test stations and missile firing ranges, it would appear that adequate facilities to handle the electronic requirements for aeronautical research for the foreseeable future will be forthcoming. The injection of an entirely new organization into the field would tend to complicate rather than simplify the problems. It will be difficult enough to find technically qualified people to man the presently projected facilities without considering another one.

Further, whatever coordination is required, as to the armed services, falls properly within the purview of the Research and Development Board. It should extend its Committee activities to cover all governmental and private agencies engaged in electronic research. The Commission feels that the coordination problem can well be left in the hands of the Board, and that the formation of an NACE although possibly desirable at some future date, is not necessary at the present time.

Guided missiles.—During the latter phases of World War II, Germany, after a great amount of basic research and experimentation, evolved two forms of guided missiles—the subsonic airborne "buzz bomb," V-1, and the supersonic, high altitude rocket, V-2. Both were reasonably successful at ranges up to 200 miles. In intercontinental warfare of the future, both types may prove to be useful, but their characteristics must be greatly improved and their range must be greatly extended.

The German techniques are now well known, but the development of successful missiles for extremely long ranges is still a tremendous problem. It will require the most intensive application of our best research talent, coupled with the expenditure of very large amounts of money for experimentation, before we can hope to produce a pilotless weapon of either class that will have a reasonable chance of hitting a distant selected target.

We must also consider the defense against missiles launched against us, an even more difficult problem. Nothing was developed during the war that could cope with the V-2, yet we must be prepared to intercept and to destroy invisible missiles that will plunge toward our cities out of the stratosphere at speeds of over a mile per second. The practical difficulties involved in detecting, tracking, intercepting, and destroying them with other missiles miles above the earth are enormous. Whether or not this can ever be done is not clear.

The rapid development of long-range missiles for offense, and of accurate, high-altitude target-seeking missiles for defense are of great importance to our national security. Research in these areas must be given the highest priority. Further, research effort must not be limited by failure to provide adequate funds. What may appear to be over-generosity in appropriations now may easily prove most economical in the long run.

The funds being spent this year on guided-missiles research are not insignificant. Some $75,000,000—almost one-quarter of the total research and development appropriation—are earmarked for the purpose. This work also benefits indirectly from appropriations for research in many other fields.

The figures which have been furnished us indicate some disparity of effort in the subsonic and in the supersonic, pointing up a trend toward the abandonment of the slower, more vulnerable missiles. The Commission has been advised, however, that the subsonic missile offers the most practical means of testing and developing the intricate guidance mechanisms for the supersonic types, and it suggests, therefore, that the technique be fully exploited before funds for subsonic research are entirely eliminated.

The Commission has noted that at least four agencies of the National Defense Establishment are concerned with research on guided missiles. It understands that their activities are coordinated through a very active committee of the Research and Development Board. In view of the extremely high cost of this work, such coordination should be given high priority.

From the evidence submitted, it appears that there may be some danger of overrunning our basic knowledge in an effort to develop production articles too soon in order to justify the optimistic predictions of the "push-button warfare" protagonists. We must first be certain that we are on the right track, and not permit ourselves to be led up blind alleys by too great impatience for results.

Here is a case where making haste slowly will certainly pay. A modern long-range military missile is an exceedingly complicated device built of the finest materials to watchmaker's standards. It depends for its proper functioning on the solution of the most complex problems in aerodynamics, ballistics, electronics, and metallurgy. It is extremely expensive. Time and money will be wasted unless a reasonable balance can be maintained between research progress and development demand.

Helicopters.—The direct-lift, rotary-wing type of aircraft appears so promising that continuous research and development effort is warranted. It has many possible military and commercial uses. Its capabilities for rescue work at sea and in isolated areas have been well demonstrated by the United States Coast Guard. There are many other applications that should be thoroughly explored. The direction of the research and the priorities to be assigned to helicopter investigations are matters to be decided by the NACA. There are several young and vigorous companies in the field that may be counted upon to push helicopter development as fast as the basic data become available to them.

Lighter-than-air.—We have been advised that nonrigid airships (blimps) of the type used during World War II will be useful in the future for carrying radar and other devices for the detection of submarines. The Commission has no comment to offer in this connection except that the Navy should continue whatever research and development effort may be necessary to insure the provision of lighter-than-air equipment most suitable for its special purposes.

Regarding the large rigid airship, the decision made by the Army and the Navy some years ago that it had little military use appears to have been sound. The armed services must decide such matters on the basis of their special requirements for carrying out their missions. A case has been presented for the large airship as an economic means of long-range transport for commercial passengers and cargo. If the argument is sound, private capital will no doubt be attracted to the project—and there should be little need for Government subsidy.

Personal aircraft.—Elsewhere in this report the economics of personal flying have been discussed. The assistance given to the private owner by the Government in providing and in maintaining airports and airways has also been noted.

Another way in which Government may properly encourage the development of aircraft suitable for private use is by the NACA continuing some research directly applicable to small aircraft. Any device that would make possible lower landing speeds coupled with higher top speeds would be significant from the standpoint of the private pilot and would have useful military implications. Slotted wings and trailing-edge flaps have been the subject of NACA investigations for many years, but further research on boundary-layer control would appear to be useful. Unconventional configurations (possibly combining the principles of the helicopter and the fixed-wing airplane) should be fully explored, as such studies might open new fields for designers in their search for the ideal aircraft for the private owner.

The NACA effort in these areas should be limited strictly to basic research, and not be applied to the development of any commercial article. In such fields of activity, the normal laws of economics should control the direction and rate of development.

The military services cannot offer much in the way of direct financial assistance to the individual experimenter who may have a new idea for the development of a new type of personal aircraft. They should lend what encouragement they can, however, in the form of loans of surplus or semiobsolete equipment for experimental purposes. The prewar practice of lending engines, instruments, propellers, etc., should be pursued whenever occasion offers. When such equipment is thus loaned, the services should be given first information on any new inventions or developments which may result.

Power plants.—The Commission has been advised by witnesses that gas turbines and rocket engines will ultimately replace reciprocating engines in future military aircraft. There is no doubt that these new and powerful power plants hold great promise for the future and research and development on them must be pursued diligently. The jet engine is applicable to high-speed fighters and fast bombers. It is the power plant that will make possible routine flights in the supersonic-speed range. Its development, therefore, is of prime importance. The present limitation of the jet engine is its high fuel consumption, which reduces the range of the plane. Its service life is also relatively short. Research must be directed toward overcoming both handicaps. The turbine-propeller combination offers possibilities of range improvement at somewhat lower aircraft speeds. Continued research and development on this type is also important.

The suggestion has been made that all research and development on piston-type engines should be abandoned to permit full concentration on the newer types. In this we cannot agree. The conventional combination of the piston engine and propeller will be useful for many years for both long-range bombers and transports and, therefore, any suggestion of the abandonment of research and development in this field seems premature. Moreover, it is not impossible that new applications of ducted fan or compressor jet designs may actually open up new uses for the piston engine. These potentials should be completely exhausted before the conventional engine is discarded.

Transport equipment.—The design of transport and cargo aircraft benefits directly from research and development on military types. As far as basic theory is concerned, laboratory data secured for one class applies equally well to the other. For this reason there appears to be little need for specialized basic research (apart from development) on the airplanes themselves. It is obvious, however, that there is an urgent need for improvement in equipment and methods required to increase the safety and regularity of transport operations, civil or military. The most important single item for intensified research is in the field of navigation, particularly the problem of making safe landings on airfields where visibility is limited because of bad weather conditions.

The Army, Navy, and CAA are conducting research and development in all-weather flying techniques. During the past 10 years, some progress has been made, but the surface of the problem has only been scratched. We are still a long way from the goal of 100 percent safety and 100 percent schedule regularity.

The Commission has heard a great deal of testimony regarding the several systems that have been devised for making blind landings with aircraft. Whether

Ground Controlled Approach (GCA) or Instrument Landing System (ILS) or any combination thereof is proper for any particular site is a matter that must be decided on a purely technical basis. The systems are not competitive. One supplements the other, but the combination is extremely expensive. There may be more effective and more economical ways of doing the job.

The Government is now making installations of one or both systems at some major airports in the United States. This is certainly a long step in the right direction. At best, however, these installations do not permit full operation under all weather conditions. Their capacity for the safe handling of traffic is far below requirements at many air terminals. Although they are far better than anything that has heretofore been available, they do not yet permit the degree of safety and regularity of operations that must be attained before our air transportation system can be fully acceptable. More money and more research effort must be put on the problem immediately. The public interest demands a solution at the earliest possible moment.

Since the blind landing of military aircraft in wartime may be even more important than the handling of commercial aircraft in peacetime, the Research and Development Board of the National Military Establishment should take the matters under immediate advisement in its Air Navigation Committee.

The Air Coordinating Committee has set up a subcommittee with members from airlines, Department of Commerce, military services, and the manufacturers to pull together all the existing facts and to recommend a course of action to be followed. The responsibility for future development should be clarified—whether it should be in the hands of the military or of the civil air authorities. The ACC should also advise the Congress as to the appropriations which should be made annually to implement its recommendations.

Since the problem of weather is so intimately involved, the recommendation should be extended to cover whatever research appears necessary in that field. The work so far carried out by the Armed Services and the Weather Bureau on the structure of thunderstorms, the behavior of cyclones and hurricanes, and on other natural phenomena has opened the door to better understanding of the weather. The possibility of inducing precipitation or of dispersing fogs around airports by artificial means has important civil and military implications. Vigorous research should be continued in such fields.

Recommendations—Research Policy

The Commission has, of necessity, limited itself in the preceding paragraphs to outlining certain suggestions for particular avenues of research. Paradoxically, it can be more specific in the broader areas of policy.

Budgetary policy.—The ordinary procedures laid down by the Bureau of the Budget for the procurement of specific articles are inadequate when applied to research projects. When a particular object is the end-point of a purchase order, a specification may be written, a definite delivery date agreed upon, and an estimate of cost may be made. A research project, on the other hand, particularly in a field which is as fluid as that of the aeronautical sciences, does not lend itself to this approach. It is practically impossible to forecast the outcome of a pure research project, to say nothing of detailing the procedures that must be followed, the inventions that may be necessary, or the wastage that may develop in the course of the work. To try to satisfy a formula which involves a detailed description of the proposed research and its expected results approximately a year in advance of the beginning of the work is a sheer waste of effort for the research agency and for the Bureau of the Budget alike.

To simplify procedures and to eliminate restrictive budgeting limitations on urgent research programs, the Commission recommends that each aeronautical research agency be allocated a lump sum annually. The appropriation should be based on its estimated over-all operating requirements, modified by its performance record, the importance of the objective toward which the project is aimed, and the then-current over-all budget situation. No fixed amount should be allocated to any particular piece of research. The agency should have blanket permission to distribute funds to meet the needs of the several projects on its program. At the end of each fiscal year it would be required to present a detailed accounting of the utilization of its funds to the Bureau of the Budget and to the Congress. The Commission feels that by annual review, research funds could be reasonably controlled without imposing limitations which now tend to retard progress.

The above applies to funds required for the conduct of research. Frequently an agency is hampered because an unexpected need arises within a fiscal period for the construction of a new facility or for the installation of some equipment urgently required to carry out a particular project. To meet such emergencies the Commission further recommends that each agency be allotted annually a revolving fund for the construction of new facilities. Expenditures from this fund should be approved by the Director of the Budget and should be reviewed annually by the Congress.

One of the most serious limitations on research at the present time is the inability on the part of a research agency or a contractor to commit funds for a period greater than 2 years beyond the fiscal year for which the funds are appropriated. Research is inherently a long-term matter. Few projects can yield satisfactory results if rushed to completion to meet a short-term contractual deadline. Adequate planning cannot be carried out on such a basis. It is difficult to secure and to retain the type of personnel required unless some continuity of employment is guaranteed. The Commission recommends, therefore, that appropriate legislation be passed so that research agencies may be granted contracting authorization to cover a 5-year period, and that research contracts covering work in universities and outside laboratories be drawn on a 5-year, rather than on a 1- or 2-year basis. It urges the enactment by Congress of H. R. 4035 (80th Cong.). This bill facilitates research and development by and for the Air Force and Navy. It authorizes the Secretaries to establish Research Advisory Committees and to employ experts, and provides for the availability of appropriations for four fiscal years following the year of obligation.

Some safeguards must be provided. A limit must be put on the current rate of expenditure to insure that the large volume of contract carry-over will not be used up at an improper rate and run out too soon. Also some provision should be made to recover funds that may become frozen in contracts that prove to be impracticable of completion, and should be terminated.

It would appear worthwhile to encourage manufacturers to accept research and development contracts more readily by liberalizing policies regarding cost allowances. It is now the practice to disallow most of the items that would usually be included as normal overhead in negotiating commercial contracts. Fees for management are trimmed down or eliminated entirely. As a result, manufacturers tend to shy away from taking contracts on projects that may be inherently worthwhile, but on which they stand to lose money or, at least, break even.

Items for research are generally disallowed in aircraft contracts, unless it can be shown that the research involved applies directly to a particular contract. Pure research can seldom be so specific. The net result has been to discourage general research on the part of aircraft manufacturers. They have been forced to rely almost entirely on the output of the NACA for their fundamental information.

The Commission would not argue that research effort by the NACA be reduced in any degree, but it does recommend that Government auditors be allowed more leeway in accepting reasonable costs for research by manufacturers as legitimate charges against development contracts. By thus encouraging manufacturers to increase their own research effort, the aeronautic art will move ahead faster. More research facilities, well dispersed, will come into being—and, most important of all, the roster of aeronautical research workers will tend to expand.

Coordination of research effort.—Under the Policy Statement of March 21, 1946, it is clearly the duty and the responsibility of the NACA to coordinate Government aeronautical research with civilian, industrial, and university programs. Coordination is carried on largely through the NACA technical committees and subcommittees. These groups are made up of representatives of the military, civil aeronautical agencies of Government, the aircraft industrial and educational and scientific institutions. It has been stated that the present coordination is not adequate due mainly to shortages of personnel within the NACA staff.

The Commission recommends that the NACA be granted funds to strengthen its organization where necessary for the proper coordination of all aeronautical research. The heads of all Government agencies involved in aeronautics are urged to establish and enforce a policy of seeking the advice of the NACA in the planning and execution of any of their own aeronautical research projects.

It has been suggested that the NACA should expand its program of research outside of its own laboratories in order to bring to bear as much of the Nation's air research potential as possible on the urgent problems in the field. We agree. The NACA should take the leading role in sponsoring supplementary aeronautical research in educational and scientific institutions. There is a limit, of course, to the rate at which Government funds can be expended efficiently in such institutions. The availability of qualified personnel is usually the controlling factor, but it is unlikely that the capacity of our educational institutions to absorb additional research in aeronautics has yet been reached. It should be expanded to its fullest extent.

It would appear to be profitable for all Government agencies dealing in aeronautics to have a limited program of this nature, coordinated, of course, through the NACA. The benefit to be derived from direct association of military and civil government personnel with scientists has been clearly demonstrated by the wartime and postwar contract research programs of the Office of Naval Research and by the work already done in the universities by the NACA. Also, as has been mentioned earlier, such contracts offer the best available means of training the additional personnel needed for our expanding aeronautical requirements.

Research carried on in this manner should be closely correlated with Government-sponsored research in the basic physical sciences outside of the strict aeronautical field (as covered by the NACA). The machinery for such coordination already exists in part in the newly formed Research and Development Board of the National Military Establishment. It would be further facilitated and broadened by the proposed establishment of a National Science Foundation.

As far as research is concerned, a clear distinction should always be made between *coordination* and *control*. Research of all kinds welcomes coordination, but resists control. Researchers must be kept informed of the work of others in their own and in related fields in order to avoid duplication of effort, but it is fatal to try to steer their thinking toward any predetermined goal. Development may be kept within planned limits, but research must be unrestricted to be of value.

Continuity of research programs.—Research by its very nature is unpredictable. No one can forecast with accuracy the time at which the end result will be available. In a development project, however, the end product is definitely foreseen at the outset and a time table for completion can be set up. Every orderly program for development must be backed by a series of research projects which will permit step-by-step advances as new knowledge becomes available when each intermediate stage of research is completed. All development projects must be consistently reviewed and brought up to date. Only by keeping them in a fluid state can the armed forces be continuously supplied with modern aircraft.

On the other hand, the current international situation requires that behind our air forces in being we have a backlog of fully developed advanced projects ready to be put into production at a moment's notice. We must not become so concerned with long-range "out in the blue" thinking that we overlook the possibility that we may stumble into a war in the immediate future which will require something better than the equipment with which we ended World War II. Research must be continuous and forward-looking, but development projects must go ahead on a step-by-step basis. There must be frequent and definite points at which production of useful articles could be started if necessary. We must never be caught in an emergency with nothing but partially completed projects in our lockers.

New facilities.—A growing need for intensified research in transsonic and supersonic aerodynamics has led recently to many proposals for new supersonic wind tunnels. Various Government departments and a number of aircraft manufacturers have drawn up plans and have sought funds for such equipment. Because high-speed tunnels are expensive and supersonic research is costly, some coordination seemed necessary to avoid waste and duplication of effort. The NACA, quite properly, within the scope of its directive, undertook the job in midsummer of 1945. With the help of the industries and the services, it evolved "A National Program of Transsonic and Supersonic Wind Tunnels," now known as the "Unitary Plan."

The Plan provides for 16 small tunnels to be located in universities and other educational institutions throughout the United States; several new supersonic tunnels at existing Government laboratories; and the establishment of two new research centers, (1) the National Supersonic Research Center (NSRC), and (2) the Wind Tunnel Division of the United States Air Forces' Air Engineering Development Center (AEDC). The function of NSRC is to conduct transsonic and supersonic *research*. The function of AECD is to *test and evaluate* transsonic and supersonic air vehicles.

The NSRC, as planned, is to be an entirely new installation operated under the NACA. It will eventually include a number of supersonic wind tunnels, somewhat larger than those already in existence. The site has not yet been selected. Because of extremely high power required to operate supersonic wind tunnels, it must be located in a section of the country where electric power is cheap and abundant.

The AEDC is designed to perform much the same functions as are now handled by Wright Field, but on a greatly expanded scale. The installation will include facilities for testing and evaluating airframes, engines, propellers, electrical equipment, armament, and other accessories of much larger size than can be handled with the present equipment at Dayton. The most expensive single item is a 40-foot square, transsonic wind tunnel. The estimated cost of the tunnel is $140,000,000, and 500,000 horsepower will be required to operate it. A firing range for the launching and testing of guided missiles is also projected. The site for AECD has not been determined. It obviously must be located in an area where large quantities of electric power are available.

We are thoroughly convinced, however, that the United States is dangerously short of equipment for research in the transsonic and supersonic speed ranges. This deficiency should be remedied as quickly as possible. We recommend that the 16 supersonic tunnels projected for the universities be authorized and installed as quickly as possible. This will not only expand our available facilities, but will tend to alleviate the present personnel shortage by training more students in aeronautical research techniques. We recommend also that we proceed without delay in supplementing existing laboratory equipment with the new tunnels projected under the Unitary Plan in whatever order of priority and at whatever rate as will be recommended by the Research and Development Board. The Board will provide the necessary coordination to keep the programs in balance, and insure that our research establishments will get the equipment they need.

Personnel.—The most serious bottleneck in the research and development picture as laid before the Commission is not money nor facilities—but men. During the course of the war, the output of engineering and scientific graduates from our schools and universities suffered a serious decline. We are short-handed now, so there is real danger that we may find ourselves without qualified personnel to man the new wind tunnels and test centers that are being planned. The problem is acute in all scientific fields. It has been dealt with in detail by Dr. John R. Steelman in the report of the President's Scientific Research Board on "Science and Public Policy."

The Commission recommends that education in the aeronautical sciences be given high priority in research policy discussions. The fact that the problem was not covered in the drafting of the Policy Statement of March 21, 1946, is a defect in that document which should be corrected. To insure uniformity of relationships and continuity of effort, some national program must be set up on a permanent basis, under a National Science Foundation.

The placing of supplemental research contracts in universities and other educational institutions is one way of improving the situation, but that in itself is not enough. Without further encouragement, the demands for scientific personnel of all kinds will cut into the available supply of those who might normally tend toward specialization in the aeronautical sciences.

One way to attract capable men for aeronautical research, particularly in Government, would be to lift the current limitation on salaries. Under the present Classification Act, the limit is $10,000 a year, unless raised in individual cases by special act of Congress, or under certain limited powers within the National Military Establishment. In view of the impossibility of attracting top-calibre scientists at such a figure, with industry also bidding for their services, we recommend that the Congress remove the salary ceiling for such categories.

Once having induced good civilian research workers to enter Government service, they must not be driven out by poor working conditions and bad housing for themselves and their families. This is particularly true where their jobs are in arid or remote localities. The Air Force Air Base at Muroc Dry Lake in California is one case in point which we happen to have seen. It is an ideal place for high-speed testing of rocket motors and piloted aircraft, but living quarters for the staff are substandard, and along with other similar installations, should be improved immediately.

Continuity of leadership in research is highly desirable, particularly in view of the long-range nature of aeronautical problems. The research and development work of the armed services has suffered because of frequent transfers of officer personnel from engineering to operations or from shore to sea duty. Such rapid turn-over in personnel puts a serious handicap on research projects because of the loss of individual experience and the break-up of long-range thinking it entails. Continuity is important at policy-forming levels, but it is also necessary down through the lower echelons. Any research organization that does not encourage specialization of its personnel, and that suffers frequent changes in its research staff, is destined to mediocrity.

The Commission recommends, therefore, that the Servces offer every possible inducement for capable officers to enter aeronautical research and development work. They should be given opportunity to take graduate work in their specialty in the best civilian schools in the country at Government expense. They should be assured that they will be allowed to work in their special fields without interruption, and that their opportunities for advancement in rank will not be prejudiced as a result. Only by so doing will we be assured of the continuity of research leadership that we require.

SECTION IV

CIVIL AVIATION

The air lines, the most important element of civil aviation, are passing through one of the most serious crises of their history. The domestic trunk lines of the country suffered an operating loss of approximately $22,000,000 in the fiscal year ending June 30, 1947.

This situation is significant for two reasons. If not relieved it will contribute to rapid deterioration of air-line service to the public. A second reason is now of even greater importance. The air lines have a fleet of aircraft of great value to the military services as a reserve in time of war. As a potential military auxiliary, the air lines must be kept strong and healthy. They are not in such a condition at the present time.

Most of the air lines are in financial difficulties for a number of reasons. Both their management and Government aviation officials were overoptimistic as to the volume of postwar passenger traffic. Starved for both airplanes and personnel during the war, the lines hired large numbers of new people when the war ended, ordered many new airplanes and in several instances made what may prove to have been unwise route extensions.

Losses for a number of lines began in the latter half of 1946. There were high expenditures due to the changeover from war to peacetime conditions. These included costs from the expansion of routes, services, and organizations; the introduction of new types of airplanes; rapid and unforeseeable cost increases; a reduction in passenger fares and mail rates coupled with a decline in mail volume; the reappearance of seasonal declines in passenger traffic; a series of dramatic accidents; and public dissatisfactiton resulting from lack of dependability. Strikes and the grounding of airplanes have added additional heavy financial burdens on some lines. To a large extent the causes of these losses are temporary, but only if the air lines and the Government profit by the recent experience.

We have heard much testimony on what to do to rectify the present situation. We will discuss the major problems under the headings of Air Mail Payments and Subsidy, Safety and Regularity, Economic Regulation, Taxation, and International Transport Problems.

Air Mail Payments and Subsidy

The Government has had a policy of encouraging the development of an air transport system in this country ever since 1918. In 1925 the Kelly Act provided for financial assistance to private air line operators. The most important promotional legislation was the Civil Aeronautics Act of 1938. Throughout the prewar years, the air transport system which we had in this country could not have existed without subsidies by the Government. The Congress recognized that a strong air transport industry was necessary for national defense, for American commerce and for the postal service, and accordingly enacted the policy of governmental financial aid to the air lines.

By the end of 1942, several of the largest air transport companies which had grown up with the aid of subsidy had reached a point where they could earn a profit without depending on subsidy mail pay. Their receipts from passenger service, express service, and a mail payment based on a rate roughly equal to the passenger rate, more than offset their total expenses. This was an important milestone in the history of air transportation, for it indicated a successful policy on the part of the

Government and successful management by those companies which had reached the much desired point of relative self-sufficiency.

Throughout the war the air lines were financially strengthened by military contract work plus abnormally high load factors. In both the CAB and the air lines it was believed that a greatly increased demand for air transportation in the postwar years would continue this trend toward self-sufficiency. The difficulties in which the air transport industry now finds itself can be traced primarily to over-expansion based on the mistaken assumptions of postwar traffic.

Although some air line problems of 1947 may differ from those of the prewar period, the over-all situation is the same: The revenue from passengers and cargo, plus a revenue for the carriage of the mail roughly equal to the passenger rate, will not support the operations of many of the companies. If they are to continue in operation and start again up the ladder toward self-sufficiency the Government will have to increase the mail rates.

There is no need to change the law in this respect. It already is drawn to cover exactly such a situation.

The method of determining mail payment for subsidized carriers under the Civil Aeronautics Act of 1938 was developed by the Civil Aeronautics Board as follows: On the basis of estimates made by an air line and by the Board's staff, the Civil Aeronautics Board determined the probable future income to the line from the carriage of passengers and property. It likewise determined the probable over-all cost of the operations. Such a cost figure invariably exceeded the estimated nonmail revenues. The mail rate then was set at a figure which provided enough additional income to close the gap between nonmail revenues and expenses incurred under honest, economic and efficient management and to leave something over as a profit.

By "subsidy" is meant the payment to an air line for the carriage of mail of a sum greater than that to which the carrier would be entitled for the simple performance of this function at a service rate on a strictly business basis. The excess of payments above the "service" rate is a subsidy, or as described in the Civil Aeronautics Act, a "need" payment, based on the need of the air line for financial assistance to balance its expenses with its revenues and earn a reasonable profit.

As noted above, in the early days of the war certain lines reached a stage where mail payments could be based on a rate roughly equivalent to the passenger rate. Since that time there have been two principal ways of paying for the carriage of mail. Ton-mile payments have been made to relatively self-sufficient carriers; plane-mile payments have been made to other carriers considered to be in the "need" class and therefore requiring higher mail rates. In either case, if the carrier has found that the rate does not in fact enable it to cover its expenses, it may petition the Board to increase the rate. When the Board has examined the new facts it may fix a new future rate. The Board may and usually does then also set a retroactive rate back to the date on which the carrier petitioned for a rate increase.

In the case of the international carriers, the Board has followed a slightly different practice. It usually fixed an avowedly temporary, experimental rate and then, in the light of experience, adjusts this rate to meet the actual needs of the carrier over a past period of a year or more. The rate continues to be a temporary one until such time as the Board feels experience is sufficient to enable it to fix a permanent rate, if necessary retroactive to the date of the original petition.

Recently the Board has modified somewhat the usual forms of domestic mail payment for certain carriers in special distress. In grave emergencies such as existed during the winter of 1946-47, the Board sets an emergency rate without taking its usual careful consideration and then starts a careful scrutiny of the justification of the expenses of the companies to make sure that the gap between nonmail revenues and expenses is not due to uneconomical, inefficient, or dishonest management.

The task of making the estimates necessary to setting a mail rate is a difficult one almost always involving disagreement between the claims of the interested air line and the Government officials who must be concerned about the public expenditure of funds.

We consider that direct Government financial aid to commercial air lines is fully justified on grounds of national security and economic welfare. We believe the air transport system of this country can, with such aid now, become self-supporting in the future. We are convinced that any impartial investigators of air transport would endorse the use of public funds to obtain such a sound air transport system. This means the continued granting of subsidies to air lines for an additional period.

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Means must be found to decrease the time necessary for the Civil Aeronautics Board to process rate cases. We believe that the transfer of safety functious out of the Board, an increase in the Board's staff, and an increase in the number of members in order to make possible a special division of the members focusing their attention primarily on rate cases are therefore desirable. These are recommendations in Section V of the report.

It is not only necessary that the Board act quickly in determining air mail rates but that it grant enough mail pay to keep all the lines in business to the extent required by the public interest, provided their difficulties are not due to dishonest, uneconomical or inefficient management. This can be done at a total cost that appears reasonable compared with other Federal expenditures for aviation purposes.

It has been suggested to us that a division in the air mail pay be made to show how much of the pay is for service rendered by the airline and how much is for subsidy. We see no advantage now in disturbing a practical working situation. It is desirable, however, for the Civil Aeronautics Board, in cooperation with the Post Office Department, to study the cost of air mail service with a view to the future when most air lines will be able to operate without subsidy payments. It is to be expected that, as the Civil Aeronautics Board develops new methods of cost accounting in determining fair and reasonable rates for the carriage of passengers and property, it also will develop cost standards applicable to mail carriage.

When the Civil Aeronautics Board made temporary upward adjustments in mail payments for certain carriers in financial difficulties in the spring of 1947, at the same time it wisely initiated field investigations into the efficiency and economy of those carriers. It is admittedly difficult for any Government regulatory agency to determine whether the management of a particular company in any field is in fact efficient and economical. Yet such a requirement is imposed upon the Board by the mail rate provisions of the Civil Aeronautics Act.

It has therefore been suggested to us that standard operating costs for various types of services be developed by the Board. These standard costs would be kept current with changes in the general price level by frequent adjustments to conform to an industry cost index. Components making up the index would be the major items which enter into air-line costs. The standard operating costs could then be used as yardsticks on which "need" air-mail payments could be based. With such yardsticks, "need" mail payments could be made more quickly and bear a closer relation to efficient and economic operation.

We have considered this proposal and believe that it might have substantial advantage to all air lines. The Board might well be able to keep a closer check on efficiency and economy of air-line operation. We realize that the Civil Aeronautics Board has considered similar proposals. We recommend that the Board give this problem further study and investigation.

A suggested financial aid to the air lines would be the carriage of first-class mail by air where delivery would be expedited. Domestic air-mail volume for fiscal 1947 amounted to an estimated 33,000,000 ton-miles. The Post Office Department has estimated an additional 146,000,000 ton-miles of domestic first-class mail which movement by air would expedite. The institution of a policy of moving first-class mail by air whenever the postal service would benefit thereby would increase the volume of air mail by something over eight times in pounds and over five times in ton-miles. The benefits to the air lines by giving them this traffic, even if a large amount were carried at "service" mail rates, are obvious. For during the same period, total mail revenue to the domestic carriers amounted to a little over $21,000,000.

We do not believe, however, that provision of traffic to the air lines is the major criterion in advocating the movement of first-class mail by air without surcharge. Rather, the test as to what first-class mail shall move by air should be the best service to the public. And it is obvious that long-haul mail can often be handled faster by the air lines than by surface carriers.

The Post Office Department estimates a loss of approximately $5,000,000 to domestic surface carriers if first-class mail were to be carried by the air lines whenever such handling gives faster service. The taking of a large volume of first-class mail now handled by surface carriers and giving it to the air lines would not be discriminating against the surface carriers if the service to the public were better. The question raises, however, the over-all problem of the dependence of a war effort on all forms of transportation. We have not gone into that problem but anticipate that the Congress will do so.

The Congress will undoubtedly also consider the fact that carrying first-class mail by air without surcharge, whenever delivery can be expedited thereby, will involve, according to Post Office figures, an additional cost to the Government of some $96,000,000. This loss would come from a decrease in the present profit made on first-class, 3-cent mail, a profit which now subsidies the carriage of other classes of mail.

We understand that the Post Office Department has now under way studies of the cost of inaugurating air parcel post on both domestic and international air routes. Our recommendation is that the step of carrying by air all first-class mail which can be expedited thereby and the step to parcel post service by air not be taken until the air lines achieve a satisfactory regularity status. At that time we recommend that the Congress should give most serious consideration to these proposals.

Safety and Regularity

We have not gone into the technical aspects of safety because the President's Board of Inquiry on Air Safety, appointed June 15, 1947, has been intensively studying the problem. We do, however, wish to make a few comments on this important subject.

In section V of this report, we recommend the establishment of an Air Safety Board.

The question of safety in commercial aviation is of prime importance, not only because of the importance of human life but because of its psychological effect on traffic and the effect of traffic upon the self-sufficiency of the air lines. Air line travel is, in fact, far safer than the public believes. The increasing size of planes, with the resultant increase in number of passengers killed in any one accident, has increased public anxiety out of all proportion to the actual conditions of safety. The disproportionate amount of publicity inevitably given air line crashes gives an unwarranted impression that air line travel is basically unsafe. Statistics on scheduled air-line operations compiled by the Civil Aeronautics Board show that the the chances of fatality in terms of passenger miles flown are very slight.

Normal competitive business factors, between manufacturers and between air lines, as well as the pressures of traffic upon equipment, result in a strong tendency to put new planes into service as quickly as possible. In spite of this, new planes have been put through long and careful test periods. It is our belief, however, that events have proved that these periods have not been long enough.

We recommend that new types of transport planes be operated regularly on non-passenger schedules for a specified mileage before passengers are carried. The period should be sufficiently long to permit mechanical or design weaknesses to become apparent under normal operating conditions. We suggest that the test airplanes be operated day by day on cargo and air-mail runs over approximately the same routes and using the same airports as they will later be flown in passenger use. We realize that both the manufacturer and the air line buying a new type of plane have flown the aircraft for long periods prior to its use in passenger service. But such flights are usually made with special crews, under special conditions, and with special maintenance. We are aware that it may be expensive to follow our recommended practice. The test planes may be operated at a relatively low load factor and income will necessarily be less than if the airplane is carrying passengers.

We are also concerned over the lack of consideration for safety that has been shown by some contract carriers.

The fact that the Civil Aeronautics Board does not have economic regulatory control of contract carriers means that the Board has no official record of their activities. Often the Board's first consciousness of the existence of a charter operation over which its safety regulations do apply is when such accidents as that of the Bermuda Sky Queen or of Page Airways call public attention to the operations. We are confident that the Civil Aeronautics Board is endeavoring to take all possible steps to eliminate hazardous accidents among contract operations. Its effectiveness in this regard will be greatly increased if it is given the economic control of such carriers we recommend below.

Next in importance to increased safety on the air lines is an increase in regularity of service.

Air travel will never be mass transportation until people are reasonably certain that they can depart and arrive on schedule. An illustration of unreliability in good weather is afforded by the figures from an air line flying in and out of New York City in June 1947, which was a good-weather month. This air line offers over-all service considered to be among the best in the country, yet of planes arriving in New York, 89 percent were late and 46 percent of all airplanes were delayed more than 1 hour. Forty-one percent of all airplane departures from New York were late, and 16 percent were over 1 hour late. The steady traveler, most often a business man with appointments to maintain, has learned from bitter experience that his plane will arrive on time about once in ten trips and will depart on time even less often.

Delayed departures are often as irritating as late arrivals. It is irksome to passengers to make a great effort to get to the airport 20 or 30 minutes before scheduled departure, a practice recommended by the air lines, only to wait an hour or more for the take-off. This is especially true on early morning flights.

It is equally irritating for the passengers not only to arrive at their destination hours late but sometimes to arrive at alternate airports which are often miles away from the intended destination of the particular flight. Problems of cancelled flights or the using of alternate airports, however, will not be solved until safe all-weather flying has been achieved.

For safety and regularity on the air lines a basic requirement is a Nation-wide system of air traffic control, navigation, and landing aids. The Federal Government has, for many years, built and operated navigational facilities and emergency landing fields.

We consider that adequate airways and airports coupled with ground aids for traffic control, navigation and landing are so important to the preservation of our air transport system that the Government must continue to be responsible for developing, installing and maintaining a thoroughly adequate network. The Federal Government must accept the financial burden until the users of these aids are in a financial position to pay their fair share of the costs.

All-weather flying will not be achieved until adequate instrument landing systems are installed and operating at a majority of air line stops. Technical knowledge in the field of electronic aids for aviation is far ahead of actual practice. Systems have been developed which would go far toward increasing reliability and safety.

The Civil Aeronautics Administration has already installed improved-type radio and high intensity lighting facilities at a considerable number of air fields. But the program has only been started. The CAA estimates the cost of new construction of air navigation aids, air traffic control and landing aids over the next 5 fiscal years as $190,000,000. The estimated annual cost of maintenance and operation for an integrated network of aids will cost $100,000,000 per year, beginning with 1953.

Before the Congress can be expected to appropriate these large sums, the various interested private groups and responsible Government agencies must reach agreement on a common system of landing aids for immediate installation which will adequately serve both civil and military needs. Such agreement is now being sought by a technical group of experts, the Radio Technical Commission for Aeronautics, at the special request of the Air Coordinating Committee. As soon as agreement has been reached, the Executive Branch of the Government should request the Congress for funds to carry out the necessary air traffic control, navigation and landing aids programs.

Equally important is early agreement on research and development programs in the field of electronic aids to aviation, which will insure that the means of handling traffic will keep pace with the steadily increasing traffic. The Research and Development Board is now engaged in exploring the types of research and development in electronic aids which will have application to both military and civil aviation. The work of this Board should be expedited and should be coordinated with the long-range program on electronic aids, now being developed by the Radio Technical Commission for Aeronautics under the policy direction of the Air Coordinating Committee.

Larger expenditures for electronic aids to air traffic control, navigation, and landing will do more than anything else foreseeable today to build the air lines toward economic self-sufficiency. They will also materially bolster certain phases of the national defense. A carefully worked out program for these aids together with its rapid implementation has become a top priority for civil air transportation.

We believe that Government money can be spent more productively on the means for increased regularity of operation than by increasing subsidy payments to support additional competition in the present air-line system.

The question of dependability with safety is not exclusively a domestic matter. It affects the international operations of our air carriers as well. Testimony has been submitted which shows that aviation communications and electronic aids are in a very unsatisfactory state on most of the international routes now in operation. We have investigated the "joint support" program of the International Civil Aviation Organization. Under this program each nation whose air lines expect to use a facility outside its own territory which is not being constructed by the state where the facility is found to be required, contributes to the cost of its establishment and operation in proportion to the use made of the facility. It was under this program that the nations flying the North Atlantic agreed on the Ocean Weather Stations Program for that area of the World. We believe that the "joint support" program of ICAO provides the best and fairest means of insuring the installation of adequate aviation aids along the routes of the world, and accordingly recommend that the Congress appropriate funds necessary to permit the United States to participate fully.

Airplanes are often late in clear weather due to congested airports. Airports at large centers of population are not adequate for handling air traffic at peak periods. Although the Civil Aeronautics Board might be blamed in part for authorizing more air lines into these airports than can be handled, the solution for this phase of the problem lies in the hands of the local governments. In cities where existing airport facilities are inadequate to handle growing traffic, local government action, plus Federal aid under the Airport Act, can and must remedy the situation. It is obvious that the Nation's airport system must be improved if we are to have a larger fleet of commercial airplanes in daily operation. Specific recommendations on the Federal Airport program are made below.

As discussed above, the Government can and should do much to improve regularity of service on the air lines. But the air lines themselves have control of a large share of their own destiny. They can improve their operations to make air travel more attractive to the public. They are now carrying many empty seats that could be filled if their service were better.

In the investigations of the Commission an interesting fact came to light. It developed that neither the Civil Aeronautics Administration nor the Civil Aeronautics Board keeps records of air line regularity, nor were they, on request, able to supply them. Nor do many of the air lines themselves keep more than fragmentary statistics on this subject.

Now that air travel is accepted as a standard form of transportation, passengers are deeply critical of delays and the whole matter of public dissatisfaction and lack of confidence in the air lines touches everyone's pocketbook because it can directly affect subsidy. We have been given estimates of millions of dollars which the air lines have lost because of flight cancellations and irregularity in general.

Economic Regulation

Domestic route pattern.—The problem whether there is too much or too little competition in our domestic air-transport system involves not only the question of new entries into the field and competitive extensions of the routes of existing companies, but also the important question whether combination of existing companies should be encouraged or prevented by the Board.

We recommend that the Civil Aeronautics Board defer for a short time decisions in new route certification cases. This should not be confused with a freezing of the present route pattern, which would certainly be undesirable. There is, however, a widespread confusion as to the principles which guide the Civil Aeronautics Board in its route determinations. A body which is under the constant pressure of daily decisions of case after case cannot accomplish the careful planning which the development of a national route pattern demands. The present air transportation system has not developed as expected before and during the war. There is need for a comprehensive survey of the present situation and the development of a more cohesive philosophy. The resulting clarification of policy should bring about acceleration of subsequent route decisions.

As a part of such review, if the Board should find any routes no longer now required by public convenience and necessity, it should use any present legal powers such as suspension or reduction of "need" payments to reduce the effect of any errors in the present system. This appears preferable to causing instability in the industry through granting to the Board the right of outright revocation of routes.

If it is found that the Board is unwilling or unable to develop a more clear-cut plan for an over-all domestic air transport pattern, the Congress should give serious thought to giving over-all planning functions of route development to the Secretary of Civil Aviation recommended in Section V. We have had testimony from some of those interested in Government organization and procedure that such a step is now desirable, but we are much impressed with the difficulty, both practical and theoretical, in breaking apart this function from other Board functions, and propose that the Board be given ample opportunity to develop a thoughtful, over-all approach to the problem before such action be taken.

Contract carrier regulation.—A contract carrier in any form of transport can operate when he wishes and renders his service by specific contract with a shipper or group of shippers. The contract carrier has less responsibility than a common carrier and is normally subject to more competition. A common carrier of goods or people holds himself out to serve the public at large and has many responsibilities to the public. In return for undertaking these obligations it has been customary for the Government to grant to the common carrier a limitation on the amount of competition from other common carriers in his field. The Congress found it necessary to give the Interstate Commerce Commission control of both common and contract motor carriers. In contrast, although the Civil Aeronautics Board has economic control over common carriers, it has no such control over contract carriers. This is true in spite of the fact that competition between the two types is often intense.

When the Civil Aeronautics Act was passed the volume of business done by contract carriers was small and few carriers were engaged in contract operations except those who had qualified for common carriers status before the Civil Aeronautics Board.

Much of the development of air cargo over the past 2 years is due to the aggressive and capable management of certain contract cargo carriers. Unfortunately, some passenger contract carriers have misrepresented their services, and have operated illegally as common carriers. Disregard by some of these contract carriers of the responsibility and duty owed to the public by any carrier for hire tends to discredit all carriers in the eyes of the traveling and shipping public.

We believe that the economic regulation of contract carriers is necessary to prevent unstable conditions in the air transport field similar to those in the motor carrier field prior to the Motor Carrier Act of 1935. The difficulties encountered by the Civil Aeronautics Board during the past 2 years as regards contract carriers is adequate evidence that the Board should be given the authority to regulate all types of carriers for hire. There should of course be adequate provision in any new legislation to protect legitimate contract carrier rights of currently operating contract air carriers, including those now operating under CAB regulation 292.1 and those operating under regulation 292.5 if their present request for full common carrier status is denied, just as was done for contract motor carirers on adoption of the Motor Carrier Act of 1935.

Furthermore, until the Civil Aeronautics Board is given the authority to promulgate and enforce economic regulations over contract carriers, the Board will constantly be placed in the embarrassing position of having little or no information on the services performed by such operators.

Air cargo development.—The question of air cargo development has been widely discussed. The issues appear to be two: (1) Should the potential market for air cargo by common carriers be spread among more lines than now exist in the category, and (2) should there be subsidy stimulation of cargo carriage by common or contract carriers, or both?

Property carried by air has increased strikingly since the end of the war although there has been some carriage of property by air as long as there has been air transportation. It was slowly and steadily growing in the period just before the war. Several factors account for the fact that since the war more air cargo has been carried by noncertificated carriers than by certificated carriers.

One was the necessary concentration of the certificated lines on handling passenger traffic which was overwhelming their equipment. This required the concentration of management upon that problem and the use of available financing for the building up of the passenger fleet. Another factor was the existence of large numbers of military surplus cargo planes available at low cost and on easy terms from the War Assets Administration.

A third factor was the large number of men who started and operated air cargo lines and developed traffic; but at rates too low to cover their costs of operation. Their activity created an increasing consciousness in the shippers' minds of the possibilities of air cargo service. Yet another factor was the aggressiveness and lasting power of a few of the more rugged organizations which entered the air cargo field.

Cargo operations by noncertificated lines were carried on as contract carrier operations. The certificated carriers gave only their secondary attention to the increase of air cargo. With the realization that postwar passenger business was not going to be as great as had been expected, and with the striking results of aggressive management on the part of some of the contract operators becoming evident, the certificated air-line managements, while bedeviled with organization and safety problems, nevertheless began to turn with more and more energy to the development of the cargo business.

In regard to the first issue (spreading air cargo among more lines than now exist as common carriers) as we have said above, most common carrier air lines certificated for the carriage of passengers, property, and mail, after a steady progression toward self-sufficiency from 1938 to 1946 have suffered a serious set-back. Our major problem is to get them started once again up the ladder toward self-sufficiency. To advocate at this time the entry into this field of a large number of new carriers would certainly seem to postpone rather than hasten the attainment of such a state.

The Civil Aeronautics Board has faced this problem of the economic number of companies since 1938, in regard to the carriage of both passengers and property, although the problem has only recently been focused in the direction of property. The basic question to be decided by this Board is whether the public convenience and necessity require that additional service be supplied and if so whether it should be supplied by expanding the service of existing lines or by letting in additional carriers. This is exactly the kind of problem for which the act of 1938 has provided a Civil Aeronautics Board and it is certainly not for this Commission to recommend the decision.

We do express our belief, however, that in deciding on certificates for new cargo operations, the Board should avoid impairing the soundness of the existing air-transport system by spreading the present and potential traffic among too many separate carriers. If the Board finds that the public convenience and necessity does require some additional common carrier operators, we hope that it will give weight to the records built up by any of those contract operators that have proven their ability to operate economically and efficiently and now desire common carrier status. The Board will also undoubtedly give serious consideration to the suggestion that certification for cargo operations should apply between and within specified areas rather than between fixed terminii.

In regard to the second issue raised above (a subsidy stimulation of cargo carriage), we feel that the only excuse for the subsidization of cargo carriage by air at this time would be to develop a fleet of cargo planes to act as a military pool for emergency use. One way to meet the military need would be for the services to buy the air transports they need in the same way that they buy combat aircraft. Congress may decide not to appropriate money for this purpose and may prefer to obtain replacements and additions to the present military transport fleet reserve, through subsidizing the carriage of cargo by air. If it chooses the latter method, it will undoubtedly weigh the effect such a course would have on other forms of transport since it might well raise the possibility of a subsidy of reduction in taxes to these forms to make possible the readiness for war loads on such transportation. The problem of building up a pool of military transport planes in commercial use seems to warrant a more coordinated study of the number of transports needed, the potential commercial cargo traffic, and the possibly subsidy cost to the Government than has been carried on by the armed services, the Department of Commerce, and the Civil Aeronautics Board. We recommend that the problem receive the immediate attention of the Air Coordinating Committee.

Witness after witness has testified to the difficulty of obtaining the amounts of private capital that are needed to develop new and advanced types of airplanes.

The soundest way to build up a pool of cargo planes for an emergency is to develop a cargo plane that can operate on a profitable basis. We are recommending the creation of an Aircraft Development Corporation whose initial and primary task could be the development of an all-cargo transport airplane. Such a plane would of course have to be useful to the military; but it should be designed primarily with a view to economic commercial operation. A description of the proposed corporation is given in section V of this report.

Feeder air lines.—A complicated problem facing the Civil Aeronautics Board is that of the feeder air lines, a term popularly used to apply to an air line operating a local service with frequent stops at intermediate centers of population.

The chief objection to these local service air lines is their potentially high cost to the Federal Government. Their costs vary widely with different regions, depending upon the adequacy of surface transportation. Some regions have topographical features which make the surface connections between cities unsatisfactory. In these areas there appears to be a need for local service air transportation and we believe that feeder air lines in such places are desirable for the full development of the national air line network.

There is a real need on such routes for proper navigation and landing aids, and adequate airport facilities. In carrying out its airport and electronic aids programs, the Federal Government will undoubtedly pay adequate attention to the needs of population centers served only by local service air lines.

In granting feeder air-line franchises, the Civil Aeronautics Board has done so on a 3-year experimental basis. Feeder-line officials appearing before us have pointed out that the 3-year period does not give them enough stability to permit sound financial and other planning.

We recommend that the experimental period for existing feeder air lines remain for the present at 3 years, unless it becomes evident that this period can be extended without burdensome cost in mail pay. Then, and only in that case, it should be extended, even if the initial testing period has not been completed. We also recommend that new certifications, if any are found to be required by the public convenience and necessity, be made for 5 years.

Surface carriers in air transportation.—The question of whether or not surface carriers, such as railroads, buses, and steamship lines, should be permitted to enter the air transport business is an important policy matter. There are differences of opinion as to the intent of the 1938 act.

We recommend that the Civil Aeronautics Board prevent the control by surface carriers of the United States air transport system or any important segment thereof. We believe, however, that individual progressive surface carriers, desirous of developing air transport as a part of a coordinated service, should not be automatically prevented from such action simply on the grounds that they are surface carriers—as now appears from the record to be the case. We recommend that the Congress enact legislation clarifying these two points.

Air line finance.—The air lines have traditionally operated on low working capital. Moreover, current assets accumulated during the war years were depleted by the purchase of new airplanes and by operating losses.

Loans secured by equipment are difficult to obtain in the air transport field. Railroads are able to secure financial aid to buy new equipment through the sale of equipment trust certificates at low interest rates without restrictions on their operations or finances. It would be desirable if the equipment-trust method of financing, so successful with railroads, could be used for the purchase of air transport equipment.

Three legal obstacles, however, must be overcome before this method can be made effective. These are: (1) Federal recordation of engines, propellers and major spare parts, similar to the present recordation of aircraft; (2) clarification of the liability of the trustees of equipment trusts for damage done by aircraft; and (3) assurance that creditors having equipment liens can obtain immediate possession of the equipment in event of reorganization, similar to that now applicable to railroad equipment under section 77 (j) of the Bankruptcy Act.

In addition United States air lines operating the international routes are faced with the difficulty that in many cases foreign laws are not uniform either among themselves or with American law concerning the rights of lien holders on aircraft used in international operations.

These legal obstacles should be removed as soon as possible. It may be that the private market for aircraft equipment-trusts will never reach the high credit standing now enjoyed by rail equipment trusts. Every effort should be made, however, to make aircraft equipment-trusts salable in the private investment market. The elimination of these obstacles would hasten that accomplishment.

Studies are now being made with a view to making recommendations for legislative action by the Federal Government and the states to eliminate these domestic legal obstacles. It is recommended that the Department of Commerce take the lead through the Air Coordinating Committee in developing an agreed legislative program to eliminate these domestic impediments to the sale of aircraft equipment trusts.

For aircraft engaged in operations abroad, an international convention to make uniform the rights of lien holders has been drafted for presentation to the next assembly of the International Civil Aviation Organization. We recommend that the United States Government press for adoption of the convention and promptly ratify it thereafter.

It has been suggested by members of the Civil Aeronautics Board that they be given authority to pass upon air-line financing. The Interstate Commerce Commission now has the duty of approving or disapproving security issues of railroads as does the Maritime Commission for subsidized shipping lines. The public utilities commissions of the States in many cases have similar authority as to the security issues of public utilities. The Securities Acts of 1933 and 1934 give to the Securities and Exchange Commission the duty of considering security issues in the interest of the investing public.

It has been argued before us that unsound financial planning has played a part in contributing to the difficulties of the air lines today. It may be that the absence of legal control over air-line financing is a gap in our regulatory system which should be filled.

However, any authority which the Board might be given over air-line financing would have to be applied with great expedition. In another part of this report we have made recommendations aimed at facilitating a speed-up in Board procedures. If, as a result of the carrying out of these recommendations or for any other reason, the Board does reach a point where it is in a position to handle its present duties expeditiously, consideration should then be given to the question of conferring the desired authority upon the Board.

International Air Transport

Competition vs. monopoly.—We agree with the present Civil Aeronautics Board policy which favors limited competition among American operators on international routes. We have studied the testimony before the Interstate and Foreign Commerce Committee of the House of Representatives in the spring of 1947, in which both sides of the issue were exhaustively presented. The Commission has also heard testimony from those advocating one international air line instead of a number of lines operating abroad.

Some forecast that we shall carry less and less international traffic through inability to compete with low-cost, heavily subsidized, foreign air lines and that we shall be driven from the skies, as our Merchant Marine was once driven from the sea. We do not agree with this pessimism. We believe that our international operators should receive such Government aid as will permit them to compete effectively with their foreign rivals. American technical and managerial ability, plus the spur of competitive effort, should win for them a substantial share of the world's traffic. The policy of regulated competition that has assured the development of our domestic air lines should be followed in our international system. Present competition seems only adequate to provide the desired incentive to management and a yardstick for comparison between American carriers.

Several of the most important certificates granted by the Civil Aeronautics Board for international operations are temporary and will expire in 1952. At that time there should be a complete review of the entire international competitive picture. There is no evidence now that an earlier appraisal is either necessary or desirable.

Restrictions on travel.—International air travel can reach its fullest development only when governments have taken steps to do away with or improve the restrictive conditions which now exasperate the passenger. Requirements for the issuance of passports and visas; customs rules, and public health and quarantine regulations must be greatly simplified subject to proper security regulations. Our own Government is and has been one of the chief offenders in imposing burdensome regulations. Full support should be given to the efforts of the Air Coordinating Committee to eliminate obstacles to international trade and travel by air created by our own laws and regulations, and to the work which the International Civil Aviation Organization is attempting in the same field.

Executive agreements vs. treaties.—Past experience has proven that executive agreements are better than treaties for covering international air transport rights. It is only because the Department of State, working closely with the Civil Aeronautics Board, effectively negotiated bilateral agreements with some 34 nations that we have a world-wide pattern of operating rights. These agreements came into effect upon signature, thus permitting immediate inauguration of services. Treaties would have required ratification in most instances by the legislative bodies of the two signatory states. The inevitable delay in getting the ratification of 34 treaties would have kept our air lines out of action so long that foreign competitors would have had a commanding leadership from the start. Due to prompt action on our part, that leadership is now ours.

Because of changing conditions, it will almost certainly be necessary to amend the existing agreements with various countries from time to time. We should not incur the risks we would run from delay if these agreements were in treaty form and could be amended only by the treaty process.

International rights of operation.—The Commission has seen with regret the failure of the International Civil Aviation Conference at Geneva to agree on a multilateral treaty covering rights and obligations in international air operations. We feel, however, that agreements should not be sought at the cost of abandoning the so-called Bermuda-type provision in regard to the right to carry passengers between any two foreign countries on a route.

This right, known as the Fifth Freedom, appears essential not only for the economic operation of our international carriers, but also for the widest development of air transportation. Unreasonable restrictions on traffic would adversely affect all long-haul international carriers, and would hamper that full expansion of world-wide air commerce which modern aviation can do so much to promote. While for a few nations such restrictions may appear temporarily advantageous to their national air lines, in the long run these restrictions will react against the best interests of those nations along with the rest of the world.

We feel that there should be no change in our present policy of exchanging operating routes through executive bilateral agreements, and fixing universal standards of practice and procedure through multilateral treaties.

Economic control needed.—The Civil Aeronautics Act of 1938 gives the Civil Aeronautics Board control over all types of domestic traffic rates. Similar control over international rates is conspicuous by its absence from the act. The volume of traffic and the number of United States flag carriers employed in carrying that traffic have increased greatly. With the present lack of specific authority over international rates the Civil Aeronautics Board cannot control the rates set by foreign air carriers permitted into this country under reciprocal agreements as effectively as is desirable. We see no valid reason why rate control is not just as necessary in international operations as in domestic operations. The Executive Branch of the Government has committed itself, under the Bermuda and other bilateral air transport agreements, to use its best efforts to obtain direct authority over international rates from the Congress. We recommend that the Congress comply with the Civil Aeronautics Board request that it be given authority over all international rates.

The control of contract carriers operating internationally poses especially difficult problems. At the present time, the Civil Aeronautics Board has no control over nonscheduled and contract foreign carriers entering this country. The only requirement for the entry of these carriers is a permit issued by the Civil Aeronautics Administration under the reciprocal provisions of Section 6 (c) of the 1926 Air Commerce Act.

The extension of Civil Aeronautics Board economic regulation to cover all carriers for hire as recommended above would permit the economic regulation of all types of carriers by air operating into or out of this country to be centered in the Civil Aeronautics Board. However, the status of nonscheduled and contract carriers operating internationally still needs clarification. Article 5 of the Convention on International Civil Aviation states that aircraft not engaged in scheduled international air services and carrying passengers, cargo, or mail for hire, shall have complete traffic rights subject only to regulations, conditions, or limitations as any State may consider desirable. At the present time, no agreement has been reached among the countries adhering to the convention on the meaning of this article. We recommend that our Government urge an early clarification with respect to the interpretation of Article 5 of the Convention on International Civil Aviation so that there shall be clearly established legal status for nonscheduled and charter flights, operating internationally.

Taxation

Air lines engaged in interstate commerce operate in many taxing jurisdictions. They are thus subject to multiple taxation which may well result in burdens on interstate commerce. The Congress, realizing this situation, adopted Public Law 416, Seventy-eighth Congress, second session, pursuant to which an investigation was made by the Civil Aeronautics Board resulting in a report to the Congress.

On the basis of the facts disclosed in this report, it appeared that an undue burden may be imposed on interstate commerce by (1) the multiple taxation by the States and their subdivisions of air carriers engaged in interstate commerce; (2) the absence of adequate judicial protection against multiple taxation; and (3) the absence of statutory standards or administrative procedures for accomplishing the avoidance of such multiple tax burdens on interstate commerce.

Taxation of aviation fuel by the States is an anomaly caused by the fact that State taxes on gasoline were intended to be paid by operators of automobiles. Taxes collected on gasoline for aviation uses were not, in any significant amount, used for aviation needs. The injustice of such taxation is attested by the fact that 27 States and the District of Columbia grant either total exemption or a full refund of such taxes, and 12 States grant a partial refund. However, there is no assurance that these exemptions and refunds will not be rescinded, or taxes increased, by State legislation at any time.

It is true that the States are making substantial contributions to airport development. On the other hand the air lines make user contributions to airports in the landing fees and rentals and other charges. Any additional contributions through a tax on fuel in the case of the subsidized carriers often constitute an additional levy on the Federal Treasury since these payments will have to be balanced by higher mail payments.

To meet these problems, a bill, H. R. 1241, has been introduced in the Eightieth Congress. This bill provides formulae for the equitable allocation of the taxable base between different jurisdictions measured by (*a*) value of operating property, operating revenues, or capital stock representing investments in operating properties, and (*b*) net income. The bill makes unlawful any tax imposed on the air carrier on a tax base in excess of the allocation provided by the authorized formulae. The allocation formulae do not apply to real property and tangible personal property permanently located in a particular taxing jurisdiction. The Civil Aeronautics Board is named as the agency to administer the provisions of the bill, including the allocation of the tax base to be used by the several taxing jurisdictions. Provision is also made in this bill for judicial review of such allocations on the petition of an air carrier or an interested taxing jurisdiction.

With respect to the taxation of aviation fuel, section 6 of the bill directs the Secretary of the Treasury to consult with the State authorities and recommend within 12 months a program which will remove impediments to a balanced and normal development of civil aviation.

The Federal Government establishes, operates, and maintains the Federal airways, and a reasonable Federal tax on aviation fuel is a means of making aviation generally and the air lines in particular contribute to the Government a portion of this expense. It is hoped that as a result of the consultation provided in section 6 of the bill, an equitable reallocation of aviation fuel taxes can be arranged.

We therefore recommend that hearings be held on this bill at an early date, and that it be enacted into law with such amendments as the hearings may show to be desirable.

Personal Aviation

The term "personal aviation" is meant to include all flying activities not classifiable as either military or as the carrying of persons or property for hire. It includes "private carriers," that is, the flying of executives and other personnel in company-owned planes, and "industrial flying." The latter consists of crop dusting, aerial advertising, and other activities using the airplane as a tool. The term also includes most of the activities of "fixed-base operators" such as the sale, renting, repairing, and servicing of personal aircraft, and flight instruction. "Private flying" is the ownership and operation of aircraft for personal business or pleasure.

Federal support.—A number of witnesses representing these varied activities came before the Commission. Most of them pleaded for Government subsidies for flight training, airport development, navigation aids, research on personal planes, or for other services that would benefit personal aviation. Many arguments were based on claims that the stimulation of personal aviation would be of military benefit.

Personal aviation clearly proved its value to the military services in the last war. The fact that the Nation was air-minded was a national asset. Without pilots and mechanics drawn from personal aviation, and the use of civil airports and ground facilities, the Air Force and the Navy would have been retarded. The Civilian Pilot Training Program was especially successful. Light aircraft, developed originally for private fliers, were of value as artillery spotters, for personnel transports and for other uses. Private pilots of the Civil Air Patrol made an admirable contribution. In any future conflict there is little doubt that an air-minded Nation, with hundreds of thousands of civilian pilots and mechanics, and a network of airports and navigation aids is better prepared for an air war than a nation with undeveloped civil air facilities.

Although instruction skills have historically been valuable to the military, testimony of the armed services indicates that this will not be as true in the future. The usefulness of civilian instructors in military training is constantly being diminished by the advancement and refinement of military techniques and equipment. But most important is the fact that according to evidence submitted to the Commission civilian instructors are unlikely to be required for any emergency within the next 15 years because of the availability of World War II pilots. This 15-year availability of World War II pilots for instructor, patrol, and transport duties ensures personnel for these three important emergency functions which were largly performed by private pilots in the early years of World War II.

The taxpayer has contributed generously in the past to personal aviation. Considerable help was given throughout the prewar years, but the greatest benefits were in the Government-sponsored civilian pilot training in the American colleges. Airport operators in all parts of the country were able to hire new instructors, refurnish and reequip their buildings, improve their airports and in general put themselves on a businesslike basis. The greatest help to the private plane industry was the demand for new airplanes for instruction, purchases of which reached a new peak in 1940 and 1941.

During the war nearly all manufacturers of personal planes produced aircraft for military purposes, or had subcontracts from other plane manufacturers. They were able to modernize their factories and buy new equipment that they could not previously afford.

Many airports built or improved by the Government during the war are now being used by civilian pilots. In addition, other new airports are being built under the Federal Airport Act of 1946. This is a program now going on which will be of considerable help to pilots.

Greatest postwar windfall to the personal aviation industry has been the decision of thousands of veterans to learn to fly, or to improve their flying, under the GI bill of rights. The Veterans' Administration estimates that $125,000,000 was spent for flight training in 1946 and it is likely that veterans will continue to take flight training until the program terminates.

As was true with the Civilian Pilot Training Program before the war, Government money under the GI bill filters down to nearly all phases of the personal aviation industry. A considerable amount goes to manufacturers for new airplanes. Other Government money spent for airports, control tower operation, navigation facilities, and other purposes is also a direct help to private flyers.

In the past 10 years the Government has paid for the training of hundreds of thousands of military and civilian pilots who compose the largest ready-made market for personal planes and for airport facilities that has ever existed. This great mass of pilots will decide the near future of personal aviation. If enough of them do not continue flying to support the personal plane industry, their neglect should be an unmistakable sign to airplane designers that a new airplane is needed which will provide more utility at a lower operating cost. If, in fact, private aircraft do possess a significant economic potential, the Commission is confident that private enterprise will seize the opportunity as it already appears to be doing in the development of light planes for executive transportation.

This Commission, trying to judge personal aviation impartially, believes that a healthy, personal plane industry is of value to the Nation. We believe that it should be encouraged by the continuation of funds for airports, for navigation and landing facilities, and for basic improvement in personal plane design (discussed in Sec. III of this report). We believe that the appropriations to personal aviation for these purposes, plus the very substantial financial assistance provided for veterans' flight training, are sufficient.

Federal Regulation of Personal Aviation.—We recommend that every effort be made by Government agencies to simplify and reduce the air and ground regulations affecting the personal flyer as a further step toward the development of personal aviation. In Section II of this report we have made recommendations aimed at lightening the regulatory burden on the light plane manufacturer.

State Enforcement and Participation in Federal Aviation Policy.—The postwar expansion of personal aviation has made impossible the direct Federal enforcement of Civil Air Regulations without the creation of a large and cumbersome Federal policing agency. Rather than expanding the Federal pay roll, the Commission recommends that the Civil Aeronautics Act be amended to authorize State aviation officials or courts to enforce the noncarrier safety regulations of the Federal Government. We emphasize, however, our belief that the Government should retain its power to promulgate Civil Air Regulations in order to preserve national uniformity.

State aviation activities have grown rapidly in both extent and function, and the States will have an increasing concern with Federal policies. At present, the States have no formal representation or participation in any Federal aviation agency. Section 205 (b) of the Civil Aeronautics Act empowers the Civil Aeronautics Authority to confer with or to hold joint hearings with State aeronautical agencies. We believe that more extensive use of this provision by the constituent Federal agencies is desirable.

To give official recognition to State and local aviation organizations at the Federal level, we recommend the establishment of a State-local aviation panel, advisory to the Air Coordinating Committee. The panel should be organized along lines parallel to the ACC industry advisory panel and should include representation from nationally recognized State and municipal aviation associations. This panel would provide Government agencies other than Federal agencies with a formal medium wherein they can work closely with Federal aviation agencies. The panel will permit responsible State and local aviation officials to express their views on the larger issues of national air policy and will guarantee their associations official status in consulting with departments and agencies represented on the Air Coordinating Committee.

Airports

An adequate domestic airport system can best be achieved through the combined efforts of the Federal and local governments. By enactment of the Federal Airport Act in 1946, which provides for Federal participation with local governments in building new airports or improving old ones, Congress has reaffirmed its long-established policy of furthering such cooperation.

As a general rule, military fields were not built close enough to cities for airline or personal-plane use, and there is still need for more commercial airports. Traffic congestion in large metropolitan areas is so great that additional airports are badly needed. Many smaller communities must also have new fields if they are to attract air lines and get the benefit of civil aviation.

The Federal Airport Act authorizes financial grants totaling $500,000,000 within the United States over a 7-year period and an additional $20,000,000 for Hawaii, Alaska, and Puerto Rico, and placed a limit of $100,000,000 in any one year. The act did not appropriate any funds. The 1947 appropriation was $45,000,000.

Although the President requested $65,000,000 for 1948, Congress appropriated only half that amount. We recommend that Congress appropriate each year the full amount of Federal aid permissible under the law.

Representatives of local governments and the aviation industry testified that the airport construction program has been delayed by complicated and confusing CAA regulations. While we believe there is some merit in these complaints, we recognize that much of the delay is due to difficulties of hiring a staff and carrying out the new act. The CAA is now taking steps for future simplification of regulations which are expected to result in the desired acceleration of this program.

Whether a public airport should grant exclusive rights to any fixed-base operator or other person to engage in an aviation or a nonaviation business is at best a difficult question and one which is ordinarily best answered on the merits of each individual airport situation.

Due to the relatively small business potential at many airports, some local communities find it difficult to assume the financial burden of airport maintenance and operation without the power to grant exclusive rights. In these circumstances, there may be some cases where exclusivity is justified.

On the other hand, fixed-base operators and others prevented from establishing themselves at public airports argue that they are built with public funds and should be open to all desiring to engage in business.

We feel there is no question but that the landing area should be available for the use of all aircraft on a nonexclusive basis. At the other extreme, we feel there is no objection to exclusive contracts for such services as a restaurant at an airport. The difficult question to decide is whether exclusivity should apply to such services as gasoline and maintenance facilities. The Civil Aeronautics Administration is now in the process of working out regulations to cover these questions. In doing so, it has the advice and cooperation of interested airport officials. We believe that experience under the new regulations should be watched carefully with an eye to amendment in the light of results over the next few years.

It is charged that certain overseas facilities were constructed in whole or in large part with Government funds made available to the owner air line through mail pay or otherwise, and therefore that these facilities should be available on reasonable and equal terms to all United States civil aircraft. Otherwise there must be a wasteful duplication of facilities the cost of which the American taxpayer will be called upon to defray through air-mail payments.

The Commission believes that where a question arises as to whether airport facilities were constructed with the aid of Government funds or through the use of private capital, an investigation should be made by the Civil Aeronautics Board, with the coöperation of the other pertinent Government agencies through the Air Coordinating Committee. In the event it is found that Government funds were used, steps should be taken to make these facilities available to other United States civil aircraft at reasonable rates.

PROPOSED ORGANIZATION OF

DEPARTMEN

Fosters, develops
and domestic commerc

AIRCRAFT DEVELOPMENT CORPORATION

Board of Directors.—Two members designated by the Secretary of Defense, one of which shall be the Secretary of the Air Force, two members designated by the Secretary of Commerce, one of which shall be the Secretary of Civil Aviation, who shall act as Chairman, and one member selected by the four members of the Board.

Finances the development and purchase of civil aircraft and components, and air navigation facilities and safety appliances utilizing the research, advisory, and procurement facilities of the Government; submits annual fiscal report to Congress and the President.

AIR SAFETY BOARD

Three members appointed by the President with the advice and consent of the Senate.

Responsible for investigation of aircraft accidents, the conduct of public hearings thereon, and the determination of probable causes; makes recommendations to the Secretary of Civil Aviation to prevent recurring accidents; obtains from the Department of Civil Aviation special studies and research in air safety and statistics on air safety. Investigation of minor accidents may be delegated to the Department of Civil Aviation.

DEPARTMENT OF CIVIL AVIATION

Fosters and promotes the development of civil aeronautics, aircraft manufacturing and foreign and domestic air commerce.

CIVIL AERONAUTICS BO

Grants or denies "certificates of public convenience and ne
for both domestic and international operation and "permits"
approves rates and rate practices of air carriers and fixes
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takes appropriate action to enforce the act; prescribes acco
be kept by air carriers; prescribes reports required from air c
the Department of State in the negotiation of agreements with

BUREAU OF FEDERAL AIRWAYS

Develops and establishes a system of civil airways and aids to navigation including the installation, operation, and maintenance of facilities necessary to assure the safety and control of air traffic; collaborates with other public, military, private, and foreign agencies in the adoption of domestic and international airways systems and services, the provision and utilization of necessary facilities, and the collection and dissemination of information on aids and hazards to navigation.

BUREAU OF AIRPORTS

Plans and coordinates the establishment of a nation-wide system of airports suitable or adaptable to the future needs of civil aviation and national security, including the development of standards of location, design, construction, operation, and management; consults with and advises other Federal, state, and local officials or interested groups on airport legislation, policies, and programs, including the granting of funds to sponsors for the development of airports in conformity with approved programs necessary to achieve such a system; operates and maintains the Washington National Airport.

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carrier water transp
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utaries, except the Oh
rior River and its
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water and rail transpo

BUREAU OF SAFETY REGULATION

Promulgates the Civil Air Regulations, which include standards on the design, operation, and maintenance of aircraft and appliances, and on the training and proficiency of airmen; provides for the administration of such regulations including the inspection and certification of aircraft and appliances, or of persons who operate, repair, or maintain such aircraft and appliances, or who control the flight of aircraft along the airways or at airports; provides for the registration of aircraft nationality and recordation of ownership of civil aircraft; and collaborates with other public, military, private, and foreign or international agencies in the adoption of aircraft and airmen standards necessary to promote safety in flight of civil aircraft.

BUREAU OF FACILITIES PLANNING

Determines that the aviation policies and practices of the United States will not only foster the peacetime development of aircraft manufacturing, air transportation and personal flying but will also provide the supporting air strength suited to supplement the requirements of the National Military Establishment; advises the Secretary of Civil Aviation on all phases of mobilization planning for the aircraft industry and on the correlation of civilian aviation needs with military requirements including uniformity of equipment to the extent practicable; recommends, to the Secretary of Civil Aviation, revisions of policies or practices which are required by changes in business trends or other domestic or international conditions.

BUREAU OF FOREIGN AND D

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Note 1.—This chart is presented to reflect the distribution of functions between the Department of Civil Aviation and the Department of Industry and
Note 2.—The broken line indicates that the Civil Aeronautics Board, the Aircraft Development Corporation, and the Air Safety Board are a part of th

E DEPARTMENT OF COMMERCE

F COMMERCE

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eign carriers; prescribes or
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mergers, and acquisitions of
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f the Civil Aeronautics Act;
and records and memoranda to
rs; consults with and assists
gn governments.

DEPARTMENT OF INDUSTRY AND TRADE

Fosters, develops, and promotes the foreign and domestic commerce of the United States including the manufacturing industries.

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BUREAU OF FACILITIES PLANNING

Determines that the policies and practices of the United States will help to maintain a sound, stabilized, civilian industrial economy, which, even during periods of economic emergency, will meet the requirements of the National Military Establishment; advises the Secretary of Industry and Trade on all phases of industrial mobilization planning and on the correlation of civilian industrial needs with military industrial requirements; recommends, to the Secretary of Industry and Trade, revisions of policies or practices which are required by changes in business trends or other domestic or international conditions.

WEATHER BUREAU

Collects, processes, and disseminates weather information required for the public safety and the national welfare.

COAST AND GEODETIC SURVEY

Provides for the United States and its possessions information required for the safe navigation of coastal waters; basic geodetic control data; information concerning earthquakes; and aeronautical charts for use in civil aviation.

IC COMMERCE

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NATIONAL BUREAU OF STANDARDS

Provides means for accurate and adequate measurements in commerce, science, and industry, and determines physical data such as constants of nature and properties of materials.

PATENT OFFICE

Responsible for administering the patent and trademark laws as they relate to the granting of patents for inventions and to the registration of trade-marks.

BUREAU OF THE CENSUS

Responsible, in cooperation with business, industry, and other Government and private organizations, for developing and carrying out activities, programs, and policies for providing business, Government agencies, and the public with factual statistical information to be used as a basis for establishing policies and guiding their economic, commercial, and industrial activities.

. The assignment of functions to the individual bureaus is not to be regarded as the ideal organizational structure.
partment of Civil Aviation for administrative housekeeping purposes only.

SECTION V

GOVERNMENT ORGANIZATION

Never before in our history have we maintained a large military organization in peacetime. After each war, we have demobilized most of our ground and air forces, keeping as our only force in being the Navy. In the immediate years to come, however, we will face a new situation. We must also keep a strong air force in being, and our ground Army, because of occupation duties and the need for a skeleton force capable of rapid expansion, must be larger and more mobile than in the past. This degree of preparedness—new in American life—calls for a new concept for the organization of the civilian branches of the Government whose activities directly relate to military plans.

The creation of a Military Establishment capable of defending the country will put a disproportionate share of the power of Government in the hands of the military, and at the same time will place new and heavy burdens on the civilian agencies of Government in matters contributing to the national security. This will require the strengthening of the civilian departments in those areas which are of common concern to the Military Establishment and the civilian agencies of the Government.

As we are not an aggressor nation, and as attack upon us may be delayed for years, our will to continue to carry the financial burden, which will increase from year to year for several years, may weaken, especially if we should have a period of depression combined with calculated changes for the better in the public attitude of a possible enemy.

That is our gravest danger.

For a potential enemy is apt to be contentious and threatening when getting ready and reverse his attitude when preparing to strike.

While we believe that a planned war will not start until other countries have the atomic bomb or other comparable weapons in quantities, the possibility that constant friction may cause war will compel us to continue in a state of partial mobilization of our productive resources to be adequately prepared for war.

Our people will look to the military agencies to formulate the programs for their requirements and to civilian agencies to organize industry and foreign and domestic commerce to be prepared to furnish those requirements.

During this entire period commerce and industry must be maintained on the highest possible productive level to yield earnings which will enable business, and the public sharing the profits distributed, to meet the mobilization costs without unbearable taxes.

We accordingly have been influenced in our recommendations for changes in the organization and procedures of the Government dealing with aviation by the need to make the civilian agencies having to do with aviation more efficient in themselves and to strengthen them in relation to the growing military establishment.

* * * * *

In the Federal Government there are now three agencies which are primarily concerned with civil aviation. The Civil Aeronautics Board (now within the Department of Commerce for housekeeping purposes only) grants or denies air routes, fixes rates, prescribes systems of accounts, promulgates safety regulations, and investigates aircraft accidents. The Civil Aeronautics Administration, now a part of the Department of Commerce, enforces safety regulations, operates the Federal Airways System, and directs the Federal Aid Airport Program. The National Advisory Committee for Aeronautics supervises and directs the scientific study of the problems of flight and propulsion and conducts research in aeronautics and power plants. Several other agencies participate in governmental civil aviation activities, such as the Weather Bureau and the Coast and Geodetic Survey (both of which are part of the Department of Commerce), the Post Office Department, the Coast Guard (now a part of the Treasury Department), the Federal Communications Commission and the Department of State. The Air Coordinating Committee examines aviation problems affecting more than one governmental agency, develops and recommends integrated policies, and coordinates the aviation activities of the Government. A description of certain other governmental agencies dealing with aviation is in the appendix which follows.

A Department of Civil Aviation

We recommend that the Government's executive functions relating to civil aviation remain under the direction of the Secretary of Commerce, who shall have immediately under him a Secretary of Civil Aviation in charge of a Department of Civil Aviation. The position of Administrator of Civil Aeronautics should be abolished and the functions, activities, and duties of the Civil Aeronautics Administration transferred to the newly formed Department.

We believe that when and if all executive transportation functions of the Government are centralized within the Department of Commerce (as discussed below), the title of Secretary of Civil Aviation should be changed to Secretary of Transportation and the organization reporting to the Secretary of Transportation should be set up to conform with the change.

A Department of Civil Aviation would have all the functions of the present Civil Aeronautics Administration as well as the responsibility for safety regulations now in the Civil Aeronautics Board. The Department of Civil Aviation would also have certain duties in connection with the Aircraft Development Corporation which is discussed below. In addition it would perform administrative housekeeping functions for the Civil Aeronautics Board and the Air Safety Board referred to below.

The Secretary of Civil Aviation would have the responsibility of initiating our broad domestic and foreign civil aviation policy, subject to the direction of his superior officer, the Secretary of Commerce, who in turn would consult with the Secretary of State of matters of foreign policy. The Secretary of Civil Aviation also would have the responsibility of making recommendations with respect to the mobilization of our aircraft and air transport industries resources as part of the industrial mobilization plan of the country. We also recommend below that the Secretary of Civil Aviation be Chairman of the Air Coordinating Committee.

We do not recommend the inclusion of the Weather Bureau or the Coast and Geodetic Survey in the Department of Civil Aviation as these agencies have only specialized interests in aviation and serve numerous non-aviation departments and agencies.

* * * * *

With this responsibility and authority, the Secretary of Civil Aviation would become the recognized spokesman in executive matters for civil aviation in the Government.

We lay special emphasis on the duties of the Secretary of Civil Aviation in connection with the Industrial Mobilization Plan. Of the many important tasks which American industry performed during the last war as part of our industrial mobilization, the building of aircraft was of major importance. In any future war aircraft production would form an even greater part of our industrial mobilization. We must therefore have a close and smoothly coordinated relationship between the civilian and military departments of the Government in the development of our future Industrial Mobilization Plan. The Secretary of Civil Aviation can perform a highly useful service in its development. At present the responsibility within the Department of Commerce for intimate knowledge of conditions in the aircraft industry, the air lines and other phases of aviation is not concentrated in one point. The planning of industrial mobilization of our air establishment will necessitate arrangements in peacetime for the assembly of the production of literally thousands of manufacturers of primary components, instruments and other items required in aircraft production. The civilian agencies should have a leading role in this planning. This role is appropriately that of the Secretary of Commerce and as to aviation matters, the Secretary of Civil Aviation.

The Department of Commerce could effectively act as the chief representative of the Government as to civil aviation and related matters, serving as a balance to the Military Establishment.

The Department of Commerce would be organized on a pattern comparable to the Military Establishment. The Secretary of Commerce would have under him the Secretary of Civil Aviation and the Secretary of Industry and Trade which we recommend below. The National Security Act of 1947 injected a new form of organization into our governmental structure: that of three non-Cabinet Secretaries reporting to the Secretary of National Defense. Civil aviation and commercial matters would be represented by the Secretary of Civil Aviation and the Secretary of Industry and Trade under the Secretary of Commerce.

The combination of the various civil aviation functions in the Department of Civil Aviation would have additional advantages, particularly in relation to safety regulation. There is some confusion in this regard at the moment. Now the Civil Aeronautics Board formulates safety regulations while the Civil Aeronautics Administration has the responsibility for enforcing them. The concentration of the responsibility for safety regulations in the Department of Civil Aviation would relieve the hard-pressed Civil Aeronautics Board members from the kind of work which takes much of their time. The Civil Aeronautics Board members would be given more time for their principal work—that of making decisions on route and rate cases.

A Government Corporation to Finance Aircraft Development

In the preceding section, we have discussed the importance of air-cargo development as a means of building a fleet of commercial planes that could be used by the military services in war. From testimony presented to us, we have concluded that a major handicap to such a development is the lack of a suitable cargo aircraft.

We propose that a Government Aircraft Development Corporation be set up within the Department of Civil Aviation. The Board of Directors would consist of five members, with the Secretary of Civil Aviation as Chairman. The Secretary of the Air Force would be a member, and one other member appointed by the Secretary of National Defense. The Secretary of Commerce would appoint a fourth member and these four would choose a fifth. The Corporation would be authorized to pay all or a portion of the development cost of cargo or other non-military planes, components, navigational aids and safety appliances, which the Board of Directors would decide should be developed in the national interest and could not be developed by private enterprise. The Corporation also would be authorized to make loans to manufacturers for the development costs when such financing could not be obtained from private sources. We believe that a specialized Government corporation directed by the Departments could do this work better than if the Reconstruction Finance Corporation, operating in a much broader and varied field, were assigned the responsibility.

The Aircraft Development Corporation should finance the development of planes, components, navigational aids and safety appliances only when there is a proven need for the product. There is nothing new about this method of developing commercial airplanes. Many of our transports have been created in this way. Many transports are commercial developments of military planes, the developmental cost of which was paid in major part by the Military Establishment. The purpose of our recommendation for an Aircraft Development Corporation is to provide an orderly specialized medium to carry out this method for the development of commercial aircraft and components.

At the outset we believe that the Aircraft Development Corporation will be concerned with the development of an efficient and economical cargo plane. Its authority, however, would not be limited to this type of plane. It would finance the development of such types of planes, components, navigational aids or safety appliances as would be shown to be necessary from time to time in the judgment of its Board of Directors.

Air Safety Board

There is no phase of commercial aviation that is more important than safety. We believe that an Air Safety Board should be established within the Department of Civil Aviation. We recommend that it consist of three members appointed by the President, subject to confirmation by the Senate. The Air Safety Board would be responsible for the investigation and analysis of air accidents and for submitting reports to the Secretary of Civil Aviation to be made public by him. The Air Safety Board could, in its discretion, delegate to the Department of Civil Aviation, the investigation and analysis of minor accidents, as the Civil Aeronautics Board now delegates to the Civil Aeronautics Administration in the great majority of accidents. The Air Safety Board should be provided with sufficient staff to enable it to carry out its assigned functions, but the Secretary of Commerce should determine that there is no unnecessary duplication or overlapping of activities between the Air Safety Board and the Department of Civil Aviation. We believe that the Air Safety Board should have the same relationship to the Department of Civil Aviation that the Civil Aeronautics Board now has to the Department of Commerce. It thus would not be a separate agency within the Government but would be within the Department of Civil Aviation for housekeeping purposes only.

We realize that the success of an Air Safety Board will depend upon two factors: the quality of its members and their independence of judgment. If these factors are assured, the Board should be able to make a valuable contribution to air safety.

The Civil Aeronautics Board has done commendable work in connection with safety. We recommend the transfer of these safety functions from it principally because we believe that it should be as free as possible for the performance of its economic functions.

We are aware of the difficulties that surrounded the earlier Safety Board, and realize that our proposal has a striking similarity to it. We believe, however, that the logic of the situation compels the establishment of such a Board. The function of accident investigation and analysis should not, we believe, be in the Department of Civil Aviation; for such an arrangement would not provide the desired independence of the investigators. We believe that it should be in a Board with an independence analagous to that of the Civil Aeronautics Board. But since we believe that the Civil Aeronautics Board should not have this function for the reasons we have just given there is no alternative other than to create a new body.

The Civil Aeronautics Board

We believe that the Civil Aeronautics Board should continue to be an independent agency, located within the Department of Civil Aviation for housekeeping purposes only, for granting or denying air routes; fixing rates of air carriers and mail rate computation; approving or disapproving consolidations, mergers, interlocking relationships, and so forth, affecting airline carriers; and prescribing the accounts and records to be kept by air carriers and the reports required from them. All of these functions are broadly classified as Air Carrier Economic Regulation in the Civil Aeronautics Act of 1938.

We have heard considerable criticism of delays by the Civil Aeronautics Board in the processing of cases before them and of the resultant high cost to the carriers in these cases.

The route and fare functions of the CAB are judicial functions. The procedures for the determination of these cases are judicial. These procedures therefore are subject to the delays that are inherent in the judicial process; for the theory of this process is that where the rights of individuals are affected, these individuals shall have the fullest opportunity to present their case and defend their interests.

It may be argued that because of the high national interest in the domestic and international route pattern, the determination of routes and possibly of the rates to be charged should be decided by an administrative process rather than by a judicial process. If this were done, it would be possible to speed up substantially the decisions to be made. But if this were done, the guarantee of a full hearing which the judicial process provides might well be lost. We are not prepared to make a recommendation that the determination of routes and rates be determined otherwise than by judicial forms.

For these reasons, then, we must anticipate some delay in the processing of route and rate cases. Nevertheless, we believe some improvements in speeding up this work can be made.

We believe that the membership of the Civil Aeronautics Board should be increased from five to seven in order that the practice of the Interstate Commerce Commission of operating by divisions may be adopted.

We also recommend that the salaries of the Board members be established at \$15,000 a year. The Civil Aeronautics Act of 1938 provided that the members of the Civil Aeronautics Authority, the predecessor of the Civil Aeronautics Board, should receive \$12,000 a year, but Congress has not appropriated sufficient funds to pay Board members more than \$10,000.

The Civil Aeronautics Board also recommends that its staff be increased. From the evidence submitted to us, we believe that this demand is justified.

The recommended increase in the membership of the Civil Aeronautics Board brings up the important point of the calibre of men to form its membership. We recommend that experienced career men within the Government, as well as qualified persons from private life, be considered in selecting members of the Board.

A Department of Transportation

We believe that sometime within the near future all executive transportation functions of the Government should be centered in a single executive department, in order effectively to coordinate the development of all forms of transportation. The establishment of a Department of Civil Aviation within the Department of

Commerce will provide the structure that can later be used to combine all transportation functions within one department.

The Department of Commerce presently contains a nucleus of transportation agencies, namely, the Civil Aeronautics Administration, the Inland Waterways Corporation, and the transportation activities of the Bureau of Foreign and Domestic Commerce. The Weather Bureau and the Coast and Geodetic Survey, both of which provide services for transportation, are also a part of the Department of Commerce. And it should be noted that the President's Advisory Committee on the Merchant Marine has just recommended that all functions of the Maritime Commission, other than quasi-legislative and quasi-judicial, be transferred to the Department of Commerce. Although the Weather Bureau and the Coast and Geodetic Survey would not be included in the Department of Civil Aviation, these two organizations could be included in the Department of Transportation.

There is an evident need of executive coordination in the over-all field of transportation. At present there is no official in the administration who has responsibility for such coordination. We believe that bringing the various executive functions in regard to transportation within one department will satisfactorily fill the present requirements. One of the most notable examples of the need for the establishment of such clear-cut responsibility is the recent Sea-Air issue dealing with the control of air carriers by surface carriers in which the Civil Aeronautics Board and the Maritime Commission took opposing views. There should be some executive official responsible for bringing the two Commissions together to work out a common policy. Lacking success in this, he should advise the President as to recommendations to the Congress for clarifying action. Moreover, another war may involve the disruption of transportation facilities within the United States, and Government planning should be now going forward on an over-all transportation basis with this fact in mind.

The independent, semijudicial bodies in the transportation field should be brought into the Department of Transportation for administrative housekeeping purposes only. These independent regulatory agencies should maintain full independence in the way the Civil Aeronautics Board has maintained its complete freedom of action in all policy matters. This is not a recommendation to consolidate all regulatory agencies dealing with transportation into one regulatory body. We doubt that one judicial body could handle the many and diverse cases which are presented in the whole transportation field.

A Department of Industry and Trade Within the Department of Commerce

We recommend the establishment within the Department of Commerce of a separate Department of Industry and Trade. All activities of the Department of Commerce would be divided at the outset between civil aviation on the one hand and industry and trade on the other and later between transportation (including aviation) and industry and trade.

We would not have recommended the establishment of a Department of Civil Aviation unless we believed that it was also necessary to have a parallel department within the Department of Commerce dealing with trade and industry. The need for this latter department is, we believe, clear.

To support the military establishment we need a strong industry. It should be the responsibility of the Department of Industry and Trade to take the leadership in all matters in which Government is concerned for the development of this strong industry.

The Department of Industry and Trade would have the further responsibility of organizing all pertinent industrial information for the benefit of our businessmen and for the Government. This information could be a guide to business and the Government to a much greater extent than ever before.

Periodic reports showing the flow of merchandise, by key products, from raw materials to finished goods, by price lines, would be invaluable to every businessman and banker in the country.

This information would serve as a basis for ascertaining industrial and trading trends and would serve the needs of all branches of the Government and particularly of Congress, the Council of Economic Advisers to the President, the Treasury Department, the Bureau of the Budget, and other agencies. Data on foreign and domestic commerce, properly analyzed, interpreted, and presented by the Departments of the Government representing business, would clarify many of our domestic and international policies.

These activities should not conflict with the functions of the Departments of Agriculture, Interior, and Labor, as the Department of Commerce is the authorized agency to obtain essential information on all transactions after resources and agricultural products enter the processing or trading stage.

Secretary of Commerce as Member of the National Security Council

The function of the National Security Council is to advise the President on all phases of national defense. The Secretary of Commerce is the chief governmental representative for two important activities which must be coordinated with national-defense planning: Civil aviation, and major segments of commerce, industry, and some phases of transportation other than aviation. It is appropriate that the Secretary of Commerce be a member of the National Security Council to insure the representation of these important activities in national-defense planning. The Secretary of Commerce is already a member of the National Security Resources Board. Making him a member of the National Security Council would round out the utilization of his Department, and give proper recognition to the indispensable part which industry plays in both war and peace.

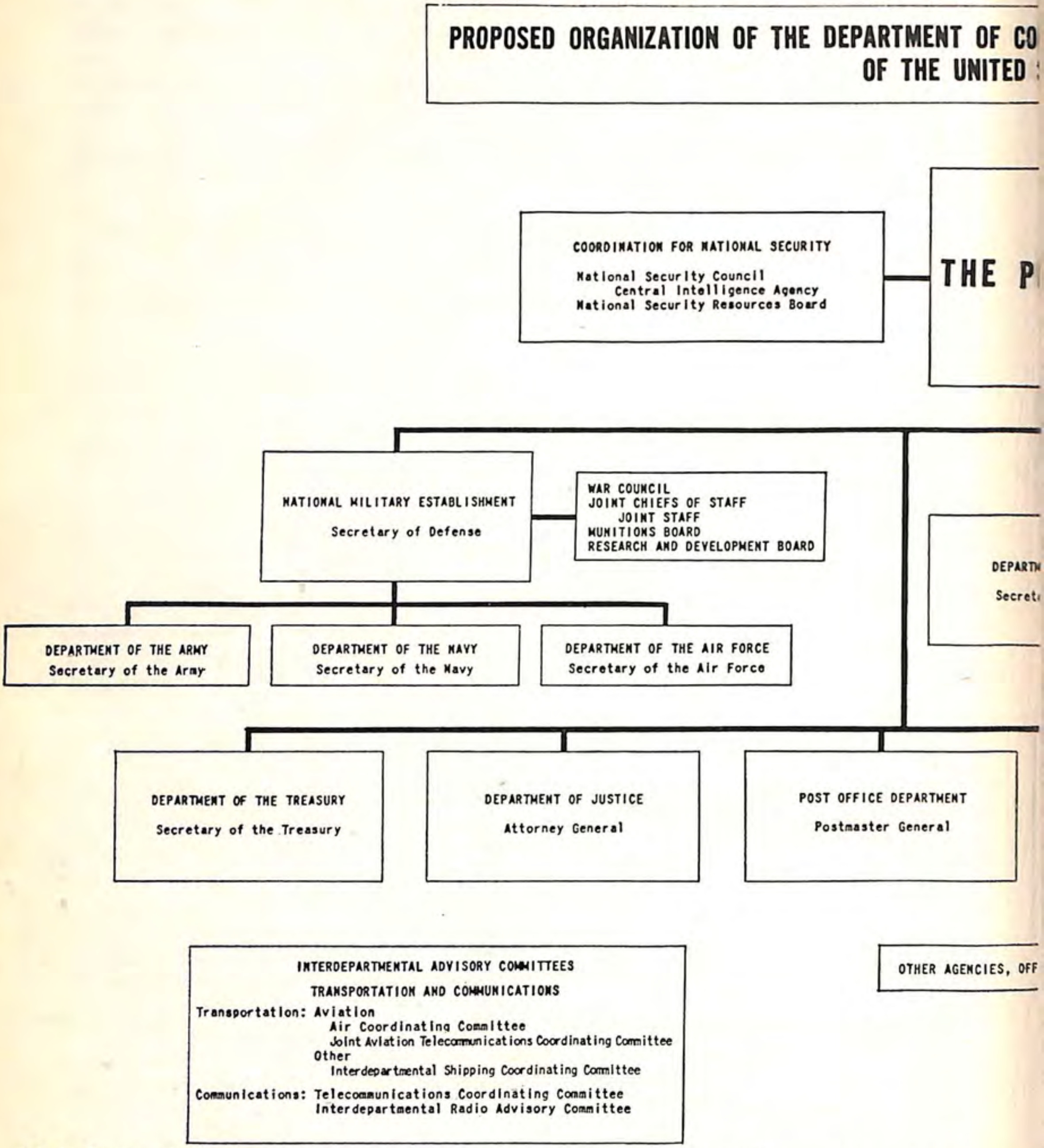
Chairman of the Air Coordinating Committee

The Secretary of Civil Aviation should be the Chairman of the Air Coordinating Committee. The ACC is an interdepartmental advisory and coordinating group responsible for examining aviation problems and developments affecting more than one participating agency, and for developing and recommending integrated policies to be carried out by the governmental agencies affected. The membership of the Air Coordinating Committee consists of one representative each from the Departments of State, Commerce, Air Force, Navy, and Post Office, and the Civil Aeronautics Board, with a representative of the Bureau of the Budget serving as a nonvoting member.

The Air Coordinating Committee, as is evident from all the testimony presented to us, has served a useful and effective purpose. It should continue as the over-all coordinating agency in aviation matters of the Government.

The Secretary of Civil Aviation, in his individual capacity and as Chairman of the Air Coordinating Committee, should be recognized as the governmental spokesman on civil aviation matters except for those activities which are the responsibility of other agencies, such as the Department of State and the Civil Aeronautics Board. He should be able to give adequate time and attention to ACC problems, most of which will have common factors with those facing him within his Department.

It has been forcibly presented to us that the Air Coordinating Committee should have a permanent full-time Chairman appointed by the President, subject to confirmation by the Senate. It has also been suggested that there should be an administrative assistant to the President to advise on civil aviation matters. Our basic concept is that the President should look on military matters to the Secretary of Defense and on civil aviation matters to the Secretary of Commerce except where these matters lie primarily within the responsibility of the Secretary of State or the Civil Aeronautics Board. Where the Air Coordinating Committee cannot resolve differences, the Secretary of Civil Aviation as Chairman of the Air Coordinating Committee should have the responsibility of referring the matter to his superior, the Secretary of Commerce. It would then devolve upon the Secretary of Commerce to work out a solution at the Cabinet level. Failing in this the matter should be referred to the President. We do not therefore subscribe to either of the recommendations above.



Note 1.—Proposed structural organization changes are indicated by parallel lines around the boxes.
Note 2.—This chart is submitted to show the general effect of the recommended changes on the Department of Commerce and its relati Executive Branch of the Government.
Note 3.—The broken lines indicate that the Civil Aeronautics Board, the Aircraft Development Corporation and the Air Safety Board are

MERCE IN RELATION TO OTHER EXECUTIVE DEPARTMENTS
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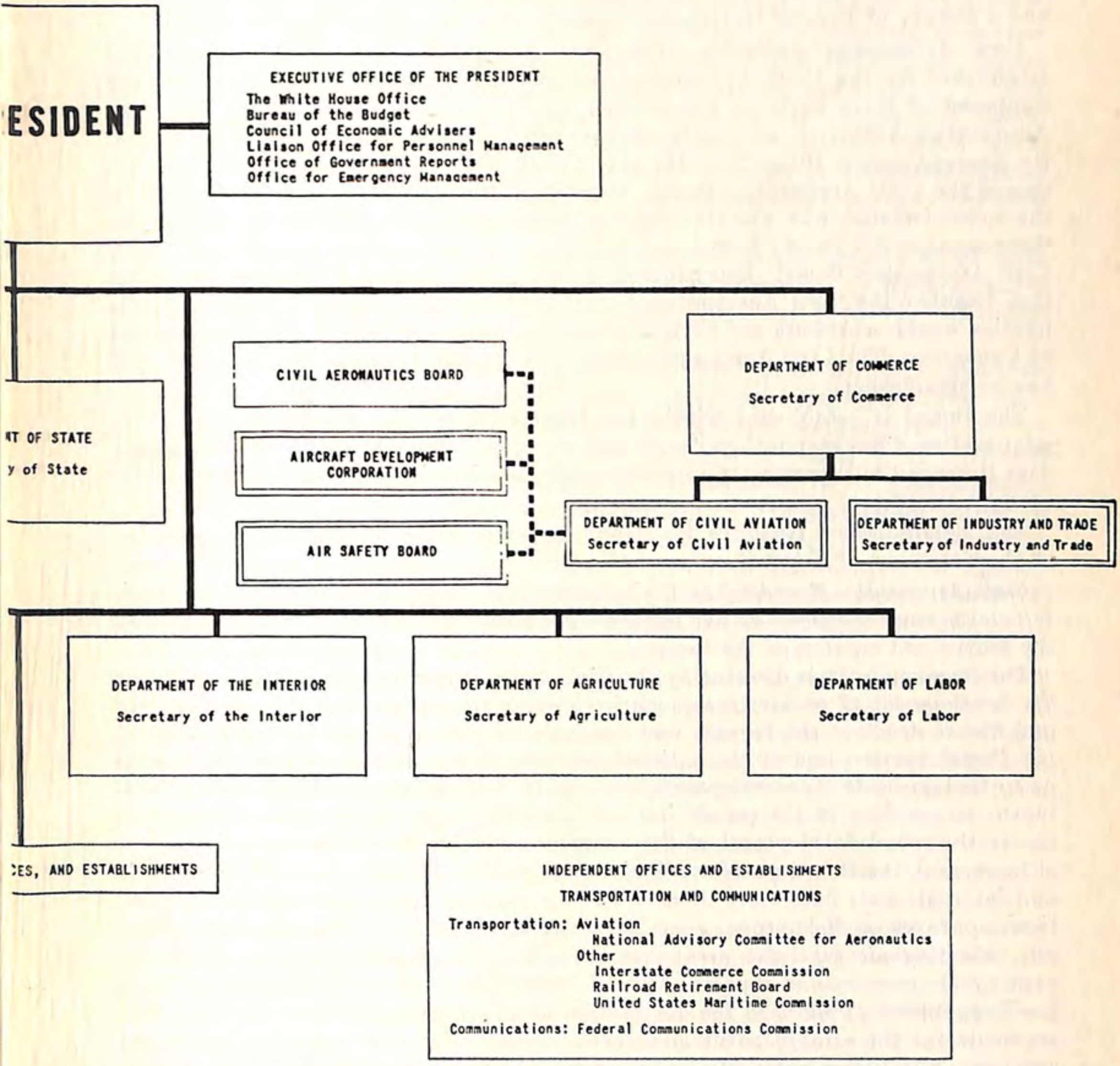


ship to other Executive Departments and is not intended to be a complete chart reflecting all agencies, offices and establishments of the

part of the Department of Civil Aviation for administrative housekeeping reasons only.

APPENDIX I

GOVERNMENT ORGANIZATION AND PROCEDURES

The information in this appendix contains a brief description of the functions, as of January 1, 1948, of those organizations of the Executive branch of the Federal Government which are primarily responsible for civil aviation activities and a history of Federal Government organization for civil aviation since 1926.

Civil Aeronautics Authority.—The Civil Aeronautics Authority, as originally established by the Civil Aeronautics Act of 1938, was an independent agency composed of three parts—a five-member group confusingly also called the Civil Aeronautics Authority, an Administrator, and a three-member Air Safety Board. By Reorganization Plans Nos. III and IV of 1940 the five-man group was renamed the Civil Aeronautics Board. Certain of its functions were transferred to the Administrator, who was renamed the Administrator of Civil Aeronautics; the three-member Air Safety Board was abolished and its functions transferred to the Civil Aeronautics Board. Reorganization Plans Nos. III and IV further provided that together the Civil Aeronautics Board and the Administrator of Civil Aeronautics would constitute the Civil Aeronautics Authority within the Department of Commerce. The Civil Aeronautics Authority as such performs no functions and has no significance.

The Board is established within the framework of the Department for "administrative housekeeping" purposes and reports to the Congress and the President through the Secretary of Commerce but exercises its functions independently of the Secretary.

The Administrator performs his functions under the direction and supervision of the Secretary of Commerce.

Civil Aeronautics Board.—The Civil Aeronautics Board is an independent quasi-judicial agency composed of five members appointed by the President by and with the advice and consent of the Senate.

The five-man body is directed by the Civil Aeronautics Act of 1938 to encourage the development of an air transportation system properly adapted to the present and future needs of the foreign and domestic commerce of the United States, of the Postal Service, and of the national defense; to regulate air transportation so as to best promote its development and safety and preserve its inherent advantages; to consider in the public interest competition to the extent necessary to assure the sound development of the air transportation system described.

In general, the Board grants or denies applications for air routes both domestic and international; fixes rates of domestic air carriers; fixes mail rate compensation; approves or disapproves consolidations, mergers, interlocking relationships, etc., affecting air carriers; prescribes accounts, records, and memoranda to be kept by air carriers and reports required from them. The Board cooperates with the Department of State in the negotiation of any agreements with foreign governments for the establishment and development of international air routes and services. The Board prescribes safety rules and regulations including standards covering the issuance of airman, aircraft type, production, airworthiness, and air carrier operating certificates. The Board investigates aircraft accidents and analyzes them in order to ascertain the facts, circumstances, and probable causes.

Department of Commerce.—The Assistant Secretary of Commerce for Aeronautics supervises the activities of the Civil Aeronautics Administration, the Weather Bureau, and the Coast and Geodetic Survey.

Civil Aeronautics Administration.—The Civil Aeronautics Administration is headed by the Administrator of Civil Aeronautics who is appointed by the President by and with the advice and consent of the Senate and is directed by the Civil Aeronautics Act of 1938 to encourage and foster the development of civil aeronautics and air commerce in the United States and abroad and to encourage the establishment of civil airways, landing areas, and other air navigation facilities.

The Civil Aeronautics Administration applies and enforces the safety standards, rules, and regulations established by the Civil Aeronautics Board; plans, constructs, maintains, and operates the Federal Airways System; maintains and operates the Washington National Airport; develops, directs, and fosters the coördination of a national system of airports, and directs the Federal-Aid Airport Program; performs developmental work, evaluation and service testing of devices and systems required for the safety and development of civil aeronautics; fosters and encourages the development of civil aviation education and training; collects and disseminates civil aviation information; regulates for purposes of safety United States-flag air carriers operating internationally; promotes United States air commerce abroad through technical assistance to foreign governments, training of foreign nationals, and the provisions of technical aviation experts to represent the United States at international conferences.

Weather Bureau.—The Weather Bureau was created in the Department of Agriculture in 1890 and transferred to the Department of Commerce by Reorganization Plan IV of 1940. Prior to 1890 its functions were performed in part by the Signal Corps of the Army beginning in 1870.

The basic purpose of the Weather Bureau is to collect, process, and disseminate weather information required for the public safety and national welfare. More specifically, the Weather Bureau disseminates forecasts, warnings, and advices for public and private uses; and organizes and operates special weather services required for safe and efficient air transport. In addition to its general public services it also operates special services for agriculture (including forest resources) and for several other fields of business, industry and transportation (including maritime commerce). The Bureau publishes information on climatic conditions in the United States and elsewhere as it affects the national interest; and promotes the development of meteorological science through research.

The Weather Bureau maintains close liaison with the Army and Navy to coordinate civil and military meteorological operations, and cooperates closely with the Civil Aeronautics Administration, the Coast Guard, the National Advisory Committee for Aeronautics, the Department of Agriculture, the United States Engineers, and Reclamation Service, etc., in the performance of its functions. With ships provided by the Coast Guard, it participates with the meteorological services of foreign countries in the maintenance of ocean weather stations.

Coast and Geodetic Survey.—The Congress authorized a survey of the coast of the United States in 1807 and in 1871 provided for the extension of the geodetic work across the country.

Included among the functions of the Coast and Geodetic Survey are the surveying and charting of the coasts of the United States and its possessions and the study of tides and currents to insure the safe navigation of coastal and intracoastal waters; the establishment of geodetic control, including gravitational and astronomical observations, to provide a framework of positions and elevations necessary to coordinate all surveying and mapping of the country, and the observation and analyses of the earth's magnetic data essential to the land surveyor and to the navigator of the air and sea.

The Air Commerce Act of 1926 made it the responsibility of the Department of Commerce to provide aeronautical charts for civil aviation. The production of these charts was delegated by the Secretary of Commerce to the Coast and Geodetic Survey.

By Act of Congress approved August 6, 1947, the Coast and Geodetic Survey was further authorized (1) to conduct field surveys for aeronautical charts; (2) to compile and print aeronautical charts of the United States, its territories and possessions, and charts covering international airways required primarily by United States civil aviation; and (3) to distribute these aeronautical charts and related navigational publications.

State Department.—The State Department has responsibility for assisting the President in the determination of United States foreign policy. The Secretary of State, who is the highest ranking member of the Cabinet, directs the home establishment in Washington and the Foreign Service abroad.

One of the six Assistant Secretaries of State, the Assistant Secretary—Transportation and Communications Affairs, is responsible for the initiation and coordination of policy and action concerning the international aspects of transport and communications; and is currently serving as Chairman of the Air Coordinating Committee, the Shipping Coordinating Committee, and the Telecommunications Coordinating Committee, which are interdepartmental advisory groups composed of representatives from the various governmental agencies concerned. The Office of Transport and Communications, which is under the direction of the Assistant Secretary, is divided into three divisions: the Aviation, Shipping, and Telecommunications Divisions.

With specific reference to the development of international air transport services, the Department of State conducts negotiations with foreign governments for new or additional rights determined to be desirable as a result of collaboration between the Department and the Civil Aeronautics Board and with the advice of the Air Coordinating Committee. Applications of foreign air carriers for permits to operate into United States territory are forwarded through diplomatic channels and, upon receipt by the State Department, are transmitted to the Board for appropriate action. The Department also has responsibility for liaison with and representation on ICAO and the coordination of this government's policies with that organization.

Post Office Department.—The Postmaster General superintends generally the business of the Department; executes all laws relative to the Postal Service; and, subject to the approval of the President, negotiates postal treaties with foreign governments.

The second of the four Assistant Postmasters General is charged with authority and responsibility for administering all matters relating to the transportation of the domestic and international mails by any and all media of transportation, and the management of the international postal service. He is assisted in the execution of these duties by an under Second Assistant Postmaster General and four deputy Second Assistant Postmasters General. One of these deputies supervises all domestic and foreign air mail routes flying the American flag and is responsible for research and analysis with respect to proposed new air services, and for the development, improvement, and expansion of transportation of mail by air. Another deputy is responsible for the establishment and maintenance of postal relations with foreign postal administrations and for the preparation of agreements and formal conventions with foreign countries covering all phases of international postal operations.

Air Coordinating Committee.—The Air Coordinating Committee was originally established on March 27, 1945, by agreement of the Secretaries of State, War, Navy, and Commerce which was adhered to shortly thereafter by the Civil Aeronautics Board subject to certain reservations. It was formalized by Executive Order 9781 of September 19, 1946, in which provision is made for submission to the President of important matters upon which the Committee cannot reach a unanimous decision.

The functions of the Committee are to examine aviation problems and developments affecting more than one participating agency; to develop and recommend integrated policies to be carried out and actions to be taken by the participating agencies or by other government agency charged with responsibility in the aviation field; and, to the extent permitted by law, to coordinate the aviation activities of such agencies except those relating to the exercise of quasi-judicial functions.

The Executive order provided that the Committee shall have as members one representative from each of the following-named agencies: the State, War, Post Office, Navy, and Commerce Departments and the Civil Aeronautics Board. The members are designated by the respective heads of the participating agencies. The President names one of the members as the Chairman of the Committee. The Director of the Bureau of the Budget designates a representative of the Bureau as a nonvoting member of the Committee.

At the present time the following are members of the Air Coordinating Committee: an Assistant Secretary of State who serves as chairman, the Chairman of the Civil Aeronautics Board, who serves as co-chairman, the Under Secretary of Commerce, the Assistant Secretary of the Navy for Air, an Assistant Secretary of the Air Force, and the Second Assistant Postmaster General, with an Assistant Director of the Bureau of the Budget as a nonvoting member.

The Committee, after obtaining the views of the head of each agency concerned, submits to the President, together with the said views, (*a*) such of the Committee's recommendations on aviation policies as require the attention of the President by reason of their character or importance, (*b*) those important aviation questions the disposition of which is prevented by the inability of the agencies concerned to agree, (*c*) an annual report of the Committee's activities during each calendar year, which is submitted not later than January 31 of the next succeeding year, and (*d*) such interim reports as may be necessary or desirable.

The Committee has a Technical Division concerned with technical questions affecting techniques of flight, an Economic Division for economic and political problems affecting air transportation, and an Industrial Division for problems relating to the aircraft manufacturing industry. It also has an Aviation Industry advisory panel composed of representatives of the Aircraft Industries Association, the Air Transport Association, the Institute of the Aeronautical Sciences, the National Aeronautic Association, the American Federation of Labor, and the Congress of Industrial Organizations; an ICAO (International Civil Aviation Organization) panel which plans and coordinates the work performed by the Committee's divisions and subcommittees; and a legal subcommittee which among other things coordinates agency views with respect to legislation.

National Advisory Committee for Aeronautics.—The National Advisory Committee for Aeronautics was established by the Congress on March 3, 1915, to supervise and direct the scientific study of the problems of flight with a view to their practical solution, and to direct and conduct research and experiment in aeronautics in laboratories placed in whole or in part under its direction.

In general, the Committee coordinates the research needs of private, commercial, and military aviation; and conducts fundamental and applied research with a view to increasing the performance, economy, and safety of aircraft.

The Committee is composed of 15 members serving without compensation appointed by the President: two representatives each of the Navy and the Air Force Departments and the Civil Aeronautics Authority; one representative each of the Smithsonian Institution, the United States Weather Bureau, and the National Bureau of Standards; together with six additional persons who are "acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences." To assist the main committee in the formulation of programs of scientific research and in the coordination of aeronautical research generally there are 6 major and 20 subordinate technical committees comprising members serving without compensation and drawn from the military, industrial, and scientific aeronautical organizations.

Within the NACA are two subsidiary organizations: the Office of Aeronautical Intelligence, which serves as a depository and distributing agency for scientific and technical data on aeronautics; and the Office of Aeronautical Inventions which gives preliminary consideration to, and analyses and prepares reports on, the merits of aeronautical inventions and designs submitted to the Government through any agency.

The Committee operates the Langley Memorial Aeronautical Laboratory at Langley Field, Va., the Ames Aeronautical Laboratory at Moffett Field, Calif., and the Aircraft Engine Research Laboratory at Cleveland, Ohio, which are the principal aeronautical research laboratories of the Government.

National Security.—The National Security Act of 1947 provides for the coordination for national security through the establishment of the National Security Council (with the Central Intelligence Agency under it) and the National Security Resources Board; and establishes the National Military Establishment headed by the Secretary of Defense.

The function of the National Security Council is to advise the President with respect to the integration of domestic, foreign, and military policies relating to the national security so as to enable the military services and the other departments and agencies of the Government to cooperate more effectively in matters involving the national security. Membership includes the President, who presides over meetings of the Council or designates a member to preside in his place; the Secretary of State; the Secretary of Defense; the Secretaries of the Army, the Navy, and the Air Force; the Chairman of the National Security Resources Board; and any of the following whom the President may designate from time to time: the Secretaries of the executive departments, the Chairman of the Munitions Board; and the Chairman of the Research and Development Board.

The function of the National Security Resources Board is to advise the President concerning the coordination of military, industrial, and civilian mobilization. Membership includes the Chairman, appointed from civil life by the President with the advise and consent of the Senate, and such heads or representatives of the various executive departments and independent agencies as the President may designate from time to time. On November 13 last the President appointed the Secretaries of the Treasury, Defense, Interior, Agriculture, Commerce, and Labor as members of the Board.

The National Military Establishment consist of the Department of the Army, the Department of the Navy, and the Department of the Air Force; the War Council, the Joint Chiefs of Staff (including the Joint Staff), the Munitions Board, and the Research and Development Board.

HISTORY OF FEDERAL GOVERNMENTAL ORGANIZATION FOR CIVIL AVIATION

AIR COMMERCE ACT OF 1926

Promotion of Air Commerce.—The act made it the duty of the Secretary of Commerce to foster air commerce by encouraging the establishment of airports, civil airways, and other air navigation facilities; by making recommendations to the Secretary of Agriculture as to necessary meteorological service; by studying the possibilities for the development of air commerce and the aeronautical industry and trade in the United States and by collecting and disseminating aviation information; by cooperating with other executive agencies of the Government in research and development for the improvement of air navigation facilities; by investigating and publishing the causes of accidents in civil air navigation in the United States, etc.

Regulatory Powers.—The Secretary was authorized to provide for the registration of civil aircraft; for the certification of civil aircraft as to their airworthiness; for the rating of airmen and air navigation facilities; for the issuance, suspension, and revocation of registration, aircraft, and airman certificates; and for the establishment of air traffic rules for the navigation, protection, and identification of aircraft.

Aids to Air Navigation.—All airways, together with all emergency landing fields and other air navigation facilities except airports and terminal landing fields, used in connection with the air-mail service were transferred from the jurisdiction of the Postmaster General to that of the Secretary of Commerce.

The Secretary was authorized to designate and establish civil airways; to establish, operate, and maintain along such airways all necessary air navigation facilities except airports; to chart and arrange for the publication of maps of such airways.

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, was directed to furnish weather reports, forecasts, warnings, and advices required to promote the safety and efficiency of air navigation in the United States and above the high seas.

Assistant Secretary of Commerce.—Provision was made for an additional Assistant Secretary of Commerce, to be appointed by the President with the advice and consent of the Senate, to assist the Secretary in performing his duties under the act. (The Aeronautics Branch of the Department of Commerce was created to administer the act; name changed to Bureau of Air Commerce by administrative order of the Secretary of Commerce, July 1, 1934.)

Air Mail Act of 1934.—The act authorized the Postmaster General to award air-mail contracts and to determine the routes for the transportation of air mail. Holders of air-mail contracts were required to keep their books, records, and accounts in the manner prescribed by the Postmaster General; and were restricted as to maximum remuneration, aviation stockholdings, directorships, etc.

The Interstate Commerce Commission was required, after notice and hearing, to fix fair and reasonable rates of compensation for the carriage of air mail over each route, not to exceed the maximum established by the legislation. (The Bureau of Air Mail was created in the Interstate Commerce Commission to carry out the provisions of the act.)

The Secretary of Commerce, administering the Air Commerce Act of 1926, was ordered to certify to the Postmaster General the nature of the equipment to be required with respect to speed, load, and safety. The Secretary prescribed maximum flying hours for pilots and operational techniques for mail carriers.

The Air Mail Act of 1934 also called for the President to appoint a five-man Federal Aviation Commission to study the country's air transportation system, and to report to Congress "its recommendations of a broad policy covering all phases of aviation and the relation of the United States thereto."

Civil Aeronautics Act of 1938.—The act created an independent agency for civil aviation—the Civil Aeronautics Authority—composed of the Civil Aeronautics Authority of five members which exercised broad adjudicative and rule-making functions classified as economic and safety regulation; the Administrator who was responsible for the designation of airways and the construction, operation, and maintenance of air-navigation facilities; the Air Safety Board of three members which investigated aircraft accidents. All such appointments were made by the President with the advice and consent of the Senate.

The personnel and property of the Bureau of Air Commerce of the Department of Commerce and of the Bureau of Air Mail of the Interstate Commerce Commission were transferred to the Civil Aeronautics Authority.

The Secretary of State was directed to advise the Authority concerning the negotiation of air agreements with foreign governments.

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, was directed to furnish the required meteorological services.

Reorganization Plan III of 1940.—The intent of plan III was to clarify the relations of the Administrator and the five-member Board of the Civil Aeronautics Authority. The administrator, renamed the Administrator of Civil Aeronautics, was made the chief administrative officer of the Authority with respect to all functions other than those relating to economic regulation and certain other activities primarily of a rule-making and adjudicative character entrusted to the Board.

To this end certain functions were transferred to the Administrator of Civil Aeronautics, including the functions vested in the Authority by the Civilian Pilot Training Act of 1939; the functions of aircraft registration and of safety regulation (except the prescription of safety standards, rules, and regulations) and the function of suspending and revoking certificates after hearing, etc.

Reorganization Plan IV of 1940.—By this plan the Civil Aeronautics Authority was brought within the framework of the Department of Commerce. The Weather Bureau was transferred from the Department of Agriculture to the Department to Commerce to permit better coordination of government activities relating to aviation and to commerce generally.

The Air Safety Board was abolished and its functions transferred to the five-member Civil Aeronautics Authority, renamed the Civil Aeronautics Board.

The plan further provided that the Administrator of Civil Aeronautics and the Civil Aeronautics Board would constitute the Civil Aeronautics Authority within the Department of Commerce; the Administrator exercising his functions under the direction and supervision of the Secretary of Commerce; the Board reporting to Congress and the President through the Secretary of Commerce and performing its budgeting, accounting, personnel, procurement, and related routine management functions under the direction and supervision of the Secretary but exercising its functions of rule-making (including the prescription of rules, regulations, and standards), adjudication, and investigation independently of the Secretary.

APPENDIX II

HISTORY AND ORGANIZATION—PRESIDENT'S AIR POLICY COMMISSION

Immediately following the appointment of the Commission by the President's letter of July 18, 1947, the Chairman and the Vice Chairman met in Washington to discuss plans, programs, and policies. Much of the procedural groundwork was laid before the first formal meeting of the entire group on July 29. On that day, the five commissioners were sworn in, and the nucleus of the staff was assembled. The Executive Director was appointed on July 30, and was sworn in on August 11.

By mid-August, the recruitment and organization of the working staff was virtually complete. Before the end of the month, an outline for the final report and the procedures for the conduct of the entire program had been agreed upon and were in effect.

An accompanying chart shows the organization of the Commission and its staff. Some changes in staff personnel and functions took place in the course of the work but they were of a minor character. The chart shows accurately the duties and responsibilities of the members of the organization during its active life.

One major change occurred in Commission membership. For reasons stated in his letter to President Truman of September 16, Mr. Henry Ford tendered his resignation. It was accepted by the President on Septembr 27, and on the same day, Mr. John A. McCone, the Commission's advisor on national security matters, was appointed to replace Mr. Ford. Subsequent to his appointment Mr. McCone continued to carry the specific responsibility for the national security phase of the study.

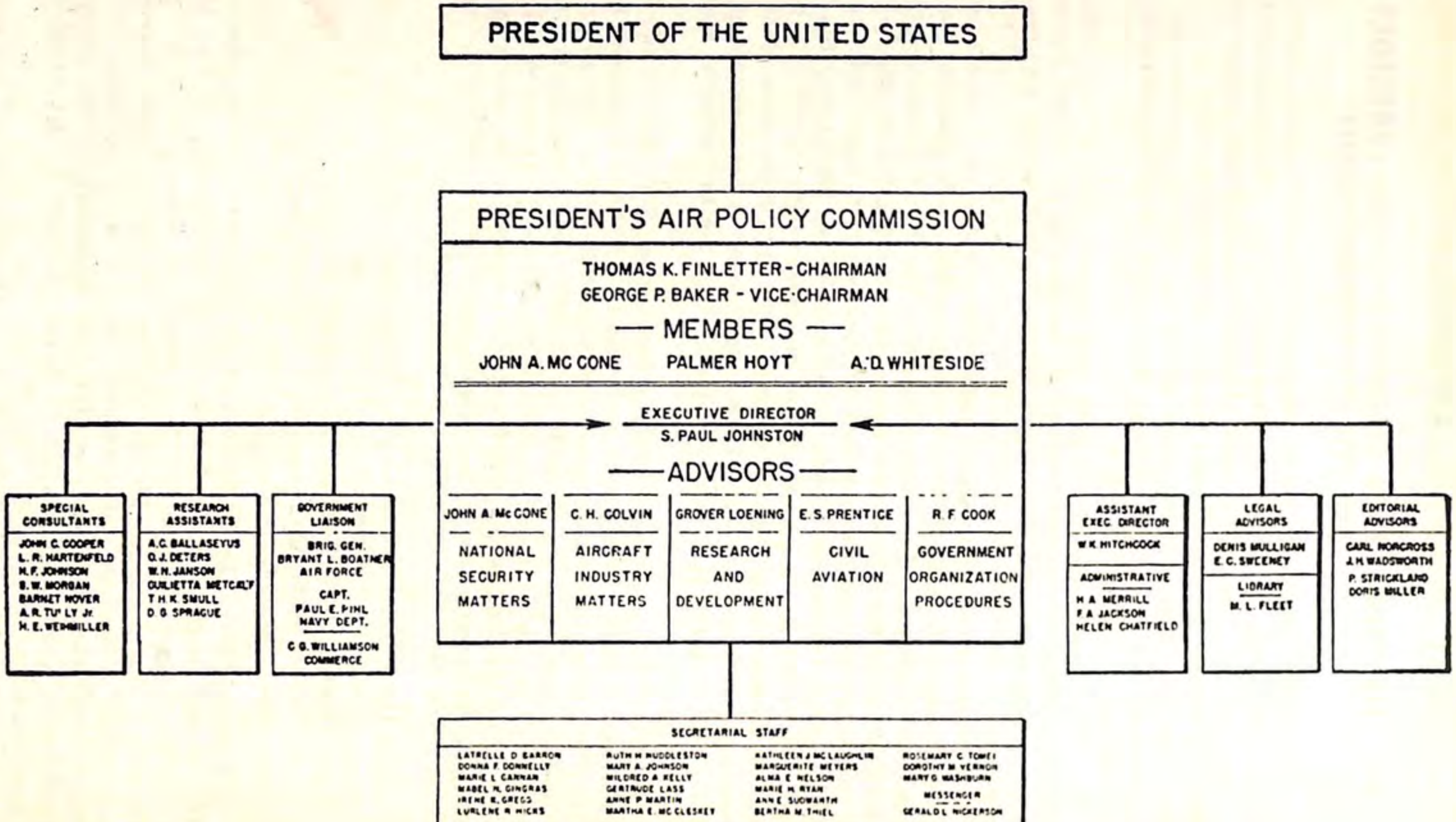
The Commission opened its formal hearings on September 8 and closed them on December 3, 1947. Both public and executive sessions were held, interspersed by many less formal conferences and meetings with civilian and governmental representatives and agencies. The National Military Establishment, the Department of State, the Department of Commerce, the Civil Aeronautics Board, and the Bureau of the Budget were particularly cooperative in arranging presentations of their problems at the Commission's convenience. The total number of formal Commission meetings was 206, distributed as follows:

Open hearings	96
Executive sessions	65
Luncheon meetings	33
Dinner meetings	5
Miscellaneous	7

Witnesses before the Commission were requested to file statements in advance. The formal hearings consisted mainly of questioning by the Commission to elaborate upon or to clarify the information submitted by the witness in his statement. Full stenographic records were kept of all public hearings. Abstracts were made of both the statements and the testimony as taken. For convenience, these abstracts have been compiled both alphabetically by witnesses and also classified by subject matter. These documents form a part of the records of the Commission.

An accompanying list shows all those who gave formal testimony before the Commission, either in public or executive session. Many others, not listed, gave the benefit of their views on many subjects, either orally or in writing. The

ORGANIZATION-PRESIDENT'S AIR POLICY COMMISSION



Commission takes this opportunity to make acknowledgement of the invaluable assistance rendered by all those who appeared, or who contributed of their time and experience during the course of the investigation.

It was impossible, within the time available, for the Commission to visit all centers of aeronautical activity in the United States. It did, however, make several field trips.

On August 26, the NACA laboratories at Langley Field were inspected.

During the week of October 5-12 the Commission visited aircraft establishments in the midwestern and Pacific regions of the United States, including:

Air Matériel Command, Wright Field, Dayton.
Civil Aeronautics Administration Technical Development Center, Indianapolis.
Allison Division, General Motors Corp., Indianapolis.
Beech Aircraft Corporation, Wichita.
Boeing Airplane Co., Wichita.
Cessna Aircraft Co., Wichita.
Consolidated-Vultee Aircraft Corporation, Fort Worth, San Diego.
Ryan Aeronautical Co., San Diego.
Lockheed Aircraft Corporation, Glendale, Calif.
Douglas Aircraft Co., Inc., Santa Monica, Calif.
Northrop Aircraft, Inc., Hawthorne, Calif.
North American Aviation, Inc., Inglewood, Calif.
Hughes Aircraft Co., Culver City, Calif.
Muroc Army Air Base, Calif.
National Advisory Committee for Aeronautics, Moffat Field, Calif.
Naval Air Transport Service Headquarters, Moffat Field, Calif.
Boeing Airplane Co., Seattle.

On October 21, at the invitation of the Department of the Navy, members of the Commission and staff, together with members of the Congressional Air Policy Board, went aboard the aircraft carrier *Midway* for a day's demonstration of aerial tactics at sea.

On November 6, members of the Commission visited the following eastern aircraft plants:

Grumman Aircraft Co., Bethpage, N. Y.; Republic Aviation Corp., Farmingdale, N. Y.; United Aircraft Corp., East Hartford, Conn. On December 10 the groups inspected the Glenn L. Martin Co.'s plant at Baltimore.

For the western tour, and the trip of November 6, the President made his personal airplane, the *Independence,* available to the Commission, a fact which added greatly to the speed and comfort of both trips, and which was much appreciated by all those aboard.

Many Government departments contributed in many ways to the Commission's work. The temporary release of needed personnel for transfer to the staff was of great assistance. A willingness everywhere to consult with Commission staff at any time on any subject was also very helpful.

Special mention should be made of the untiring work of the military liaison officers, Brig. Gen. Bryant L. Boatner, United States Air Force, and Capt. Paul E. Pihl, United States Navy. As the designated channels through which all military material flowed to the Commission, these officers were called upon to handle extraordinary loads under conditions that were often far from ideal. Their work did much to pave the way for the Commission in its research in matters pertaining to the armed services.

The responsibility for housing and servicing the Commission during its entire existence has been in the hands of the Department of Commerce. Special acknowledgment is due to its administrative officers for the high degree of cooperation that has been accorded to the Commission and its staff. The personnel, fiscal, and housekeeping problems that inevitably arise in conjunction with a temporary organization working under high pressure require extraordinary tact and patience in the handling. The efficiency and dispatch with which all our problems were handled by our hosts in the Department of Commerce contributed in no small degree to the successful operation of the Air Policy Commission.

The Commission expresses its especial appreciation to S. Paul Johnston, the Executive Director, for his efficient organization and direction of the staff and his invaluable and informed advice.

Final acknowledgment is due to the loyal and untiring work of the members of the Commission staff. From beginning to end, they have worked long hours under extreme pressure to provide the necessary background material, to prepare for hearings, to analyze testimony, and to assemble the facts and figures on which this report is based. Without their help, it would have been impossible for the Commission to carry out the President's directive within the time limit that was set.

80TH CONGRESS } SENATE { REPORT
2d Session } { No. 949

NATIONAL AVIATION POLICY

REPORT

OF THE

CONGRESSIONAL AVIATION POLICY BOARD
CONGRESS OF THE UNITED STATES

PURSUANT TO

PUBLIC LAW 287 (80TH CONG.), AN ACT TO PROVIDE FOR THE ESTABLISHMENT OF A TEMPORARY CONGRESSIONAL AVIATION POLICY BOARD

MARCH 1 (legislative day, FEBRUARY 2), 1948.—Ordered to be printed, with an illustration

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MERRILL C. MEIGS, *Director, Aircraft Division, War Production Board, 1940-42; Consultant, 1942-44*

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GERALD B. BROPHY, aviation attorney, United States representative, Provisional International Civil Aviation Organization, 1945-46.

WILLIAM A. M. BURDEN, Assistant Secretary of Commerce for Air, 1944-47.

RALPH S. DAMON, president, American Airlines, Inc.

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Dr. CLARK M. MILLIKAN, professor of aeronautics, California Institute of Technology.

L. WELCH POGUE, aviation attorney, chairman, Civil Aeronautics Board, 1942-44.

D. W. RENTZEL, president, Aeronautical Radio, Inc.

Dr. WILLIAM R. SEARS, director, the Graduate School of Aeronautical Engineering, College of Engineering, Cornell University.

EARL F. SLICK, president, Slick Airways, Inc.

CHARLES E. SORENSEN, vice chairman, Willys Overland Motors, Inc.; adviser to Aircraft Production, War Production Board, 1942.

Admiral JOHN H. TOWERS, United States Navy (retired).

Col. ROSCOE TURNER, president, Turner Aviation Corp.

J. CARLTON WARD, JR., president, Fairchild Engine & Aircraft Co.

GILL ROBB WILSON, aviation editor, New York *Herald-Tribune*.

C. E. WOOLMAN, president, Delta Air Lines.

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ALICE ROGERS HAGER, consultant.

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HALFORD G. DAVIS, consultant.

Col. E. E. ALDRIN, United States Air Force Reserve, consultant.

RESEARCH AND DEVELOPMENT

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COMBAT AVIATION

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Maj. L. C. QUINN, JR., United States Air Force, consultant.

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Air transport, ALAN PASSEN.

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ALTERNATES

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Maj. Gen. H. J. KNERR, United States Air Force.

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Prof. WILLIAM R. SEARS.
EARL F. SLICK.
Admiral JOHN H. TOWERS, United States Navy (retired).
Col. ROSCOE TURNER.
J. CARLTON WARD, JR.

80TH CONGRESS } SENATE { REPORT
2d Session } { No. 949

NATIONAL AVIATION POLICY

Mr. BREWSTER, from the Temporary Congressional Aviation Policy Board, submitted the following

REPORT

[Pursuant to Public Law 287, 80th Cong.]

FOREWORD

Within 2 years after cessation of hostilities in World War II, general concern over national security and the threatened bankruptcy of the aircraft industry and civil air carriers of the United States, indicated necessity for review of national aviation policy by the Congress.

As early as January 1947, legislation was introduced in the Senate for establishment of a National Aviation Policy Board. After months of debate, a bill, H. R. 3587, was passed by both Houses on July 22, 1947. This act to provide for the establishment of a temporary Congressional Aviation Policy Board, was signed by the President on July 30, 1947, thus becoming Public Law 287.

The first meeting of the Board was held September 15, 1947. It has been followed by continuous staff work and joint Congressional Board and Advisory Council meetings at frequent intervals from that time until now, when the Board, recognizing individual differences of opinion which inevitably occur in a study of this magnitude and importance, unites in this report.

Before Board study had proceeded far beyond preliminary stages, it became apparent that the primary problem of national aviation policy was one of providing well-balanced military and naval air forces rather than one of finding means to maintain an aircraft industry. If the former were accomplished, the health of the latter would be assured.

It also became apparent that development and installation of a basic system of ultramodern facilities and controls would expedite high density civil air traffic with safety and certainty under all conditions, assuring a major degree of air-defense mobility.

Availability of exhaustive testimony in public hearings before the contemporary Presidential Air Policy Commission enabled the Congressional Board to proceed in executive sessions without duplication of time and expense by Government and witnesses alike. Additional testimony and voluminous research data have been required, but the unfailing courtesy and cooperation of the Presidential Commission in making its experience available has been of the greatest material assistance, and is acknowledged with most sincere appreciation.

The Congressional Board likewise wishes to express appreciation of the cooperation of those Government officials, aviation experts, and private citizens who generously submerged personal interest to furnish information and advice in the public behalf.

In particular, the Board desires to commend to public appreciation the membership of its Advisory Council, which has given without stint from a vast aggregate of knowledge and experience, to the formation of sound national aviation policy. In conclusion it should be clear that the emphasis of this report upon air power is not to be construed as implying any opinion whatsoever concerning the importance or necessity of any other branches of the armed services.

LETTER OF TRANSMITTAL

CONGRESS OF THE UNITED STATES,
CONGRESSIONAL AVIATION POLICY BOARD,

March 1, 1948.

The PRESIDENT PRO TEMPORE OF THE SENATE,

United States Senate, Washington, D. C.

SIR: In accordance with Public Law 287, Eightieth Congress, as chairman of the Congressional Aviation Policy Board, it gives me pleasure to present to you the report of this Board which I ask that you lay before the Senate of the United States for consideration, with a view to its being printed as a Senate document.

Respectfully submitted.

OWEN BREWSTER, U. S. S.,
Chairman.

CONTENTS

PREFACE

On August 6, 1945, an airplane bearing the insignia of the United States Army Air Forces dropped an atom bomb on Hiroshima. Militarily speaking, at that same hour the security frontiers of all nations disappeared from the map. National defense, in the traditional sense, is no longer possible. More devastating weapons and more competent weapon carriers than those which struck Hiroshima are in existence. The cycle of history has turned and once again civilization stands vulnerable to annihilation.

Joint action for peace by all major nations alone can meet our modern dilemma. Determined and continuous effort in the United Nations must not be abandoned while the slightest ray of hope remains. In the meantime, an alternative plan to maintain a balance of peace must be contrived in the name of the free world.

World War III, if it comes, will be in sudden and indiscriminate attack on our cities, our factories, our transportation lines, our communication centers and water supply, and more important than all else, upon our lives. It will be more extensive than the attack on Hiroshima. There will be no time, as in World War I and World War II, for mobilization. The only "defense" will be swift and more devastating retaliatory attack.

To defend ourselves in the age of atomic bombs, of radioactive dust, of bacteriological contamination and guided missiles—to mention some of the new and terrible weapons—we must have air power that is supreme. We cannot have less if we are to discourage attack or, if attacked, to defend ourselves.

Existence of opposing weapons in quantity, and the means to deliver them, is a restraint upon any nation contemplating attack. Possession of weapons in quantity, and the means to deliver them in overwhelming force, if attack comes, is judged the best and surest protection against defeat and slavery.

Until men of all nations can meet in good will in the council chambers of the world, anything less than this complete supremacy in air power is self-deception.

Air power is the total ability of a nation to capitalize on the medium of flight. The ramifications of the air power we must have call for definition of political rights in air space. They require revaluation of international alliances. They overlay the traditional map of commerce with air trade routes. They profoundly influence the expenditure of national budgets. They presage the existence of a vast new industry.

Amazed as we are today over speeds in excess of 600 miles an hour, the ultimate attainments of flight are only vaguely apparent. New sources of propulsive power are being determinedly researched. More efficient design is breaching the way to supersonic speeds. Fully automatic flight control and navigation are in prospect.

Considering these projects, it is self-evident that search for a national air policy for the United States must range from telescopic to miscroscopic analysis. It must seek to explore all the facts. It must uncover them and it must coordinate them if a pattern of national security and civil progress is to result.

It is folly to pretend that the world does not live under a sense of impending tragedy. Deliberately and continuously we are faced with the possibility of aggressive attack. The deadly character of the new weapons makes war an open invitation to mass annihilation.

The answer to this greatest of historical dilemmas would be a Magna Charta of world defense, a ringing declaration of moral challenge to match the danger. This should come from the united voice of the major powers implementing their joint will through the United Nations. Their forces of inspection would be guarantors to whom modern weapons might be surrendered.

That this, presently, cannot be the case is tragic. But it is true. Until there is a solid foundation upon which freemen can build for security and survival, these same freemen, who seek only self-preservation with justice and with freedom, are faced with the necessity of defending themselves.

Interested only in freedom and justice, the United States has no other course to follow but to maintain such a military air force and civil air effort that no sudden attack upon the American people can succeed—and that any such attack will prompt swift and awful retribution in overwhelming volume with effective and devastating weapons.

Therefore, it is the judgment of the Congressional Aviation Policy Board that the capability of the United States most likely to discourage an aggressor against attack upon this Nation, most effective in thwarting such an attack if launched, and most able to deal out retaliation to paralyze further attack, is air power.

National air power is an entity not fundamentally divisible as a weapon, or as a carrier. Materials, organization, and craftsmanship which go to make a great aviation industry are as readily turned to the combat plane as to the transport. Airway facilities which give scheduled dependability to civil air lines also give tactical dependability to military air forces. Airports which serve the burden of national and international traffic can also base tactical or strategic combat squadrons. Transport fleets which serve commerce in peace can tie together tactical and administrative requirements in war.

Hence, it is the conviction of the Congressional Aviation Policy Board that a strong, stable, and modern civil aviation component is essential to air power for national security.

In view of the foregoing, the Congressional Board has sought to determine a broad national air policy which by coordination of all phases of air power will most discourage aggression, preserve the national security, and promote the total social and economic welfare of the United States.

CONCEPT OF NATIONAL AVIATION POLICY FOR THE UNITED STATES OF AMERICA

1. That the costs of the air-power program of the United States be coordinated with all other costs and expenditures of government, both domestic and foreign, that we may protect ourselves against both aggression from abroad and bankruptcy at home.

2. The military air power of the United States should be maintained at such effectiveness as to be able under all circumstances to control the air spaces of the United States, its possessions, Territories, bases, and occupied lands wheresoever, and be able to retaliate in greater degree for any attacks launched by air, or otherwise, against the peace and security of the United States or those free allied governments with which it is joined for mutual defense.

3. Scientific research should be fostered and coordinated to maintain the leadership of the United States in technical aeronautical development.

4. The airways, weather stations, airports, and essential facilities of air navigation and control should be developed and maintained to accomplish the maximum degree of safety and certainty in air commerce and military operation, regardless of weather, burden of traffic, enemy action, or other cause whatsoever.

5. The aviation industry of the United States should be maintained in such production status and degree of expandability as to serve adequately, and without delay in emergency, the requirements of the military air forces.

6. The domestic and foreign air commerce of the United States should be fostered and promoted by whatever means appear most practical until it reaches such stature in passenger and cargo capacity as to constitute in crisis an adequate logistical air arm of the National Defense Establishment.

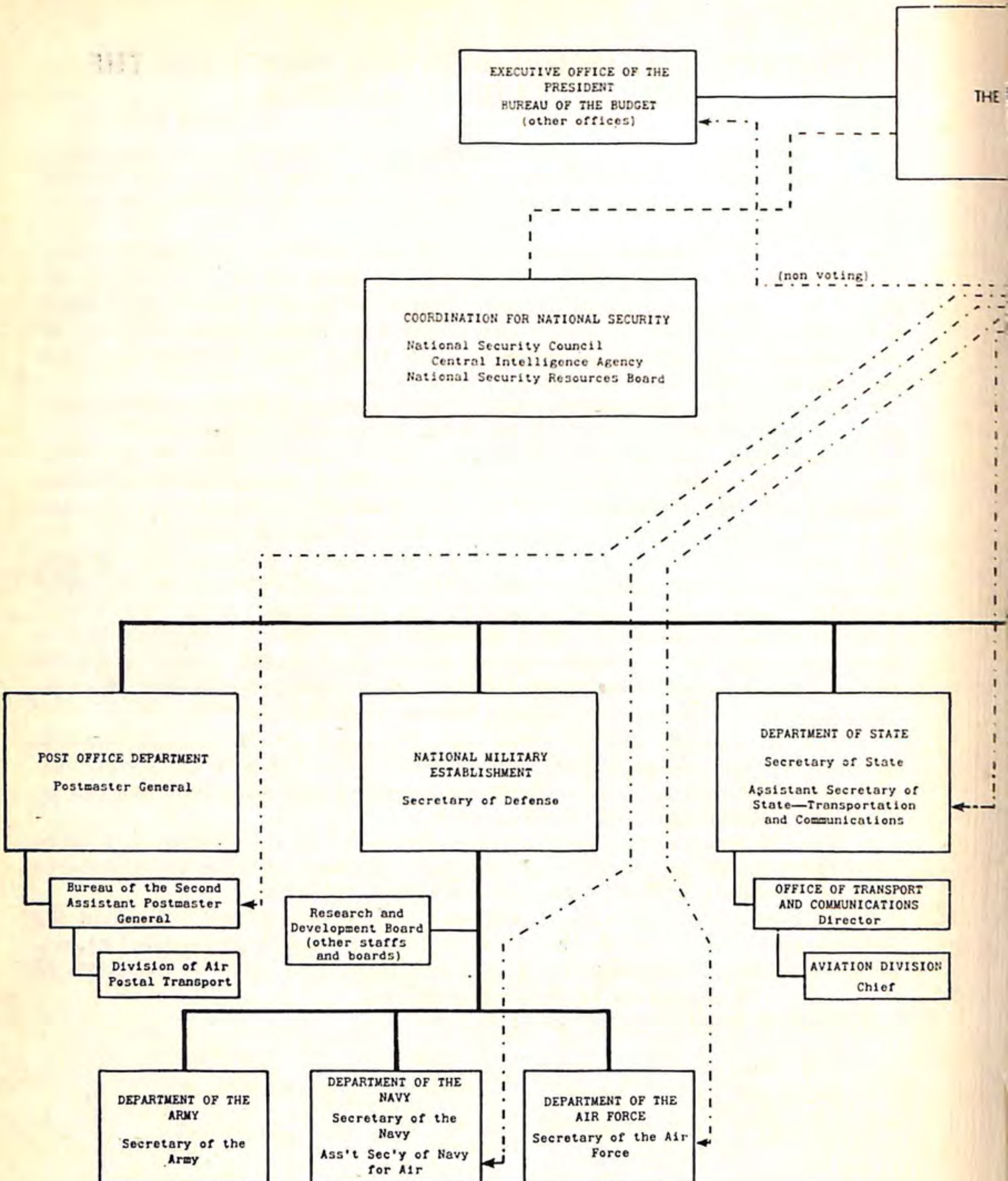
7. The value of the small-business man—the local airport operator, aircraft sales and service companies, flying and trade schools—along with the private citizen pilot and owner of aircraft should be regarded as a national asset and be given every recognition and encouragement.

8. In every phase of national air power, the policy of coordination with every other phase should prevail, and the Secretaries of State, Defense, and Commerce must be specifically charged with responsibility to this end.

9. An aeronautical educational program should be established throughout the public-school system in order that basic problems of the air age—global geography, meteorology, navigation, mechanics, communications and the rudiments of flight—are well understood by future generations.

The Board's conclusions follow:

Relation of Proposed Organization of Civil Aviation A
Recommended by the Co



Solid lines indicate organizational structure.
Broken lines indicate coordination.
Dash-dot lines indicate membership in the Air Coordinating Committee.
Proposed structural organization changes are indicated by parallel lines around boxes.
<u>This chart shows the general relationship of the principal functional aviation activities of the Executive Branch to one another, and is not intended to be a complete chart reflecting all agencies, offices, and establishments of the Government.</u>

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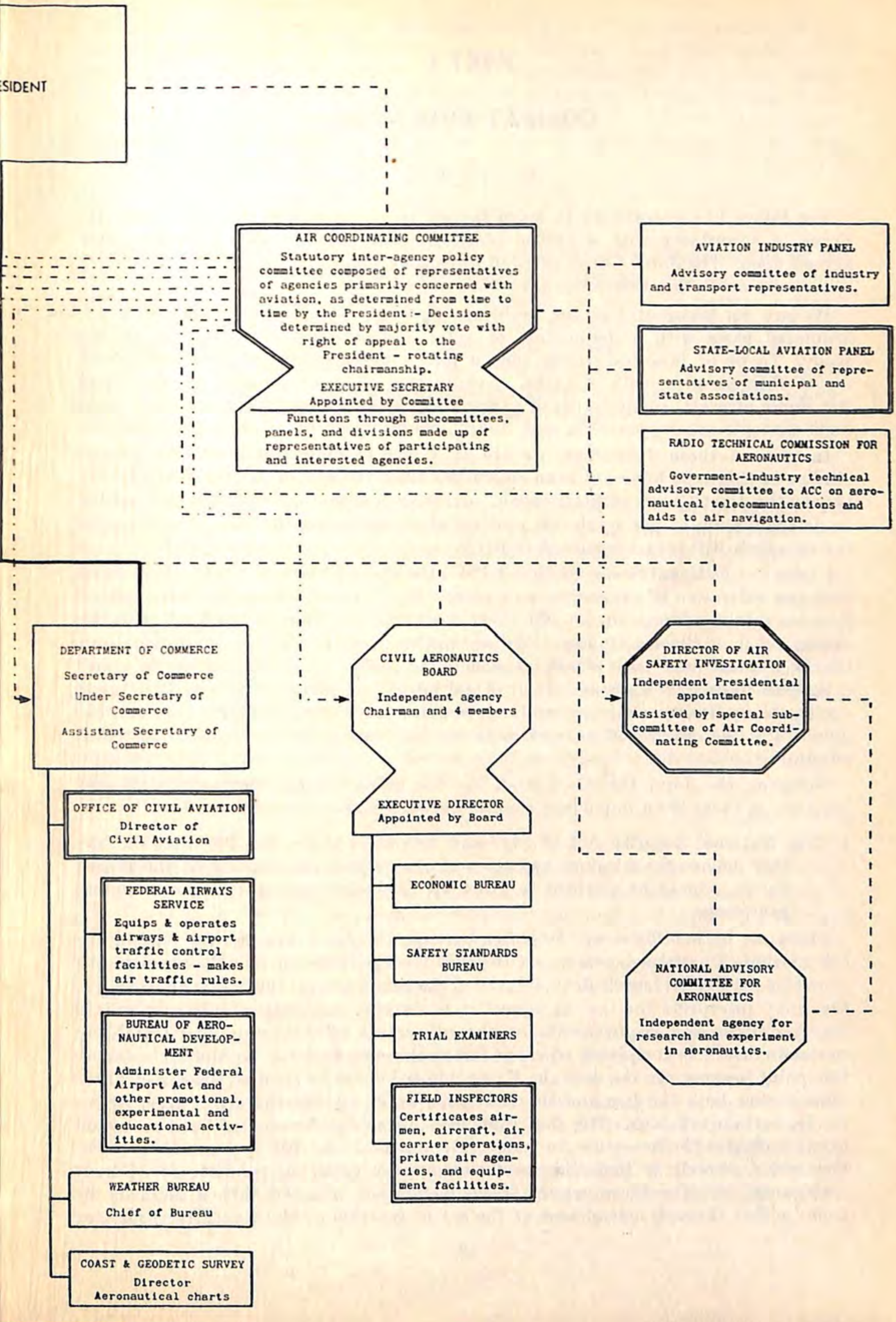

PART I

COMBAT AVIATION

SECTION I

The Board has endeavored to learn the air requirements of the Navy and Air Force in accordance with a unified plan of action, but no such plan has been agreed upon. The Joint Chiefs of Staff have been requested repeatedly to furnish a unified plan to this Board but they have yet to do so.

We are not unmindful of the problems involved. Strategic planning on a co-ordinated basis with a delineation of roles and missions is a time-consuming study. To be of practical value, such a plan must provide for coordination of target objectives, priority of tasks, co-ordination of items common to Navy and Air Force aircraft, computation of over-all logistics necessary to insure that strategic concepts are supportable, and, finally, coordination of aircraft procurement.

In spite of these difficulties, we are at a loss to understand why integrated studies of this type have not been conducted since the end of World War II. We believe the Joint Chiefs of Staff should pursue such studies intensively with a view to determination of the minimum number of aircraft and the size of the armed forces which will insure national security.

Under the National Security Act of 1947, the Joint Chiefs of Staff are charged with the obligation of preparing such plans. It is our view that the Secretary of Defense and the President should exert whatever pressure is required to make certain of their accomplishment. We are not unaware of the fact that the Joint Chiefs of Staff, who individually represent the three separate services, may find it difficult to prepare truly coordinated and integrated plans. The loyalty of each service to its traditions is understandable, but unyielding adherence to service loyalties at the expense of national security is a luxury the Nation no longer can afford.

However, the Joint Chiefs of Staff are not alone responsible for the present impasse, as there is an important conflict between Executive order and law.

1. **The National Security Act of 1947 and Executive Order No. 9877, which further defines the missions and roles of the various components of the armed forces, should be clarified in order to eliminate basic differences in interpretations.**

There are basic differences of opinion between the Air Force and the Navy as to the mission of naval aviation as set forth in Executive Order No. 9877 and in the provision of Public Law 253, the National Security Act of 1947. As an example, the Navy interprets the law to permit it to develop any type of weapon and to base its plans and requirements on the utilization of any weapon. The Navy contends that it is complying with the law in disregarding the Executive order on this point because the law and the Executive order are in conflict. The Air Force view is that both the law and the Executive order give to the Air Force, exclusively, certain missions. The fact that such a basic difference of interpretation exists indicates the necessity for immediate clarification. The law and the Executive order as well as their interpretation appear to be in conflict, or at least ambiguous, and for these reasons recommendation is made that a solution be found either through amendment of the act or revision of the Executive order, or both. This step will increase the effectiveness, efficiency, and economy of the National Military Establishment.

In view of the inability of the Joint Chiefs of Staff to prepare a unified plan, it has been necessary for this Board to accept for the time being the statements of requirements prepared by the Navy and Air Force separately but in accordance with certain assumptions referred to herein by us as "plan A" and "plan B." The total requirements in these plans, therefore, represent the sums of the separate statements of requirements and in nowise represent a unified plan as might have been anticipated from the Unification Act.

Plan A

From the information made available to the Board by the Air Force and by the Navy separately, it would appear that the initial strength necessary to mount promptly an effective, continuing, and successful air offensive against a major enemy, is what is termed the Air Force 70-group program of 20,541 aircraft, plus the Navy program of 14,500 aircraft, total 35,041 aircraft. At the level-off period in 1953 these programs would require thereafter an annual Air Force procurement of 86,000,000 airframe pounds and an annual Navy procurement of 25,000,000 airframe pounds—total, 111,000,000 airframe pounds annually.

Plan B

Based on the same sources of information, the strength necessary to prevent the loss of a war upon the outset of hostilities appears to be the same program outlined in plan A above, but without reserve aircraft, which means a combined Air Force and Navy aviation procurement of 63,000,000 airframe pounds annually. For the purpose of comparative budget study (see tabulations) we have assumed that the combined annual procurement of 63,000,000 pounds might be divided into approximately 45,000,000 for the Air Force and 18,000,000 for the Navy. This plan is designed to provide a force sufficient to (*a*) withstand an initial blow intended to cripple the United States, (*b*) form the basis for a strong Territorial defense, and (*c*) provide effective retaliation, but not a sustained offensive action. Under this plan it is estimated that the aircraft manufacturing industry would require a year longer to reach the volume of aircraft production necessary to cope with attrition, than it would under plan A.

Present Situation

In the fiscal year 1948 the Air Force is procuring 13,000,000 airframe pounds of new aircraft from cash expended in 1948 and deliveries from cash expended in previous years. The Navy is procuring 8,000,000 airframe pounds of new aircraft on the same basis. In addition, the two services are withdrawing from war-surplus storage a combined total of 43,000,000 airframe pounds. Therefore, the total input of aircraft into the two air services for the current fiscal year 1948 is 64,000,000 airframe pounds.

War surplus storage aircraft are being depleted rapidly. If plan B were to be adopted and placed in effect at once, industry might be able to expand to an annual production rate of 63,000,000 pounds at approximately the same time useful airplanes in storage would be exhausted, thereby maintaining the present program. This date approximates the close of fiscal year 1950. Therefore, if this strength is to be maintained, immediate action is necessary to preserve the strength we now possess. If plan B were adopted, complete modernization of the air services at the strength specified in this plan, would be effected approximately by the end of fiscal year 1954.

Expenditures and (new contract authority), by fiscal years in billions of dollars

Particulars	Present, 1948	Plan A (111,000,000 airframe pounds)						Plan B (63,000,000 airframe pounds)					
		1949	1950	1951	1952	1953	Level off	1949	1950	1951	1952	1953	Level off
Army:													
Total appropriation for Army[1]	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12
Total contract authority for Army[2]	(.02)	....	....	....	....	....	....	....	....	....	....	....	....
Navy:													
Appropriations for aircraft procurement	.28	.52	.95	1.39	1.28	1.30	1.20	.45	.67	.88	.96	.96	.96
Contract authority for aircraft[2]	(.25)	(.91)	(1.04)	(1.21)	(.96)	(.96)	(.96)	(.57)	(.77)	(.77)	(.77)	(.77)	(.77)
Total appropriations for naval aviation[3]	.73	1.20	1.75	2.08	2.05	2.00	2.00	.96	1.31	1.42	1.50	1.50	1.50
Total contract authority for naval aviation[2]	(.25)	(.91)	(1.04)	(1.21)	(.96)	(.96)	(.96)	(.57)	(.77)	(.77)	(.77)	(.77)	(.77)
Total appropriations for Navy[3]	4.13	4.80	5.75	6.48	7.30	7.80	8.00	4.46	5.11	5.22	5.45	5.50	5.50
Total contract authority for Navy[2]	(.52)	(1.49)	(2.05)	(2.48)	(2.18)	(2.13)	(2.13)	(.92)	(1.32)	(1.32)	(1.32)	(1.15)	(1.10)
Air Force:													
Appropriations for aircraft procurement	.12	.80	1.70	2.40	3.00	3.50	3.20	.80	1.70	2.40	2.70	2.70	2.00
Contract authority for aircraft[2]	(.43)	(1.90)	(2.60)	(3.20)	(3.20)	(3.20)	(3.20)	(1.90)	(2.60)	(3.20)	(2.40)	(2.00)	(2.00)
Total appropriations for Air Force[3]	3.10	3.50	5.20	6.50	7.30	7.80	7.50	3.50	5.20	6.50	6.70	6.80	6.10
Total contract authority for Air Force[2]	(.43)	(1.90)	(2.60)	(3.20)	(3.20)	(3.20)	(3.20)	(1.90)	(2.60)	(3.20)	(2.40)	(2.00)	(2.00)
Total armed services:													
Appropriations for aircraft procurement	.40	1.32	2.65	3.79	4.28	4.80	4.40	1.25	2.37	3.28	3.66	3.66	2.96
Contract authority for aircraft[2]	(.68)	(2.81)	(3.64)	(4.41)	(4.16)	(4.16)	(4.16)	(2.47)	(3.37)	(3.97)	(3.17)	(2.77)	(2.77)
Total appropriations for aviation	3.83	4.70	6.95	8.58	9.35	9.80	9.50	4.46	6.51	7.92	8.20	8.30	7.60
Total contract authority for aviation[2]	(.68)	(2.81)	(3.64)	(4.41)	(4.16)	(4.16)	(4.16)	(2.47)	(3.37)	(3.97)	(3.17)	(2.77)	(2.77)
Total appropriations for armed services	10.35	11.42	14.07	16.10	17.72	18.72	18.62	11.08	13.43	14.84	15.27	15.42	14.72
Total contract authority for armed services[2]	(.97)	(3.39)	(4.65)	(5.68)	(5.38)	(5.33)	(5.33)	(2.82)	(3.92)	(4.52)	(3.72)	(3.15)	(3.10)
Current procurement cost of aircraft transferred from storage to operation[4]	[1.84]	[2.00]	[.84]	....	....	....	....	[2.00]	[.84]	....	....	....	....
National budget other than armed services	26.88	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Total national budget, exclusive of UMT and ERP	37.23	36.42	39.07	41.10	42.72	43.72	43.62	36.08	38.43	39.84	40.27	40.42	39.72
Universal military training[5]	....	.88	1.58	2.01	2.01	1.75	1.75	.88	1.58	2.01	2.01	1.75	1.75
European relief program	.50	4.00	5.24	3.57	2.47	.62	....	4.00	5.24	3.57	2.47	.62	....
Projected national budget, including armed services, UMT, and ERP	37.73	41.30	45.89	46.68	47.20	46.09	45.37	40.96	45.25	45.42	44.75	42.79	41.47

[1] Above figures for Army do not include costs of government or relief in occupied areas, nor civil functions of the Corps of Engineers.

[2] These figures represent authority to contract, and appropriations for liquidation are included in the appropriate figures for the years in which expenditure is anticipated.

[3] The total appropration figures for naval aviation do not include pay, allowances, subsistence, medical care, etc., of uniformed personnel, whereas the similar figures for Air Force do include such pay and support of uniformed personnel. The figures for the total appropriations for Navy do include pay and support of all uniformed personnel of the Navy.

[4] These figures represent the current cost of replacement of aircraft transferred from storage to operation.

[5] These figures represent estimates for establishment and operation of military training facilities.

In order to delineate the budgetary effect of these plans over the next 5 years, we present a tabulation of budget requirements, including contract authorizations, assuming cost of labor and materials remain constant. Furthermore, in order that these military budgets may be presented in relation to the over-all Federal Budget it is assumed in the tabulation that the costs of Government (other than for the Armed Services, universal military training (UMT) and European recovery program (ERP) as set forth in the budget for the fiscal year 1948-49, remain constant at $25,000,000,000 over the period covered by the tabulation. To the totals are then added the estimated annual costs for the President's program for UMT and ERP (generally called the Marshall plan) in order to present an over-all budgetary picture.

The Board notes with deep concern that the 1948-49 armed services budgets are in amounts arbitrarily allocated by the Bureau of the Budget. They do not even approximate the stated requirements of the services.

After examination of the tables of projected Federal Budgets (p. 9) it is obvious that somthing must yield. If the over-all costs cannot be kept down within reasonable proximity of the present budget, we must either increase income from taxes to make up the difference, or engage in debt financing. Neither course is to be desired. The only alternative is a reduction in other expenditures. It should be observed here that more than three-fourths of the Federal Budget is now related largely to prevention, prosecution or liquidation of wars.

To repeat—no unified plan has yet been prepared. We believe that when such a unified plan has been determined, the total requirements of the armed services may be materially reduced below the totals of the estimates prepared unilaterally. It is not possible for your Board to estimate with accuracy the reduction in the combined military budgets that such a unified plan might make possible, but it is believed that material savings can be affected while at the same time a better and more efficient military establishment can be provided.

2. In order to obtain a more realistic national security program, determination should be made by the National Military Establishment of the alterations in the fiscal year 1949 military budgets that should be effected, and that such determination should be presented to the President and the Congress before adjournment of the present session of the Congress, but in any event not later than June 30, 1948.

Such a determination should—

(*a*) Effect the adoption of unified plans.

(*b*) Reveal the capabilities of the armed services under stated conditions or plans and the corresponding budgets required.

(*c*) Provide definitive information to the President as Commander-in-Chief which will enable him to determine for his purposes the proper budget for the national security.

(*d*) Form the basis for an industrial war plan that can be accurately translated into terms of national resources.

(*e*) Insure maximum return for the military tax dollar.

Such determination should be made annually thereafter at such time as to permit a report to the President from the Secretary of National Defense so as to be useful to the President and the Congress in the formation of the next annual budget and appropriations.

Section II

The primary military objective of modern warfare is no longer the armed forces of the enemy. The primary objective is the war potential or, in other words, the industrial organization and the resources of the enemy. It was the destruction of such objectives as ball-bearing plants and gasoline cracking plants, as well as the destruction of shipping, that immobilized the ground and air forces of Germany and Japan. The great contenders in a possible war of the future will first engage in the political and then the industrial phases of that war. The political phase of the next war has been actively engaged in since VE-day—and the industrial phase is clearly recognizable. The time lag between these elements and open warfare (if warfare must ensue) depends upon many facts—not the least of which is the degree of success of the ideological aspect of the political war. The political war rages over all the world and sparks may be struck, even accidentally, which could easily flare into open warfare.

Since the international political situation is not encouraging, military posture is of chief importance in our hope of avoiding war in this atomic age. The ability and, indeed, the promise of instant retaliation in kind in case of atomic attack is of over-riding priority. We have the atomic bomb and have used it twice in war. No other nation is likely to attack us directly if it lacks at least a comparable supply of that weapon and until it believes that it can cripple us beyond early recovery by a surprise attack.

3. The nuclear-energy propulsion for aircraft (NEPA) project should be accorded the highest priority in atomic-energy research and development and every needed resource and facility should be devoted to its early accomplishment.

In the event of war or in any international situation likely to lead to war, nuclear energy for the propulsion of aircraft would be comparable in significance to the atomic bomb itself. Presently known limitations inherent in all chemical fuels make difficult the delivery by air of atomic bombs against a distant enemy. Therefore, if the United States had nuclear-energy propulsion in addition to atomic bombs, it could be the dominant factor in maintaining world peace. Until these ends are attained, the United States must depend on military weapons and techniques currently available.

We must, therefore, devote the best efforts of the National Military Establishment and the Atomic Energy Commission to the prosecution of the NEPA project to provide our armed services an effective method of accomplishing—without geographical limitations—immediate and devastating retaliation should our country be attacked.

In addition to its military application, the successful solution of the problem of nuclear-energy propulsion of aircraft will include vital contributions to human welfare of enormous value to our people.

4. A Federal airways system should be established under a single civil head to facilitate integration of its function with military aviation in an emergency and study should be made by the Government agencies charged with mobilization planning to determine whether the employees of this system should have a military reserve status.

The report of Special Committee 31-3 of the Radio Technical Commission for Aeronautics is designed to integrate the technical requirements of radio for civil and military purposes into a single system, thus making common utilization possible. It should be implemented as rapidly as feasible. While military aviation must necessarily install and operate many facilities exclusively, there must be operating tie-ins with the civil at every point essential to common operation.

Electronic aids to air navigation and landing, airways traffic control systems, weather reporting and forecasting systems, airports and ground facilities, and communication networks are essential to military aviation in time of emergency, along with the trained personnel involved. As much of these systems and trained personnel as can be engaged in commerce and the public interest in time of peace —so much is available in a national emergency. Moreover, if the civilian personnel has a military reserve status, integration might be accelerated in an emergency. Continued study of this last aspect of the problem should be made by the Government agencies charged with mobilization planning.

5. **There should be established a joint task group designed to withstand an initial attack directed at the United States, and to form the basic organization for a strong territorial defense.**

Defense plans must contemplate an aggressive attack designed to cripple our centers of war potential. In the current atomic age it may be expected that such attacks upon the United States will be delivered by air with little or no warning. Now is the time to organize the internal defenses in order to localize and repel such an attack. It is imperative that an air warning network be extended in all directions from which an attack may be expected. Economy may be achieved by employing elements of the civil airways system wherever practicable.

6. **A competent aircraft-warning network should be established under the direction and control of the proposed Territorial Command.**

An aircraft-warning network is composed essentially of long-range surveillance radar and a system of rapid communications. As much of this system as can be employed feasibly and integrated into the civil airways traffic control system should be so employed. This will provide economy by avoiding duplication, as well as providing a reservoir of highly skilled operators and technicians in an emergency.

7. **In order to provide personnel immediately available for assignment in time of emergency wherever the military situation demands:**
   a. **A portion of military aircraft should undergo overhaul on a contract basis by civilian organizations and the employees of these organizations should be encouraged to be members of a reserve component of the armed services;**
   b. **A realistic program of recruiting and training air reserve personnel in both air and ground echelons should be developed.**

In general, the present practice is for the armed services to overhaul aircraft in their own depots. This may serve peacetime needs of the services, but it falls far short of solving problems of providing maintenance facilities and personnel available for duty with combat units should hostilities require. Experience during the past war indicates clearly that private as well as military plants must be utilized for overhaul of military aircraft in continental United States in war. It is essential that some of these contract overhaul establishments be maintained in time of peace, ready for expansion in the event of national emergency.

If the employees of these establishments are in the military reserve it will be possible to withdraw a portion of the personnel of such contractors for active duty wherever military needs require, leaving a nucleus of skilled mechanics in the private plants upon which they may expand their forces.

At the end of World War II there was an enormous reservoir of highly skilled, well trained flight and ground personnel. Only a fraction of that number is receiving training and practice in the reserve force today. Even this small force of organized reserve is in danger of disintegration due to lack of sustained training programs while the "unorganized" personnel is rapidly deteriorating through total lack of training. Hence, we are facing a dangerous situation which threatens effective mobilization and makes planning exceedingly difficult. Enlistments are expiring soon for most of those now in the Reserve. A realistic plan of training will be necessary to induce reenlistments and to attract new candidates to the program.

It will be necessary to provide an equitable system of promotions in the Reserves, assurance of equal treatment with Regulars in time of war, and some system of Reserve retirements which may be earned by sustained participation in training programs. The best qualified personnel of the Regular establishments should be assigned to duty with these civilian components.

8. The Federal Government should sponsor the design and development of prototype transport and cargo aircraft intended primarily for commercial use, but suitable for certain military purposes. Funds should be allocated to the Air Force and earmarked for this specific purpose.

The availability of the military air services of commercial transport-type aircraft in as large numbers as possible to serve as auxiliary military air lift is essential. These aircraft should be in commercial service in order that this auxiliary air lift may not be a burden upon the national defense budget in time of peace. However, the cost of design and prototype development of modern air transport types is so high that neither the manufacturer nor the air carriers can today afford to invest the sums involved. Transport-type aircraft of materially better operating and utilization characteristics than any transport now being built are needed in order to provide the low operating cost and high performance that will make possible commercial employment for large numbers of such aircraft. As the Government is vitally concerned in the existence of such aircraft in large numbers (aircraft that it need not acquire except in an emergency), it is in the interest of economy that the Government finance the design and building of such prototypes, whereup the air carriers may purchase the production aircraft, and pay for them by revenues derived from commercial utilization. In the interest of safety in the military operation of such aircraft cockpit and instrument lay-outs should be identical in essentials for each type, and purchasers should agree to make no changes after delivery except upon approval of the military.

Funds should be appropriated to the Air Force and specifically earmarked for design and development of such prototypes. A Civil Air Transport Evaluation and Development Board should be established by the Air Force, consisting of representatives of the Air Force, the Navy, other Government agencies concerned with aronautics, the aircraft manufacturing industry, and the air transport industry. This Board should be charged with drawing the specifications and developing prototypes of such aircraft.

In the determination of utility and operating characteristics, the needs of the air transport industry should be the primary concern.

9. Form contracts should be prepared now for wartime utilization by the armed services of all aircraft of United States carriers flying international routes except those that may be specifically exempted by the Department of National Defense; further, form contracts should be prepared now for wartime utilization by the armed services of aircraft of the domestic carriers of agreed percentage according to plans.

These recommendations are made to expedite the acquisition by the armed services of additional military air lift in an emergency. (Title 10, section 1361, United States Code.)

There is acknowledged obligation on the part of commercial operators to provide such assistance at reasonable cost in return for Federal expenditures such as air-mail pay, aircraft development, and airways facilities established and maintained by Government agencies. The commercial air lines responded to the fullest extent during the past war, and substantial numbers of their aircraft were taken over by the military while others were operated on a contract basis. However, the lack of advanced mobilization planning caused serious dislocation of the commercial system and delayed the acquisition of planes. It is advisable that agreement on the terms of the recommended contracts be expedited and that the contracts be reviewed annually and revised to keep them current.

10. The Navy Department should make a careful study of the career policies for naval aviators and other specialists—not specifically designated as such —in order to eliminate training and duties that are not essential.

The Navy's structure of careers and duties should be overhauled and modernized in the interest of encouragement for high competence. Prior to World War II, naval aircraft were considered by the Navy high command to be the "eyes of the Navy." Today the battleship is obsolete and naval task forces are built around aircraft carriers. However, the naval aviator in many cases is still required to do "deck duty" in order to qualify for promotion in certain ranks. The same is true of other "specialists." The revision of these anachronisms will benefit the individuals affected and the naval service as a whole.

11. The Secretary of National Defense should revise the public relation policies of the armed services in the interest of national security.

Some of the bids for public acclaim by the Air Force and the Navy constitute an undesirable practice and mislead the American public on aircraft performance in addition to disseminating information which could be of value to a foreign power and should be closely guarded.

It gives a false sense of security to the public to learn that a military aircraft has flown the spectacular distance of 10,000 miles when it is not made clear that the distance was possible only because the aircraft was "stripped down" for the flight and could not fly half that distance under combat conditions. As a matter of fact, the effective radius of action of the longest range bomber now in use is less than 2,000 miles and the famous B-29 has an effective radius of about 1,700 miles. The effective radius of action of a bomber is approximately one-third of its range. A bomber may use its full range only in a "shuttle" operation or a "ditching" operation; and without advance fighter bases it must fly over a distant target without the protection of escort aircraft.

It is equally misleading for the public to learn that an aircraft has flown faster than sound when it is not explained that such an aircraft is years short of utilization in combat. At speeds of more than 650 miles per hour no fighter plane yet built can remain aloft longer than an hour and at sonic speeds its maximum time aloft is still less.

It is well for the services to have pride in their accomplishments but security and public faith must not be violated.

PART II

AIR TRANSPORT

Civil and military aviation are indivisible in assessing total American air strength. The air-transport industry of the United States and the military air arms must fit into a single pattern.

National security requires a financially sound, operationally efficient, and technically modern air-transport industry. It envisions a large, civil air fleet operated in foreign and domestic air commerce with safety and certainty. Such an operating air fleet serves peacetime commerce and industry while remaining available for immediate conversion to military use in an emergency.

Since it is economically impracticable to maintain an air force which will provide absolute security, as many transport aircraft as possible should be operated in commercial service and available to provide a reasonable reserve.

Dependability of flight schedules is the cornerstone of a healthy civilian air arm. Yet, regular all-weather commercial service has not yet been accomplished. With present navigational and landing aids, air traffic control, and airports, the airways system of the country is near the saturation point, even for the present fleet of 1,000 aircraft.

Lack of regularity is a major factor in the air transport industry's poor financial condition, shown by heavy losses in 1946 and 1947. Airports and airway aids have not kept pace with the demands of increased operations and larger, faster aircraft. Already crowded, the system could not handle a wartime flow of air traffic. A modern system of airways and traffic aids is of first importance for both security and financial reasons.

The problem is how to provide a pool of modern transport aircraft facilities, equipment and personnel to approach most closely the requirements for a national emergency within budgetary limits that can be supported by American economy. Stimulation of passenger, cargo, and other air traffic is the obvious solution.

12. a. The target program for installation of an ultramodern all-weather navigation, landing aids, and airways traffic-control system proposed by special committee 31 of the Radio Technical Commission for Aeronautics (the RTCA program) should be endorsed as a first priority in the interests of national security and as a move toward eventual financial independence of the air transportation industry.

b. Authorization of funds should be made for the first year's portion of the program, with an endorsement to future Congresses and recommendation that they continue appropriations to the completion of the program.

c. Under the guidance of the Research and Development Board, fullest support of the cooperating agencies should be given to the comprehensive research and development program as projected in the "interim" and "target" periods for the implementation of this program.

All interested agencies of the Government, including the military services, the aviation industry, and the private flying organizations agree that the RTCA plan represents a desirable system which will insure safety and dependability of flight by all types of aircraft under all weather conditions.

The cost of the total system is estimated at $1,113,000,000 and is estimated to take 15 years to complete. Of this total, $989,000,000 is chargeable directly to national defense and will be spread through the yearly budgets, coordinating needs of the whole program, rather than covering other items contemplated before the program was developed.

In fiscal 1947-48 the commercial air lines, operating about 1,000 aircraft, will lose approximately $40,000,000 due to air-traffic-congestion delays, flight cancellations, and schedule unreliability.

If the air-traffic-control system remains essentially unchanged, the loss that could be expected during the next 15 years would amount to more than $600,000,000. It is anticipated that the adoption of the RTCA program will enable the air lines to increase their on-time schedules from the present 46 percent to 95 percent. Substantial increase in the use of airways by the air transport industry, without even considering military use, would be hazardous with today's inadequate aids, especially in view of higher speeds.

Implementation of the integrated air-traffic-control system recommended by RTCA will enable the present restrictions to be overcome gradually and systematically. Instead of being saturated by 1,000 airplanes, it is estimated that the airways could absorb 5,000 transport aircraft in the predictable future with assurance and safety, even at major air terminals.

An expanded civil air-transport industry would constitute a powerful fleet in being for national emergency, and, through normal replacement requirements (at least 10 percent per year), would provide a continuing market for aircraft manufacturers, valued at about $500,000,000 each year.

It is expected that a small, light weight, inexpensive navigational radio for use on the new airways facilities will be available at low cost to the private pilot.

The proposed modernized air-traffic-control system requires much technical development, through a program guided by the Research and Development Board and financed from the budgets of the interested services. The Congress is urged to consider favorably these coordinated budget requests, and to appropriate necessary funds each year to insure completion of the RTCA program. The Government, however, should not engage in the manufacture of production equipment.

The RTCA SC-31 report embraces a plan of modern electronic airway aids agreed upon by technicians of all aviation components after months of study. It combines the best features of present systems with ultramodern methods.

It is specifically designed for adjustment to wartime necessities while greatly aiding peacetime flying. The RTCA system is adaptable to a national emergency; communications and air-navigation information can be coded; traffic control can be tied in with military methods; instrument-landing systems can be adapted to military aircraft ashore or afloat; and the traffic-control system can be extended to keep pace with the movements of our military and naval forces.

13. The Arcata project for the development of additional visual aids to landing should be continued, as a counterpart to the electronic aids recommended by the Radio Technical Commission for Aeronautics.

Continuation of the Arcata (California) project for research and development of visual aids to all-weather landing is invaluable to the air-transport industry as well as national security. Funds for this project are provided in the budgets of the Air Force, Navy, and Civil Aeronautics Administration from year to year. The Navy Bureau of Aeronautics, through contract with Transocean Air Lines, operates the project and reports to a steering committee of three members each from the Air Force, Navy, and CAA; and one member each from the Civil Aeronautics Board, Air Transport Association, and the Air Line Pilots Association. The committee makes recommendations to the Bureau of Aeronautics for systematic progress.

Arcata's primary function is research in visual landing aids. Efforts have been concentrated on high-intensity approach and runway lights, and fog dispersal. The sight was chosen because of fog and other adverse weather conditions and sparse air traffic, permitting tests with little interference. This cooperative effort, the results of which can be integrated with the RTCA program, is highly desirable.

14. In the interest of economy, the civil aeronautics authorities should give consideration to gradual removal of airway beacon lights, except for beacons marking airports and emergency fields.

Airway visual beacons established in the early days of the Nation's domestic air routes will become out-moded by the more modern electronic system of navigational aids under the RTCA program. There are 2,050 beacons now operated by the Civil Aeronautics Administration at the cost of $625 each per year. A substantial portion of the total annual cost of $1,281,250 can be saved by the gradual elimination of the beacons on the lighted airways, except for those maintained as markers for airports and intermediate emergency fields.

15. Necessary funds should be authorized to enable the Weather Bureau to furnish weather service on routes newly approved by the Civil Aeronautics Board, when traffic warrants.

There is a serious lag between authorization of new routes and the readiness of meteorological facilities. It is impossible at the time of submission of regular Weather Bureau budget estimates to anticipate the new routes that will be auhorized by the Civil Aeronautics Board in the ensuing year. Necessary and early service could be established promptly if a revolving sum were provided.

16. Necessary funds should be authorized to enable the Weather Bureau to continue investigation of causes and characteristics of thunderstorms and hurricanes.

Severe turbulence in thunderstorms and hurricanes has caused numerous fatal accidents to military and civil aircraft. In the interest of safety, considerable flight research remains to be done on the internal structure of thunderstorms and hurricanes and their effects on aircraft in flight.

Civil aeronautics authorities and the Air Force and Navy have been conducting investigations of these problems, but there has been no direct appropriation for a complete scientific study of the subject.

17. The Weather Bureau should designate qualified personnel at airports where no official weather observers are stationed to act as voluntary official weather observers and assist the private flyer by disseminating weather information obtained from the airways or other weather centers.

The data from observation stations and the points at which the information is developed along civil airways is often not available to pilots at off-airways airports. It is impossible for the Weather Bureau to provide direct service to all these fields.

Weather information "designees" will bridge this gap and add safety service for private and commercial flyers on off-airway flights.

18. International cooperation should be encouraged for prompt exchange of accurate weather information over the oceans and in Arctic regions where observations and reports are desirable to serve air routes.

International exchange of weather reports is indispensable to meteorological services for aviation. This information is required for domestic as well as international air commerce. The circulation of the atmosphere and the movement of weather conditions across international boundaries makes it impossible to forecast accurately without reports from a widespread network of observation stations, including coverage of the oceans and the polar regions where air masses develop. One of the primary functions of the International Meteorological Organization is to foster such information exchange.

19. The Federal Government, by means of weather-station vessels, should continue to cooperate with ICAO to improve weather service over the oceans with due regard to navigation, and search and rescue activities.

Ocean weather-station ships strategically located in Atlantic and Pacific areas aid international air service by acting as meteorological stations, airway communications posts, navigation check points, and search and rescue agencies.

Aviation alone does not benefit from the ship weather stations. The soundings of the atmosphere from surface up to 75,000 feet are invaluable for the completion of weather maps of the hemisphere and the making of accurate weather forecasts.

Long-range weather maps of the Western Hemisphere which serve agriculture, forest-fire patrol, stock raising, and many kinds of industry and commerce gain in accuracy from accumulated ocean-weather data.

As an economy measure, however, a study looking toward the perfection of the pressure-pattern flying technique, is desired. This system is particularly advantageous for flying over water. It allows the pilot to fly over the "least-time track" and to take advantage of most favorable wind-pressure pattern gradients.

While the pressure-pattern technique is being developed, a minimum number of weather-ship stations should be maintained, with maximum use being made of in-flight reports and those received from merchant vessels.

20. Control towers serving interstate commerce, where the traffic justifies, should be included in the Federal system of airway communications, navigation aids, and traffic controls, but consideration should be given to the allocation of costs among the various agencies concerned, municipalities and other units of government, and the various classes of users.

Control towers are a vital and logical component of the airways system. Standardization of language and procedures is necessary because the airways are utilized by various classes of users such as commercial air lines, charter operators, private flyers, and the military services. Uniform personnel training and supervision are mandatory in the safe control of traffic and will be even more important under the RTCA program.

Consideration should be given, however, to current control tower manning tables. These towers cost approximately $30,000 a year each to operate and there should be a restudy of the size of crews with a view toward additional economy.

Thirty of 159 towers in this country are operated by local outhorities. Non-Federal towers are not permitted to conduct instrument approaches, which are handled only by Federal control centers.

Authority for the location of towers is determined by Congress. Only density of traffic flow in interstate commerce should determine locations.

21. In establishing airworthiness requirements, consideration should be given to the special nature of cargo aircraft.

The essential differences between aircraft designed for the carriage of passengers and those carrying cargo indicate that variations may be desirable in the airworthiness requirements for these different classes of aircraft. The extent to which cargo plane requirements should be liberalized, compared with passenger transport aircraft, should be determined from experience, giving full weight to pilot and crew safety. In the meantime, liberalization should be set as a goal and recommendations to this end should be made at an early date by a joint committee representing manufacturers, air carriers, and the Civil Aeronautics Board.

22. The entire airport program should be reviewed by the Congress with a view toward providing a system of airports more closely keyed to the needs of a sound air-transport industry, civil aviation, postal service, and national security.

Adequate airports for efficient, safe, and dependable operations in all weather by an expanding commercial air fleet, planned to handle the traffic volume in an emergency, is a fundamental segment of the Radio Technical Commission for Aeronautics SC-31 program discussed elsewhere in this section. This program has the highest priority in the Board's recommendations for air transport. Any basic segment of it, therefore, has priority over matters outside the program.

Airport planning must be aimed primarily at the public interest, the needs for postal service, and national security. First consideration must be given to larger, rather than smaller landing fields. Commercial air transport uses large, multiple-runway fields, and relief of the congestion already apparent can be obtained only by increasing the number of airports designated as Class IV (runways at least 4,500 feet) and larger. The complete program should include airport facilities for civilian nontransport flying—those operations which use fields known as class sub-I, I and II. It should also provide for class III airports to relieve major air terminals. The future utility of the smaller airports in the expansion of the postal service should be given consideration.

Airport construction is one of the most expensive items in the entire aviation program. The Federal Airport Act provides $500,000,000 to be available for matching by States and municipalities during 7 years.

The greatest problem which arises under the program is the proper apportionment of funds to serve the Nation's primary interest—security. Private flying should not be neglected, but it must take its priority after those components more directly concerned with military air strength.

23. In the interest of economy and where compatible with the national security, traffic density and flying safety, joint military-civil use of airports and airways facilities should be agreed upon. The civil aeronautics authorities and the military services should consult and resolve each case on its merits and refer all cases in dispute to the Air Coordinating Committee.

It is an extravagance to require communities to build airports for their use when existing military facilities will serve. Arrangements should be made for the joint use of such facilities except when the question of safety or military security is involved. When additional facilities in a given area are needed for commercial use and an existing military facility is inadequate for the needs of both, the site closer to the center of population should be allocated to civilian use. It is of less importance to the military to minimize travel time to an air base than it is to the commercial operator depending on public convenience to stimulate travel.

If agreement cannot be reached in negotiations between the local government concerned and the military, adjudication of the matter should be made by the Air Coordinating Committee.

24. The Federal Government should continue to have exclusive jurisdiction over the establishment of safety regulations applicable to all classes of aircraft and airmen, but the increases in non-air-carrier flying makes it desirable to delegate the administration and enforcement to non-Federal personnel by—

a. Extending the program of the appointment of "designees" by the civil aeronautics authorities to certification of aircraft as well as airmen.

In the interest of economy and as a part of the program to stimulate personal aviation by simplifying procedures, the issuance of airmen certificates can be facilitated by designating local aviation experts to adjudge the competence of private pilots under broad national standards. The present practice is for the civil aeronautics authorities to designate certain airmen, in addition to their own staff, to give such examinations. This practice could be broadened to relieve the Federal Government of handling the laborious detail of regulating the activities of 452,000 certificated non-air-carrier pilots and the 200,000 student pilots. These procedures should not govern the certification of commercial air line pilots.

b. Amending the Federal laws to give concurrent jurisdiction to the State courts and aviation agencies to enforce the non-aircarrier safety regulations of the civil aeronautics authorities, including the right to suspend airmen's certificates.

The essence of effective enforcement of safety regulations is the speedy and just handling of alleged violations. The need for additional enforcing services to achieve this result will increase in proportion to the growth of aviation. The several States share with the Federal Government the responsibility of protecting the safety of the citizens. It is essential that a uniform and simple procedure be used by established local enforcing agencies in this important task. This objective can be accomplished without relieving the Federal Government of its responsibility and without unduly increasing the demand for additional Federal personnel by the Congress giving concurrent jurisdiction to the State courts and aviation agencies to enforce the non-aircarrier safety regulations of the Federal civil aeronautics authorities.

c. Encouraging the civil aeronautics authorities to delegate a greater share of responsibility (1) to the manufacturers of small personal aircraft for compliance with federally established design standards; and (2) to the air carriers for compliance with federally established maintenance standards and requirements.

In the interest of economy, efficiency, simplification, and advancement of aircraft design, the delegation of responsibility to the manufacturers of small personal aircraft for the safety and integrity of their product is now feasible.

This program would not relieve the civil aeronautics authorities from their charge of maintaining over-all safety standards, but would place upon the individual manufacturer the responsibility of determining operational and safety standards, under a national pattern. It would delegate to him the right to certify airworthiness, operational limits, and flight characteristics as determined in compliance with established Federal standards. Safeguards would be insured by spot checks by the civil aeronautics authorities with power to revoke manufacturers' certificates for cause. Final airworthiness certification would be made by the civil aeronautics authorities upon certification of airworthiness by such designated manufacturer.

The same authority and responsibility for maintenance procedures should be granted to air carriers where competency is determined by the civil aeronautics authorities. Spot checking by the civil aeronautics authorities, with power to revoke competence certificates, should also be employed in these cases.

25. The Civil Aeronautics Act of 1938 should be amended to give the Civil Aeronautics Board power to regulate contract and charter operators of transport aircraft engaged in interstate, overseas, and foreign air transportation.

Need for safety and economic regulation of the contract carrier now performing types of service similar to that of certificated air carriers is apparent. The Civil Aeronautics Act of 1938 makes no provisions for such regulations, now regarded as a necessity to provide a healthy civilian air arm.

It is essential to the public welfare that Civil Aeronautics Board be given this additional authority by amendment of the act, thus making possible the same safety and economic controls over these operators as those which apply to the certificated air carriers. The charter type flyer at a fixed base who operates a typical small plane charter service should be excluded from these special carrier types of safety and economic controls.

26. The Congress should give early consideration to the transport by air, at the first-class rate, of all first-class mail, the movement of which can be appreciably expedited by air carrier, and in its considerations, Congress should weigh the public benefits of such a transfer against the added costs involved.

The carriage of long-haul mail by air would substantially benefit the Nation's commerce, national security, and air transport industry. Improved, accelerated communications increase the tempo of business and add to the integration of our total economy. Commerce and trade would benefit materially from having all long-haul first-class mail go by air when it could be materially expedited thereby.

Certificated domestic air carriers haul approximately 33,000,000 ton-miles of air mail per year. This represents about 10 percent of total long-haul (over 300 miles) first-class mail. The Post Office Department estimates that if all long-haul first-class mail which could be expedited by air were to be transferred to air carriage, the volume of air mail would be about 179,000,000 ton-miles per year.

From the standpoint of national security the importance of transferring long-haul mail to air carriers stems from the increased fleet of air transports which would result. The Post Office Department estimates that such a transfer would add from 500 to 700 more planes to the United States civil fleet. To the extent that the air transport reserve required by national security would thus be financed by mail revenue, the over-all defense costs to the Nation would be reduced.

The air carriers would receive about $47,000,000 more mail pay per year, assuming an average rate of 45 cents per ton-mile. This benefit to the air lines, however, must be balanced against the added cost to the Post Office. In the fiscal year 1947, Post Office Department revenues from all first-class mail (including air mail) exceeded expenditures by $112,000,000. All other classes of mail, however, showed an aggregate deficit of $375,000,000, resulting in a net over-all deficit of $263,000,000 for the year.

The proposed transfer of all long-haul first-class domestic mail to air would reduce the first-class mail profit to approximately $16,000,000, according to Post Office Department estimates. Hence, the net Post Office deficit would be increased by $96,000,000 and would have to be made up by increased appropriations. Because most of the present railroad space would be retained by the Post Office Department, the estimated loss of revenue to the railroads would be less than $5,000,000 per year.

The date for initiating such proposed service should be determined by recommendations from the Post Office Department.

27. Appropriate legislation should be enacted for establishment of domestic air parcel post, at reasonable experimental rates, subject to revision when more nearly accurate costs of carriage can be ascertained.

As a logical development in the Nation's air transportation industry, based on public service and national security, inauguration of domestic air parcel-post service is highly desirable. This new service would augment the proposed international service which the Post Office Department has already planned to begin at an early date. In addition to providing a new public service of great value, such a step would aid national security by adding to the fleet of civil transport aircraft in being.

The Post Office should determine rates to assure adequate ground facilities at airports and other handling procedures. Small packages sent by air express or air freight at present are comparatively costly because excessive handling is required. Bag handling of parcel post in volume will reduce such costs. An estimated 100,000,000 ton-miles of air parcel post is expected to move during the first year of operation. This is three times the present volume of first-class air mail.

28. Until the air transport system reaches more nearly self-supporting operations, no action should be taken to separate the subsidy pay from the mail service pay.

The 1938 Civil Aeronautics Act provides for financial support of the air transportation industry in the interests of national security and public service. Under a specific formula of air mail rates (known as "service" and "need" rates), the air lines are paid for carriage of the mails.

Development of air transportation has long been considered by the Congress as in the national interest. The act makes the distinction that a "compensatory" or "service" rate should be paid those carriers normally in a sound condition, as payment for service rendered. In instances where less thickly populated sections of the country are in need of transportation service, or where the traffic flow in the beginning is not heavy enough to make the carrier self-supporting, a "need" rate is awarded by the Civil Aeronautics Board to bridge the financial gap between the compensatory rate and sufficient funds for operating at a reasonable profit under honest, efficient, and economical management.

The payment above the service rate is the "subsidy." Separation of the subsidy awards from the straight service air mail rate by the Post Office Department so that the public may know exactly what is being paid is advocated by some. They contend that the present system, whereby a carrier is guaranteed a small return under honest and efficient management, does not constitute an incentive to low cost and economy of operation, and that inclusion of the subsidy element unnecessarily confuses the Post Office Department budget.

There is merit to these contentions. It must be recognized, however, that separation of the subsidy would be an extremely complicated matter, and that probable delays resulting might cause serious difficulty to the "need" carriers, with possible failure and denial of service to the public. This would be in violation of the spirit of the act and for the present could do more harm than good.

In view of the current financial condition of the industry, the Board does not feel that this is the time to make such a subsidy separation. When the air lines are on a sounder financial foundation, consideration can then be given to such a procedure.

29. Without further delay the Civil Aeronautics Board should establish "permanent" rates for the carriage of mail internationally by United States air carriers.

American-flag international air carriers are operating under temporary rates of mail pay and in consequence are unable to ascertain their exact financial condition at any given time. Sufficient experience has now been gained in international operations to warrant the early establishment of "permanent" rates. Temporary rates are set by the Civil Aeronautics Board during early stages of new operation, on the basis of cost estimate. When experience has shown actual costs, the Civil Aeronautics Board revises the temporary rate. "Permanent" rates so set are subject to revision up or down, if new conditions arise. In establishment of rates, consideration should be given to the differential between rates of mail pay to American-flag operators and those to foreign-flag operators carrying American mail.

30. A plan should be developed by the Civil Aeronautics Board for speeding action on mail rate and route cases and for reducing its backlog of pending cases, and immediate consideration should be given to a special study of this problem by the appropriate committees of the Congress.

Rate and route cases pending before the Civil Aeronautics Board are being delayed to the disadvantage of many of the air carriers and the entire air transportation economy. Mail rate cases totaling more than $232,000,000 are pending in the backlog. Some cases have been awaiting decisions for several years. Delays have contributed to the critical financial condition of a number of the air carriers, particularly in the case of smaller companies. More rapid decisions on petitions for mail pay increases are necessary if there is to be a financially sound civil aviation industry.

A report of an Appropriations Committee subcommittee asks for consideration of a special study of the work of the Civil Aeronautics Board to determine steps for insuring that the Board's responsibilities are met more promptly. Establishment of a plan whereby the Civil Aeronautics Board can facilitate its present work load and eliminate a great portion of its backlog is an urgent requirement.

31. The Civil Aeronautics Board should expedite establishment of air carrier operating costs and efficiency yardsticks.

Considering the large public investment in the air transportation industry, close check on the costs and efficiency of air line operations is required.

The Civil Aeronautics Act of 1938 directs that in its mail pay decisions the Civil Aeronautics Board consider the honesty and efficiency of the air carrier management. However, specific standards for determining such efficient management have not been fully developed.

Personnel recently has been assigned to make investigations of air-line operating costs and efficiency with a view to establishing standards for efficiency and oconomy. Efforts in this direction should be continued and intensified. Progress reports should be made frequently. Additional special personnel may be required by the Civil Aeronautics Board for these tasks.

32. The Civil Aeronautics Board should encourage action by the air carriers to achieve over-all economies, particularly by joint operation of airport and meteorological services, ground contract services, and consolidated ticket offices.

Possibilities of joint air line activity at terminal airports are manifold. Elaborate ticket office duplications by various companies appear unnecessary in many cases. When combined ticket offices are impracticable, combinations of ticketing facilities should be made in the interest of economy.

Another joint action conducive to more efficient operation and improved service is interchange of aircraft between connecting carriers. More such agreements are suggested.

Consolidation of weather forecasting services where practicable, both between carriers and the Weather Bureau is also recommended.

33. The Civil Aeronautics Board should be enabled to secure the assistance of a disinterested nongovernmental agency in making a study of the foreign and domestic air transport systems in order to prepare a basic route plan which may be used as a guide for future revisions of or extensions to the present route pattern.

The present network of air routes bears little resemblance to a planned pattern. Much of this may be due to inheritance by the Civil Aeronautics Board of a network of routes established previous to 1938 on competitive mail pay bids rather than on a carefully planned route basis. It may also be due to the changing personnel and philosophy of the Civil Aeronautics Board, to heavy competition for new routes, to overoptimistic traffic and cost estimates, and to absence of continuing standards of route patterns. Excessive competition exists in some sections and there is insufficient competition in others. Restrictions on points served by carriers on a given route add to the complications.

The Civil Aeronautics Board is already empowered to confer with and use the advice of State aeronautical agencies, but has not availed itself of this power to a satisfactory degree.

Integration of the over-all airport plan with such a route pattern is also highly desirable.

34. Private financing, particularly of the equipment trust type, of new air carrier equipment should be aided by establishment of settled practices as to legal title and rights of recovery, through legislative action by the Congress and international agreement through State Department action.

One of the difficulties of equipment trust financing is the legal question of ownership of mortgaged property in bankruptcy. To facilitate credit arrangements, revision of the Bankruptcy Act may be necessary, making it clear that the trustees obtain ownership in the case of bankruptcy.

Another impediment to equipment trust credit arrangements exists in laws of the various States, where trustee owners are equally liable in aircraft accidents. Investigation of this situation, seeking the modification of such State laws, is desirable. Equipment trust credit arrangements may also be aided by requiring the recording of engines and major spare parts. This would increase and strengthen the security behind the equipment trust loan, making it more attractive to the lender.

The question of ownership in international transit of aircraft is of great importance, since there are countries which do not recognize such rights and where there is no protection for the property of the investor. The carriers have difficulty in scuring necessary loans for purchase of aircraft unless the investors receive this potection.

Similarly, a barrier to equipment trust financing has been lack of uniformity in the laws of various nations regarding rights of mortgagors in internationally operated aircraft. A Draft Mortgage Convention, called "International Recognition of Rights in Aircraft" was developed by the Legal Committee of the International Civil Aviation Organization at the Brussels Conference in September 1947 and is now ready for adoption.

The Board urges negotiation by the Department of State to secure the adoption of the agreements of the Draft Mortgage Convention by all nations to which United States international air carriers fly.

35. The development of policies dealing with air cargo, contract flying, and charter service in the transport field is a matter of great importance to the national economy and national security. In recognition of the importance of further evolution of policies in these fields, the governmental agencies concerned and the Congress should give the earliest practicable consideration to the formulation of basic policies to govern expeditious and orderly development, on the basis of public convenience and necessity.

The rapid increase of air cargo has pointed to the existence of a tremendous potential development. Within the past 2 years the dramatic rise of cargo carried by air has been marked by an increase from 60,000,000 ton-miles carried in 1946 to 100,000,000 ton-miles in 1947.

While the development of air cargo is significant from the standpoint of interstate and foreign commerce, the increase in all civil air operations including cargo, contract, and charter flying is important to the national security because of the reservoir of aircraft and trained personnel it creates, which can be utilized by the military in time of emergency.

36. The Board does not recommend any change be made at this time in the provisions of the Civil Aeronautics Act of 1938 with respect to participation in air transportation by carriers other than air carriers.

37. Experimental feeder-line certification should be on a 5-year instead of a 3-year basis to aid in financing of such operations.

Three years seem too short a time to test the value of a new type of service. Economic hardships are imposed on carriers, particularly in raising essential capital.

38. Congress should give early consideration to reduction, or repeal, of the tax on transportation.

During 1947 the air lines paid the Government $44,500,000 in transportation tax on passengers alone.

This tax was originally imposed during wartime peak-traffic periods to discourage travel. Justification for this tax no longer exists. It is in the public interest that travel should be encouraged. Additional revenue would accrue to the carriers, reducing the requirements for Federal assistance.

39. To prevent multiple air-line taxation by States or localities, the adoption and continued use of a single formula for the allocation of taxes in interstate operations should be insured by Federal legislation.

Air transportation companies should receive no special tax treatment. To do so would invite tax favoritism or tax discrimination. So far as possible the methods of taxing business corporations generally should be followed for air carriers and altered only to accommodate the peculiar features of the industry to the prevailing tax structure. The difficulties of adaptation are almost entirely of a technical nature and can be solved by relatively minor additions to present tax laws.

Equitable operation of the tax system requires a uniform method for determining taxable situs of air carriers' property, net income, payrolls, and other tax bases. A predominant proportion of air transportation is of an interstate character, hence the industry is especially vulnerable to the assertion of varying rules for determining tax situs. The tendency of the States to adopt situs rules which are advantageous to their particular revenue interests exposes the industry to a serious problem of multiple taxation.

At the direction of the Congress, the Civil Aeronautics Board in 1945 made recommendations to eliminate multiple taxation of air carriers by States and localities. These recommendations have been incorporated in H. R. 1241 introduced in the Eightieth Congress. The Board commends this bill for consideration with a view toward protecting air transportation from tax discrimination.

40. In the settlement of landing rights and routes by bilateral agreements, more effective machinery should be set up in the State Department and the Civil Aeronautics Board, by legislation if necessary, to govern such procedures and insure full protection of the Government and of the United States flag international carriers.

Under the present law the Civil Aeronautics Board must hear interested persons before granting a permit to a foreign air carrier. These hearings have usually been mere formalities, since the bilateral agreements authorizing the routes have been previously consummated by the Department of State. It is recognized that the executive agencies are in a position to designate routes in bilateral agreement negotiations, but procedures should be examined to establish improved methods of considering the effects that the granting of such routes may have on the over-all economy of United States flag carriers.

Closer coordination of the Aviation Division of the Department of State with the overall international policies of the United States is a necessity. The possibility of securing additional operating rights for our international air carriers should be considered when such advantage would be in the spirit of mutual helpfulness.

41. The actual ownership and control of foreign air carriers making application for American permits should be carefully considered with a view toward preventing any air carrier entering the United States unless that carrier is actually owned and controlled by the nationals of the country or countries concerned.

If the spirit and intent of the 1938 Civil Aeronautics Act is not to be circumvented, the ownership and control of foreign-flag carriers by bona fide nationals of those countries must be ascertained by the Department of State and the Civil Aeronautics Board before granting certificates permitting operation into the United States.

42. The temporary conference method of rate making for international air carriers as executed by the International Air Transport Association should be continued for a reasonable time.

The temporary conference method of rate making (established under the Bermuda civil aviation agreement between the United States and Britain) was adopted after unsatisfactory experience in individual establishment of international rates, complicated by the competition between American and foreign companies with a wide variety of cost standards. The conference method is accepted for the present as the most effective means of avoiding rate wars. A basic requirement of this method is Government approval. Public protection is assured through the Civil Aeronautics Board's concurrence in any rate or traffic practice.

43. Full United States support should be given the International Civil Aviation Organization by the Federal Government.

The International Civil Aviation Organization (ICAO), now an agency of the United Nations, serves as the assembly of member nations for achieving uniformity in technical aviation matters, and as a forum for discussing economic and legal problems. If these problems are to receive prompt resolution, full support of ICAO by the Federal Government must be given. Such support does not mean relinquishment of any essential sovereign rights, since the Congress retains final control over agreements entered into by United States delegates.

ICAO has been functioning for 2 years and, although to date its most effective area of accomplishment has been in the field of standardization of technical matters, it has other important objectives. These include efforts to promote the simplification of customs, immigration, public health, passports, visas, and other border-crossing formalities, all essential matters in the facilitation of air travel.

On most technical matters ICAO can take action subject to disapproval or reservation by member countries. On economic and legal matters it can only make recommendations or initiate action subject to formal processes of treaty ratification by member countries before action is final.

In the field of joint support, ICAO appears as the agent of interested governments. The purpose of jointly supported activities is to make available adequate air-navigation facilities in many parts of the world.

44. Constructive diplomatic action should be taken through arrangement of long-term leases or by other appropriate means to assure continued availability of overseas bases necessary for world-wide United States civil and military air-transportation services.

During the war many millions of dollars were spent by this country in construction of air bases throughout the world. Some of these have remained under United States control, but a large number have become the property of countries in which they are located. Today negotiations for peacetime use of airports and facilities in other countries are carried out through the Department of State. It is highly desirable, for the sake of safety and certainty, that our carriers operating overseas be provided with the same efficient weather service, communications, and landing aids as those afforded our domestic air transport system. Undue discriminations, such as unnecessarily high fuel taxes, should be eliminated.

The Department of State should take vigorous action to insure use of all needed airports and to provide landing rights for our international air services. Further, it should make strong representations to countries where bilateral agreements are in effect when operating facilities become unsatisfactory or where discriminatory conditions prevail.

The same policy by which embassy-building requirements have been so effectively met may be applied with great advantage in securing further aviation installations.

45. Legislation authorizing financial assistance and supervision for the establishment and maintenance of international airways communications and navigation aids during their initial stages should be given early consideration, but—

- **a. There should be proportional financial participation based on use among the member nations of the International Civil Aviation Organization in support of international facilities, with provision for payment of charges by the carriers themselves when they are financially able.**
- **b. United States flag carriers should utilize and preserve the remaining Air Force Communications Service facilities and United States built airports abroad; wherever agreements for such use can be reached with the countries in which they are located.**

Modern communications and navigation facilities are necessary for the safety and dependable world-wide operation of the American international air carriers and other international carriers operating over global routes.

Cooperative plans for installation of international aids are accomplished through the International Civil Aviation Organization (ICAO), of which the United States is a member. Up to the present the only international airways aid established under this plan is a single Loran station in Iceland.

If a member state of ICAO can provide its own international airways facilities, it does so. If it cannot, the "user" states are contacted by ICAO and voluntary joint contribution for the installation of the aids are proposed. No state is forced to contribute except indirectly by service charges.

If there is a failure of joint support arrangements under ICAO negotiations, the Board suggests that the United States financial allocations to insure the necessary facilities be channeled through the carriers themselves with proper safeguards to assure provision and maintenance of the aids.

H. R. 4428, introduced in the Eightieth Congress, proposes legislation covering international airport and air navigational problems. The Navy, Air Forces, Weather Bureau, Department of Commerce, and the Air Coordinating Committee favor passage of this bill, but the civil air carriers prefer to see the bill recast as an amendment to the Civil Aeronautics Act of 1938. Early consideration of the proposals of this bill is urged.

46. a. There should be a complete examination by the Congress into present customs and immigration laws as they affect air carriers with a view toward their modernization by corrective legislation.

b. Removal of travel barriers in other countries should be discussed with representatives of those countries through the Department of State or

American representatives in the International Civil Aviation Organization on the basis of mutual desirability.

c. **Consideration should be given by interested Government agencies to establishment of additional ports of entry at airports where international traffic justifies, and the same rights of clearance granted to all classes of American aircraft.**

The number of international passengers carried by American air carriers has grown from 1,401 in 1928 to 1,242,700 in the 12-month period ending November 30, 1947. Many of the present customs laws and practices act as barirers for travelers and impose financial burdens on air carriers. These laws were enacted to cover operations of surface carriers. Payment of huge sums by the air carriers for overtime services of customs crews is an example of anachronistic practices, which have resulted. During the fiscal year 1947, United States air carriers paid a total of $821,379 to the Government for overtime cutoms services for Sundays and holidays.

There is no quarrel with proper payment for overtime work. Much of the excessive payment can be avoided, however, by assigning crews to regular tours of duty throughout the full day.

In contrast, at border stations where the public demands 24-hour service to highway vehicles, including commercial buses, no charge is made to bus companies nor to private automobiles and pedestrians.

While the Postmaster General and the Civil Aeronautics Board can and do demand air schedules throughout a 24-hour day, and on Sundays and holidays, on a basis of public convenience and necessity, the customs service penalizes the air lines for complying with mandates of other Government agencies.

Drastic delays, red tape and high charges are encountered at many ports of entry. Paper work alone is a major obstacle. Hundreds of forms are required from both passengers and air carriers. In the case of one international route, the carrier must fill out some 2,500 forms for a single scheduled flight.

Examination of immigration laws applying to air transportation is also advocated. At present heavy financial burdens are imposed upon the carriers. This is true particularly in the case of penalties upon air lines when it is found necessary to deport a passenger brought to the United States by the carrier. When visas issued by American consuls abroad are incorrect and the passenger is denied entry, the air line, which had no part in the visa issuance, is fined $1,000 and, in addition, is required to return him to his point-of-origin.

Additional gateways available to the private flier, to help develop foreign travel by personal plane, are equally desirable.

47. **Responsibility for lighter-than-air rigid airship development should be transferred to the Maritime Commission and consideration should be given to setting up a lighter-than-air division to consider experimental rigid airship construction and operations.**

The United States has never built a commercial rigid airship, nor attempted to operate one commercially. American experience has been limited to naval types.

48. **The National Advisory Committee for Aeronautics and the United States Air Forces should be encouraged to conduct intensive research in the development of small aircraft with a wide speed range and with emphasis on safety and low-cost production.**

The light aircraft, like the automobile, is to a great extent a matter of private interest and responsibility. Personal aircraft, private pilots and technicians, and he industry which supplies them, serve public interest and national welfare as a reservoir of aircraft and personnel for special tasks during an emergency. During the last war, 91,000 pilots were trained under the civilian pilot training program of the Civil Aeronautics Administration, 67,000 of them entering the military air services. Another 3,000 served in defense flying as members of the Civil Air Patrol. Light aircraft manufacturers produced thousands of liaison planes for the Air and Ground Forces.

Personal flying and its allied interests is today a sizable industry. There are 5,000 fixed-base operators employing more than one-third of all personnel employed in aviation. With more than 75,000 aircraft operating out of some 5,000 civilian airports, the private flying industry is an important component of national air power.

Development of small aircraft for use by Army Ground Forces as liaison planes, which can readily be adapted to personal use by civilians, is a logical program for NACA and the USAF. This should result in a safe and efficient light aircraft available to the private flier at low cost.

A healthy industry, resulting from a civilian market, based on low-cost production, could provide the quick expansability needed in emergency.

49. To provide an air-minded public and a reservoir of technically trained personnel, flight and technical courses should be promoted in colleges and universities with full scholastic credit given; and aviation education courses should be stressed in our primary and secondary schools.

Education has not yet reached full stride in giving our citizens intellectual preparation for the world as aeronautical science has modified it. Distance must be measured in time; surface route concepts must be abandoned.

Thirty States have adopted aviation education programs. Seventeen others are planning such programs. Several have incorporated provisions for flight experience in their courses, giving valuable understanding of flight principles.

Considerable progress toward this goal has been made, but more is necessary if our citizens are to meet the responsibilities of world leadership. The primary need is properly trained teachers. A program of providing high schools with surplus aircraft equipment to assist in development of mechanical skills is highly desirable.

PART III

AIRCRAFT MANUFACTURING

The United States cannot afford to maintain in peacetime the air force required to win a war. Therefore, plans for expanding aircraft production in wartime must be an integral part of the Nation's air policy. In addition to a continuous research and development program which will assure the best airplanes, it is essential to have enough peacetime production contracts to maintain industrial potential for rapid expansion. Beyond these basic necessities certain other preparedness steps must be taken promptly to remove existing barriers to rapid production acceleration in an emergency, and the Board recommends:

50. A comprehensive plan for allocating manpower should be developed for immediate application in the event of an emergency.

Competition between the services, and between industry and the services, must be prevented. Drafting of experienced defense workers into the military and replacing them with unskilled workers is a distinct loss to total effort. Specialized skills will be needed more critically than ever in factories. Industries nonessential to prosecution of war should be denied materials and manpower needed by essential industries.

51. New designs for aircraft should be carefully considered for producibility and serviceability.

In awarding experimental production contracts, the services should carefully consider the producibility and serviceability of designs submitted. New aircraft must be designed for easy production to avoid the time-consuming process of redesign when a production contract is awarded.

52. Experimental contracts should be performed with the necessary minimum tooling. Industry should not manufacture high-production tooling for experimental contracts.

Such tooling, applicable to but one stage of model development, in most cases would be obsolete before it could be used. Suitable low-production tooling, if soundly conceived for an airplane of good producibility, is a step on the road to high-production tooling, and makes possible rapid construction of high-production tooling when the latter is required.

53. General administrative and contractual problems between industry and the armed services should be resolved prior to any possible emergency in advance.

Contracts and leases for immediate activation on M-day should be arranged between industry and the services well before any emergency. Such advance solutions of general administrative and contractual problems would prevent delays at the crucial point of industry expansion.

54. New and advanced designs of aircraft should be available and ready at all times to place in quantity production.

An all-important requirement of any mobilization plan is constant availability of advanced designs of aircraft, proved in service and ready for quantity production. Proven types of aircraft should be ready for immediate mass-production methods.

55. In the interest of national defense, the armed services should contract for the maintenance of stand-by facilities privately owned by the aircraft manufacturing industry.

When the Military Establishment deems it to be in the interest of national defense to maintain privately owned surplus manufacturing facilities, the appropriate procurement agencies should by proper payments encourage air contractors to maintain such facilities in a desired state of readiness. This is in the nature of proper insurance for the safety of the Nation.

56. In the interest of national security, there should be planned overlapping of design and production contracts to provide continuity of labor; to obtain economy in procurement, and to assure the availability of expandable engineering and production teams in industry.

Maintenance of a healthy and expandable aircraft industry is required for national security.

Procurement policies of the Government will determine the financial condition and survival of most companies engaged in making aircraft.

Military purchases are 90 percent of total production; therefore, stability of the industry depends on wise procurement planning by the armed forces.

Presently, the services rarely are able to inform the manufacturers of their procurement programs far in advance. Future delivery schedules are for comparatively short periods and do not provide for overlapping of design and production contracts. This results from lack of long-range planning and inflexible procurement laws, as well as the constitutional limitation on appropriation of moneys beyond one Congress.

Time involved in design, construction, and development of a new airplane is comparable to that for building a battleship. Every airplane used in World War II was developed before the war. Only recently have planes developed from war experience come into limited production. World War II production to meet aircraft requirements was not attained until 4½ years after our own aircraft industry expansion began, superimposed on British and French orders.

To be secure, this Nation needs an industry with sufficient production to maintain a nucleus of facilities and engineering and production staffs to permit rapid emergency expansion.

Currently, the Navy and Air Force are "living off their fat," replacing planes from surplus in storage. All of these planes are obsolete. Replacement purchases of new planes are far below the rate necessary to keep air groups modern.

Problems facing the Government and industry in procurement planning, methods and procedures are more complicated than ever before because of—

(*a*) International relations requiring United States Air Forces to be in an immediate state of readiness.

(*b*) Greater technical complexity and rapid rate of improvement of equipment to be produced.

(*c*) Larger annual appropriations involved.

57. The Congress should assist the air services in long-range planning by removing time limitations on the expenditure of appropriations as well as the time limitation upon contract authorizations.

At present the feature of aircraft procurement that is most destructive to economical planning is a provision in the appropriation act which requires the services to obligate their funds and contract authority before the end of each fiscal year. Penalty for failure to do this is a loss of the funds and authorization. Whether procurement plans are or are not sound, the tendency is to conclude the contract.

Deletion of a time limit within which to obligate funds would eliminate the necessity of tying procument schedules to an artificial and arbitrary period of time. Contracts could be let when planning is complete. This would neither change nor increase amounts authorized but would permit more effective utilization. An additional advantage would be to permit the services to cut back contracts when more acceptable and useful equipment is available, without losing the unexpended balance. Under present time limits, such unexpended balance is lost to the procuring agency. This has a tendency to encourage the services to complete contracts which they might otherwise revise downward or cancel if it were possible to substitute improved types of equipment. Funds to liquidate obligations under contract authority should be provided by the Congress on a continuing appropriation basis, with amounts to be provided from year to year, based upon evaluation of the estimated progress under the contracts.

58. In the interest of national security, the Congress should authorize a succession of 5-year programs, reviewable yearly, for research, development, and procurement of aircraft for the purpose of maintaining a rapidly expandible production industry.

Legality of appropriating money "until expended" for "the procurement of weapons and other equipment necessary to enable personnel to carry on war" has been upheld by the Attorney General. He concluded that "there appears to be no legal objection to a request to the Congress to appropriate funds to the Air Force for the procurement of aircraft and aeronautical equipment to remain available until expended."

A 5-year plan for aircraft procurement is believed the most efficient method of stabilizing procurement and of promoting a healthy industry available for mobilization in emergency. It has many advantages:

(*a*) It allows management to plan production, employment, inventories, finances and operations, equalizing the costly peaks and valleys experienced in current procurement.

(*b*) The mere act of creating a 5-year plan encourages and requires a more mature view of Government procurement needs and of industry's ability to supply them in peacetime and in emergency. It does not bind future Congresses if they determine the national need has changed.

59. In the interest of national security, contracting officers and the aircraft industry should plan procurement and production to assure all classifications of aircraftsmen maximum job security to insure the nucleus for expansion in emergency.

Many of the best supervisors, engineers, and skilled workmen are leaving the aircraft industry because of instability and insecurity resulting from absence of a long-range program. Sporadic awarding of contracts throughout the industry has caused even the nucleus force of top-trained employees to undergo lay-offs.

The production of present day aircraft is highly complex. Frequent changes are required in methods and processes of manufacturing. Breaking up of coordinated teams of engineers, tooling, liaison, production control and production workers will have a serious effect on producibility and expandability in an emergency. Success in production depends upon the manufacturing teams which have been developed over a period of years.

60. Government procurement agencies should encourage subcontracting of parts and assemblies to other manufacturers within the industry if there appears to be an excessive concentration of procurement. In such instances, however, contracting officers should recognize that development and design must be controlled by the originating company, and that the originating

company must be duly compensated for its design rights and services in order to maintain essential development incentives.

More than 75 percent of all United States Air Force funds for airframe procurement has flowed to three companies, while the remainder of the industry has struggled to maintained its working force without too serious financial loss. Concentration on heavy bombers, insufficient over-all funds, and lack of understanding of the consequences to national air power have been responsible for this situation.

When a few companies have the bulk of contracts, Government contracting officers should encourage letting of subcontracts for parts or assemblies to other aircraft manufacturers, even though cost is increased. This would enable such contractors to keep their staffs together until they receive other prime contracts.

Government should not decide how many manufacturers remain in existence. Air Force and Navy procurement policy should insure competition between manufacturers. Constructive procurement policies, assuming adequate appropriations are available, will keep alive and strong all efficient manufacturers. Obviously, companies will go through lean periods. Occasionally, some may be forced out of business. These casualties are an unavoidable result of competition. The losses they entail are justified by over-all benefits of the system.

61. The Procurement Act of 1947 should be amended to authorize more flexible contracting procedure. The new act should give to procurement officers additional latitude, permitting more flexible contracting procedures, and authorizing the principle of negotiation as well as the principle of straight competitive bidding, when such is in the best interest of the national security. The procurement policy, the procurement law, and the procurement program, should be coordinated with the industrial mobilization plan.

Military procurement officers are not always able to consider the industrial significance which accompanies placing of contracts. They must use limited funds to best advantage. This ignores maintenance of a healthy industry with resultant bad effect on contractors and suppliers. A procurement plan stated in pounds of airframe and keyed to annual production by articles will quickly reveal maladjustments and disclose what steps are necessary to mimimize political and other extraneous temporary considerations.

Peacetime procurement laws under which the Navy Bureau of Aeronautics and the Air Force operate are antiquated and inflexible. Because of the nature of the product, the principle of competitive sealed bids should not be applied to aircraft procurement. Therefore, officers of contracting agencies should be authorized to use discretion in negotiating contracts for aircraft.

New procurement legislation should authorize negotiation instead of sealed bids wherever negotiation can be expected to provide superior equipment, encourage competition in design and production, or otherwise accomplish the objectives of the mobilization plan and the national air power policy.

62. The National Military Establishment, in collaboration with the General Accounting Office and the Bureau of Internal Revenue, should be directed (after examining the views of organizations capable of reflecting industry's difficulties under present accounting practices) to establish a single set of rules applying to audit and determination of costs under contracts of the National Military Establishment, and in agreement with the General Accounting Office, prescribe the normal time for completing the audit and the issuance of a suitable certificate or other form of final clearance (except for fraud).

There exist three different Government regulations under which costs of Government contracts are determined. They emanate separately from the Army, Navy, Bureau of Internal Revenue, and General Accounting Office.

The decisions of the Comptroller General often place an entirely different interpretation on what constitutes allowable costs. No manual is available to contractors outlining basis for decisions. Such decisions are given after the cost has been incurred; disallowances are retroactive in effect, penalizing the contractor.

Resulting complications make it desirable to establish a definitive uniform policy with respect to costs and expenses allowable under Government contracts, eliminating different interpretations by three Government agencies.

Proper function of General Accounting Office should be a review of settlement procedure and final audit, rather than duplication of audit and administrative interpretation of contracts.

The cost-plus-fixed-fee contract must continue for highly technical research and long-range developments, cost of which cannot be predetermined for bid purposes under fixed-price contracts, but the contracting agency should be able to change objectives and methods of performance for such contracts to meet changes in military needs occurring as effort progresses.

All companies must subject themselves to audit of the Bureau of Internal Revenue for income-tax assessment. The taxpayer can be best served if other procurement agencies of Government (Army, Navy, and Air Force) agree to accept the principles of the Internal Revenue Code for determination of allowable costs.

63. The Congress should enact legislation authorizing contract termination procedure for peacetime procurement, similar to the procedure provided for in the Contract Settlement Act of 1944.

The Contract Settlement Act of 1944 permitted the Government to accomplish an outstanding task in terminating and liquidating of World War II commitments. So far as the aircraft manufacturing industry is concerned, it is believed that those commitments were thoroughly and efficiently settled. Without new legislation, industry will return to the confused legal situation which existed between World War I and World War II. In that period question prevailed as to whether any settlement by agreement could be made, or, if made, could withstand the General Accounting Office rulings.

Present joint procurement regulations of the Air Force and Army provide for a so-called formula settlement of contracts. Formula settlements were tried prior to enactment of the Contract Settlement Act and found unsatisfactory both to industry and the services. The only effect of the formula is to predetermine percentage and amount of profit to be allowed on the termination portion. This is rarely a source of disagreement. Real source of disagreement and, therefore, of delay and possible litigation is almost always the question of whether certain items of cost are applicable. Under a formula settlement, or any settlement procedure other than negotiation, there develops strong tendency to excessive detail over the many thousands of items of cost going into claims. As a result, there are often differences of opinion.

Validity of a negotiated termination agreement is comparable to that of a negotiated procurement contract. Insofar as contracts for aeronautical equipment are concerned, it is desirable that negotiation be recognized as a usual means of Government contracting and settlement of Government obligations.

Authority to negotiate final settlement is particularly important insofar as industry's subcontractor and supplier claims are concerned. Unless the prime contractor is certain the settlement he negotiates is final, he will delay settlements with subcontractors.

Provisions should be made for immediate partial payments on termination claims. This is a financial necessity to both prime and subcontractors: first, because of the large values involved in many prime contracts in relation to the contractor's working capital; second, because in the preliminary stages of preparing a termination claim, supporting material is not in shape to be readily acceptable as collateral for a commercial banking loan.

Many contractors are working with minimum floor space. There is also considerable responsibility and liability connected with storage, preservation and accounting for raw material, equipment, semi-finished parts, and other inventory items supporting a termination claim. It is important that Government-owned property be removed from facilities at earliest date.

64. In the interest of national defense and the maintenance of a strong aircraft industry, the Government should continue to encourage sale and use abroad of civil aircraft manufactured in this country, but with due consideration for maintaining and increasing the strength of United States international air lines.

The problem of maintaining an export market for American-made aircraft has been complicated by war surpluses. By flooding the foreign market with war-built planes at bargain prices, the Government made it extremely difficult for manufacturers to develop new business. Of 6,000 surplus aircraft sold by the Government abroad, more than 2,500 were suitable for air-line use.

United States manufacturers of civil aircraft are experiencing increased competition in export, except in the very largest types. Potential competitors are Great Britain and Sweden. Russia's position is a question. However, it can be expected that when and if her production of aircraft is sufficient, satellite allies, for political and economic considerations, will be given purchase priority.

Great Britain is in favorable position to sell aircraft because payment can be made in sterling instead of scarce American dollars. British import needs, contrasted to United States requirements, make it possible for other nations to establish favorable credit with the British. The trade structure of the United States is less favorable because western Europe, the major potential market for our aircraft, has lost ability to buy because of dollar shortages.

65. With proper safeguards, the Department of State, the National Military Establishment, and other interested Government departments, should encourage sale and use by friendly nations of military aircraft and aviation ground equipment manufactured in this country.

With proper safeguards, the Department of State and the armed services should encourage export of military aircraft to friendly foreign nations which we can reasonably expect to be allies in event of war. Export of military aircraft would acquaint these friendly nations with the quality and operation of United States equipment, and thus tend to establish an air reserve beyond that existing in the military and civil aviation of the United States.

66. The Government, with particular regard to its civil departments with services abroad, should assist in the sale and encourage the use of all aircraft, communications and other electronic devices, together with landing, navigational, and airways aids manufactured in this country.

Encouragement of export sales would contribute greatly to total industry production. It would do much to level the peaks and valleys of production from which the industry is suffering. Increased volume of sales makes products less costly and keeps factories in production.

Equal emphasis should be placed on export sale of United States aviation ground equipment, communications and electronic devices, together with landing, navigational, and airway aids.

67. The Export-Import Bank and other appropriate Government lending agencies should make, in proper cases, dollar credits available to air lines of friendly foreign nations for purchase of new aircraft, ground and air-borne equipment manufactured in this country. Terms and credit arrangements for sale of surplus aeronautical equipment disposed of by the War Assets Administration and the Foreign Liquidation Commission should be at least as restrictive as those required by Export-Import Bank in the sale of new aeronautical equipment.

The Export-Import Bank should review its policy with respect to financing the sale of aeronautical equipment abroad. In many instances, export sales could be negotiated if credits could more easily be made available to foreign air lines desiring to operate American equipment but unable to purchase because of dollar shortages.

When sales abroad are made by the Foreign Liquidation Commission or the War Assets Administration, terms and credit arrangements should closely conform with those required by the Export-Import Bank. In this way the manufacturer of new equipment will have equal and fair opportunity in the foreign field.

68. The Government's policy on acquisition of patent rights under inventions emerging from research and development and procurement contracts should be that—

- **a. The Government does not acquire, merely by virtue of research or development contracts, any rights to companies' inventions which were reduced to practice before effective dates of such contracts.**
- **b. All rights in inventions arising under research or development contracts relating directly to the companies' normal line of endeavor shall remain with the company, subject to a free, nonexclusive, nontransferrable license in favor of the Government.**
- **c. Allocation of rights in inventions arising under a research of development contract not relating directly to the companies' normal line of endeavor shall be subject to negotiation prior to signing of a contract.**
- **d. The Government by virtue of a procurement contract involving no research or development acquires no rights in inventions involved in the articles purchased.**

Advancement and maintenance of the national security through research, dedevelopment and procurement depends largely on reasonable Government patent policies.

To assure effective incentive to established companies to maintain efficient research, development and production organizations, and to encourage new companies to enter the broad field of aeronautics, Government contracts should provide that the companies retain title to inventions made under research and development contracts. Thus, companies can maintain competitive commercial positions and Government can benefit from resulting heightened incentive.

The Attorney General has submitted recommendations to the Presidnt that all Government-financed research and development contracts should provide that rights to inventions made thereunder accrue to government. The recommendations add that in emergencies the newly proposed office in the Justice Department, of Government Patent Administrator, may approve contracts providing for retention of rights by the company if it agrees to license them to the Government.

The report of the Attorney General did not deal with points (*a*) and (*d*) of the policy recommended herein. The Attorney General stated he has no objection to the general declaration of the policy set forth in point (*a*), and no objection to point (*d*).

As to points (*b*) and (*c*), the Attorney General limited his recommendation as to the Government's obtaining all rights to inventions made under research and development contracts, to contracts under which the Government pays all of the costs. Under contracts where the Government pays less, the Attorney General stated patent rights should be subject to negotiation.

The Attorney General stated that the Government itself would need nothing more than a license on inventions resulting from its research and development contracts. If, however, public funds have been used to make possible such inventions, the public is entitled to whatever rights are involved.

Since Government is the principal developer and purchaser of aircraft, a policy assigning all invention rights to the Government would destroy competitive incentive in the aircraft industry, and materially increase costs.

Regarding establishment of a new Government office of Government Patent Administrator in the Justice Department, the Attorney General recommended that exceptions to the basic policy of Government obtaining all rights to inventions made in Government research and development contracts, "May be made upon such terms and conditions as the administrator may prescribe or approve." The Attorney General stated this recommendation as a suggestion, and said the matter is one of legislative policy for Congress to decide.

The Attorney General recommended, in cases where a contract provides that title remain with the company, that if Government determines that commercial use of an involved invention is not "adequate" within a designated period, Government can require the company to offer, at a reasonable royalty, nonexclusive licenses. This provision, if adopted, establishes compulsory licensing as the Government will have the right to "determine" whether commercial use is "adequate."

The recommendations of the Attorney General were referred to the military services in preliminary form, for comment:

Former Under Secretary of War Patterson said it would constitute a serious "obstacle to the maintenance of modern and efficient armament in the days to come." He added that it would "gravely hamper the program of research and development upon which effectiveness of our Military Establishment in the years to come will chiefly rest."

Army Secretary Royall said the recommendation "would wreck the War Department's research and development program."

Defense Secretary Forrestal said it "might altogether imperil the prosecution of a vigorous and effective research and development program."

These recommendations should be given great weight, coming from officials responsible for national defense.

The recommendations are all the more compelling when it is realized that the War and Navy Department budgets for research and development for 1947 totaled $500,000,000. For all other agencies the budget was $125,000,000.

69. If and when the proper lending agencies of the Government make loans to aircraft companies because commercial financial institutions find it imprudent to do so, service for repayment of such loans should have priority over the payment of dividends.

The proper Government lending agency should give consideration to loans to components of the aircraft industry which are vital to national defense. The Government may find it necessary to make such loans where commercial banks and financial institutions temporarily find it imprudent or impossible to do so.

The Government agency in making such loans should establish conditions which make repayment of loans take precedence over payment of dividends by the company involved.

PART IV

RESEARCH AND DEVELOPMENT

Technical preeminence is fundamental to air power. This can be achieved only through intensive research and development. The frontiers of aeronautical knowledge must be continually explored and pushed back through research to obtain new information required for the development of our air equipment.

To carry our knowledge of aeronautics forward, we must explore virtually every field of science since our aircraft and their operations have become so complex that the roots of development lie in all scientific fields. Thus a general increase in scientific knowledge is as essential as increased effort in the aeronautical field itself.

Although research and development outlays amount to only about 7 percent of the Government's total aeronautical expenditures, the entire aeronautical program is shaped around the results which are achieved.

If the United States is to retain leadership in the air, it is requisite to finance an intensive well-balanced program of research and development geared to military and civil needs.

70. The Government agencies concerned, and the aircraft industry, should adhere to the functions and responsibilities set forth in the National Aeronautical Research policy of March 21, 1946, to assure a unified effort to provide the Nation sound aeronautical research and development.

Successful conduct of aeronautical research and development is of prime importance in achieving air supremacy. Numbers (however large) of second-rate aircraft do not constitute air power. Air power requires quality aircraft. To develop aircraft whose performance is second to none requires intensive effort by all groups concerned with research and development. They must work as a team to assure maximum achievement.

The National Aeronautical Research policy of March 21, 1946, agreed to by the Army Air Force, the Navy Bureau of Aeronautics, the Civil Aeronautics Administration, the National Advisory Committee for Aeronautics, and the aircraft industry, delineates the areas of effort in which each group functions to provide research and development on civil and military aircraft and equipment. The Board endorses this policy, in particular the division of functions and responsibilities, since the most progressive research and development results only when each group understands its duties.

Relationship of education and scientific institutions to the Government's aeronautical research and development program is not included in the 1946 policy. Effective utilization of the aeronautical research potential of educational and scientific institutions should be integrated.

71. The National Advisory Committee for Aeronautics and the Research and Development Board of the National Military Establishment should expedite preparation of a unified plan for transonic and supersonic research and development facilities required in the national interest.

Advances in aviation brought by World War II, particularly application of jet and rocket engines to aircraft, have completely revolutionized aeronautical science. Jet-propelled planes have flown in the transonic range (600 miles an hour upward). They will fly at supersonic speeds (650 miles an hour and up, depending on altitude and other conditions). These are speed areas in which our knowledge is very meager. Facilities available for exploring these areas are extremely limited. However, technical information available even in 1945 showed that development of supersonic aircraft and guided missiles was possible by any country willing to make the necessary technical effort. United States failure to make this effort will jeopardize continued air leadership.

Physical facilities required for transonic and supersonic research and development of aircraft and guided missiles are so expensive they can be furnished only by Government. The NACA and the Research and Development Board are preparing a coordinated program of facilities required in the national interest. Since adequate research and development facilities are essential for continued United State aviation leadership, this plan should be expedited.

72. The National Advisory Committee for Aeronautics should coordinate basic aeronautical research to insure a sound cooperative effort to meet military and civil needs.

The National Advisory Committee for Aeronautics is the Government's aeronautical research agency. Over two-thirds of Government funds for aeronautical research are allocated to the NACA. It is the logical group to coordinate basic aeronautical research required to meet military and civil needs.

Prior to World War II effective coordination of fundamental research was carried out by the NACA. Machinery exists to continue that coordination. However, due to increased emphasis on research brought by the war, new groups have entered the field and much larger sums of money are devoted to solutions of new problems. Thus a need has risen to improve the mechanics of coordination. To insure the same effective coordination that existed prior to the war the NACA should strengthen its staff to achieve most effective coordination of aeronautical research.

73. The Research and Development Board of the National Military Establishment should integrate the needs of the military services in planning and guiding a sound program of applying research results to development of superior aircraft, missiles, and other aeronautical equipment.

The National Security Act of 1947 provided for establishment within the National Military Establishment of a Research and Development Board to "advise the Secretary of Defense as to the status of scientific research relative to the national security, and to assist him in assuring adequate provision for research and development on scientific problems relating to the national security."

The two most important of these functions are—

(*a*) Coordination of research and development plans of the three military services to produce a single program, with duplication eliminated and gaps filled, that will provide research and development commensurate with military needs.

(*b*) Advising the Secretary of Defense and the Joint Chiefs of Staff on research and development trends which may have military implications.

Responsibility of the Research and Development Board extends beyond aviation, but the aeronautical element probably is more important. Execution of this provision of the National Security Act is vital to the research and development program.

74. The National Military Establishment, in the preparation of aeronautical budgets, should consider research separately and independently from development, and both should be separated from other budget categories.

It is difficult to distinguish finely between research and development. For this reason there is often no attempt made to separate research and development expenditures. It is essential that this be done.

Only about one-fifth of the $300,000,000 1948 research and development expenditures is devoted to research. In view of the critical dependence of the entire development program on information furnished by research, the distinction between the two should be emphasized. A cut in research funds may cripple the whole program. A cut in development funds may only cause delay or reduce the number of prototypes developed. Therefore, the National Military Establishment, in preparing its budget, should consider research and development separately.

Fiscal requirements for research often bear no relation to fiscal requirements for development.

Whenever over-all budget cuts are ordered, a flat percentage should not be applied to the total research and development programs. Instead, research projects should be considered separately from those of development.

75. The National Military Establishment and the National Advisory Committee for Aeronautics should give increased attention to the aeromedical problems resulting from the severe conditions imposed on airmen by high-speed flight.

Aeronautics has reached the point where speed and altitude, range and endurance of aircraft have placed an unprecedented load on the human body and mind. Design and performance of aircraft are constantly progressing, but the human body does not change. Man can be somewhat accustomed to unprecedented conditions of existence, but he cannot survive if his basic physical or mental limits are exceeded.

If we are to have greater safety in flight and increased effectiveness of the air arms, we must look to aeromedical research to determine man's limitations and extend the science of human engineering—adaptation of machine to man.

76. The National Military Establishment should fully explore the advantages and economies that may be achieved through synthetic training equipment and methods.

Selection and training of individuals to become airmen have gone far beyond mere flight instruction. Complexity of modern aircraft, their speed, range, and scope of action, make necessary instruction in many scientific and engineering fields. Contemplated long-range operations and need for highly trained and specialized personnel to insure successful completion of missions makes it evident that selection and training must extend to many different classes of technicians besides pilots.

These considerations coupled with the continued trend toward instrument operation of aircraft, communications, control, navigation, and firing, point to the need for a vast training program. Such a program will involve enormous costs which can only be minimized by better methods of selection and training. Synthetic training equipment and techniques were eminently successful in World War II.

PART V

GOVERNMENT ORGANIZATION

One of the greatest needs of aviation today is stable Government operating policy. Only through a continuing, but firm Government policy, capable of ready adjustment to changing circumstances, can the stability which the aviation industry requires be achieved.

Revolutionary changes in present Government organization are not suggested. The principles of the Civil Aeronautics Act of 1938 have stood the test of 10 years of tremendous growth during peace and war.

The basic existing governmental structure is sound. What is needed is (1) an adequate statutory basis for interagency coordination and cooperation; (2) clarification of overlapping responsibilities and elimination of bickering that exists between the Civil Aeronautics Board and the Civil Aeronautics Administration and their staffs as a result of Reorganization Plan No. IV of 1940; and (3) an independent agency concerned with safety to investigate aircraft accidents in order to insure the utmost safety to the traveling public, the private flier, and the military user of the airways.

Corrective measures along these lines will solve many of the current problems of aviation without disrupting the economic or technical status of the industries involved.

77. The present Air Coordinating Committee should be reestablished with statutory power to coordinate and recommend aviation policies affecting two or more agencies of the Federal Government; the Committee to be composed of representatives of the agencies primarily concerned with aviation, as determined from time to time by the President.

A fundamental weakness of civil aviation is lack of adequate coordination of policy within the executive departments. The present Air Coordinating Committee, established originally by interdepartmental memorandum and later by Executive order, has encountered insurmountable obstacles in attempting to persuade autonomous departments to agree upon policies involving controversial issues and, particularly, in implementing decisions once reached. This can only be met by establishing a statutory basis for coordination of aviation policy, following the pattern employed in the National Defense Act of 1947 of establishng statutory boards for interdepartmental coordination of military research and mobilization planning. While the Air Coordinating Committee should primarily deal with general policy, certain limited operating functions can best be handled by it to bring about proper balance between military and civil agencies.

78. The Air Coordinating Committee should be authorized to reach decisions by majority vote, with provision that a dissenting member may certify the dispute to the President for his decision.

A recognized weakness of the Committee is its inability to reach unanimous decisions on controversial issues and the tendency to allow such issues to remain unresolved for long periods without carrying the matter to the President for decision, as provided in the present Executive order. It is believed that a majority voting procedure would expedite action and not unduly burden the Presidnt with technical and minor aviation disputes. To insure expeditious functioning of the

Committee, it is recommended that it continue to employ an executive secretary charged with responsibility for keeping interdepartmental coordination functioning at the tempo required by the rapid development of aviation.

79. The Chairmanship of the Air Coordinating Committee should rotate annually among the participating agencies.

With an executive secretary to organize the work of the Committee, the chairmanship should not be permanently assigned to any one agency as an indication of its greater interest in aviation or in the deliberations of the Committee. The chairmanship should rotate annually among the participating agencies.

80. The statute establishing the Air Coordinating Committee should specify in some detail the policies that may come before it and the advisory panels to be created.

Jurisdiction of the Committee should be defined so that participating agencies may know the Committee's areas of responsibilities, and thus avoid any infringement of duties reserved by law to an agency or coming within the quasi-judicial functions of an agency. Advisory panels should be created by the ACC, as needed, in order adequately to perform its functions.

The statute establishing the ACC should require it to make provisions to act as a sounding board for State and municipal agencies on aviation matters touching upon the interests of political subdivisions. This can be accomplished by the creation of an ACC State-local aviation panel which would be attached to the ACC and organized along the lines of the ACC industry advisory panel. The ACC should be directed to refer for recommendation aviation matters affecting industry to the industry panel, and aviation matters affecting State and local aviation governments to the State-local aviation panel.

A State-local aviation panel to advise the Committee is believed the most satisfactory method of giving State and local governments opportunity to express their views and recommendations concerning national aviation policies that directly affect them. Since the ACC is an interdepartmental coordinating body, it is not believed proper that States' representatives be voting members. An essential lack in the present formulation of national aviation policies is permanent liaison with State and local governments.

81. A Joint Congressional Committee on Aviation Policy should be created which, among other duties, would make a biennial report to the Congress of the defense and commercial capabilities of the Nation in the light of the then existing international situation and aviation strength of other nations.

In view of the changing military requirements and enormous appropriations required, it is believed desirable that a standing joint legislative committee review and analyze biennially the air defense and commercial capabilities of the United States, with reference to the then international situation and the aviation strength of other nations. This appraisal should be on the broadest and most comprehensive scale.

The Joint Committee on Aviation Policy should be appointed by the President of the Senate and the Speaker of the House of Representatives, after consultation with the chairmen of the various committees concerned, including the following: Armed Services, Interstate and Foreign Commerce, Atomic Energy, and Appropriations. The findings of this Committee should be translated into policy recommendations to the Congress. This procedure would coordinate the analysis of the several committees which function independently of each other, and in addition to informing the public, would provide the basis for legislation to effect a sound and continuing security for the Nation.

82. The administration and enforcement functions of the Civil Aeronautics Administration relating to aircraft and airmen should be transferred to the Civil Aeronautics Board and the operative functions of the CAA should remain in the Department of Commerce.

The Civil Aeronautics Administration is engaged in heterogeneous activities involving operation of facilities, rule making and interpretation, administration, enforcement, and promotional services. This violates the principle Congress has followed in placing quasi-legislative and quasi-judicial functions in the transportation field in independent agencies. The Board has considered re-creation of the Civil Aeronautics Authority as established by the Civil Aeronautics Act of 1938, in which all aviation administrative activities of the Federal Government were placed under an administrator who was part of the Civil Aeronautics Authority. Operation of Federal airways now requires over 8,500 employees, and the airport development program employs nearly 700. It is believed these services should be kept apart from the quasi-judicial function of making and administering rules and regulations and retained in an organization that can readily be transferred to the military in a national emergency. These services may therefore be left in the Department of Commerce together with other promotional and educational activities of the present CAA.

Planning airways routes and airways facilities should be coordinated through the ACC so that both the military users of the airways and the CAB, charged with the airworthiness of aircraft and operating specifications, can determine the needs of the services.

83. The Civil Aeronautics Administration should be abolished and an "Office of Civil Aviation" be created in the Department of Commerce; the Director of Civil Aviation should be the senior operating official and report to an Assistant Secretary of Commerce.

Transferring functions out of the Civil Aeronautics Administration, as recommended above, reduces the aviation activities of the Department of Commerce primarily to those involving equipping and operating of navigational and traffic-control facilities, regulation of flight movement, and promotion of civil aviation through airport development, education, and other means. These activities should be handed by two bureaus, the Federal Airways Service which would be charged with the equipping and operating of Federal airways facilities and the movement of aircraft over the airways, and the Bureau of Aeronautical Development, which would administer the Federal Airport Act and other promotional, experimental, and educational activities of the present Civil Aeronautics Administration. These Bureaus would compose the Office of Civil Aviation, headed by a Director of Civil Aviation. The Director should receive $12,000 per annum, the salary recommended in the Civil Aeronautics Act of 1938 for the Administrator of Civil Aeronautics.

The establishment of the Federal Airways Service in a separate bureau under a single civilian head should facilitate the integration of the airways system with military aviation in an emergency as heretofore recommended in the combat section of the report.

Confusion now exists between the statutory duties of the Administrator of Civil Aeronautics, who is primarily an operating official, and the Assistant Secretary of Commerce to whom the Administrator reports, along with the Chief of the Weather Bureau and the Director of Coast and Geodetic Survey. There is unnecessary overlapping of duties between the present Administrator and the Assistant Secretary. These could be eliminated by removing the statutory duties now vested in the Administrator and requiring the proposed Director to report to an Assistant Secretary of Commerce for policy determination.

84. a. **The Civil Aeronautics Board should promulgate, administer, and enforce regulations relating to the competency of airmen, certification and airworthiness of aircraft, air carrier operating specifications and other regulations relating to the economics of operations.**

b. **The Federal Airways Service should promulgate and administer regulations relating to the movement of aircraft in flight and at airports.**

c. **The Civil Aeronautics Board should hear and determine appeals from the Federal Airways Service in cases involving violation of regulations.**

The same agency which promulgates particular Civil Air Regulations should also interpret and administer them. It is not necessary, however, for the same agency to promulgate and administer both air traffic rules and also those relating to equipment and competency. The distinction is made between the rules and procedures to be administered in the normal course of operating the airways and airport traffic control facilities—the rules of the road—and all other rules governing the operation of aircraft and air services in flight and on the ground.

Thus, the Civil Aeronautics Board should be made responsible for promulgation, administration, and enforcement of regulations relating to competency of airmen, certification of the airworthiness of aircraft, air carrier operating specifications, regulations concerning equipment used in air tranportation and the competency ratings of private air agencies as provided in title VI of the Civil Aeronautics Act of 1938. These regulations concern the safe and economic operation of the scheduled air carriers and aircraft generally.

To discharge these duties, the personnel of the Civil Aeronautics Administration now administering and enforcing the safety regulations should be transferred to the Civil Aeronautics Board. This would place a field staff of approximately 1,500 in the CAB, administered by an executive director hereinafter recommended.

The Federal Airways Service should be responsible for promulgation, administration, and enforcement of regulations relating to movement of aircraft in flight, air traffic rules, and regulations which are normally administered by airways control and airport traffic control operators (especially sec. 601 (7) of the Civil Aeronautics Act of 1938). These bear directly upon the safe movement of aircraft over the airways and at airports.

85. **The Civil Aeronautics Board should continue as an independent quasi-legislative and quasi-judicial agency and be charged with the administration of the economic responsibilities imposed by the Civil Aeronautics Act of 1938, including the Civil Air Regulations having a direct bearing upon economics of operations.**

The importance of civil aviation in its relation to national security and to the economy of the Nation demands that the broad policies established by the Congress be administered by men of the greatest competency and integrity. The cardinal principle of the Civil Aeronautics Act of 1938, that quasi-legislative and quasi-judicial functions of the Civil Aeronautics Authority, now the Civil Aeronautics Board, should be exercised independently and free of political influence and domination by other agencies of Government, is reaffirmed. Reorganization Plan No. IV of 1940 abridged this independence and divided responsibilities for the execution of congressional policy between the Department of Commerce and the Civil Aeronautics Board. The present Board has failed in its functions, due in part to this loss of independence, inability to organize its work in a businesslike manner, and dissention among its members. Further stripping from the Board of important governmental responsibilities will scarcely induce outstanding men to accept positions on the Board. On the contrary, every effort should be made to concentrate in the Board all quasi-legislative and quasi-judicial functions so that the best talent in the country can be persuaded by the importance of the Board's responsibilities to accept membership on it.

It is recognized, however, that certain of the duties originally vested in the Civil Aeronautics Authority, and later transferred to the Civil Aeronautics Administration in the Department of Commerce, are operative functions requiring the employment of large numbers of personnel who have no relation to the judicial and legislative responsibilities of the Board. Operation of the Federal aidways, the administration of the Federal Airport Act of 1946 and the general promotional and educational activities of the CAA are in this category. These functions can and should be kept apart from the Civil Aeronautics Board and should be placed in the Office of Civil Aviation in the Department of Commerce, as heretofore recommended. Coordination in planning these operationse should be effected with the CAB thrbough the ACC. The registration and recordation of aircraft should be handled by the Board, as it is charged with the certification of civil aircraft.

86. The Civil Aeronautics Board should be freed of its present administrative ties to the Department of Commerce.

Further to strengthen independence of the CAB, it should be freed of all administrative housekeeping ties to the Department of Commerce. CAB should be specifically authorized to handle its own budget and procure its own personnel, as do the Interstate Commerce Commission and the Federal Communications Commission. Present relationship to the Department of Commerce has not produced economies anticipated from centralization of procurement, personnel processing, and budget preparation.

87. The Civil Aeronautics Board should continue to have five members.

Since it is recommended that responsibility for aircraft accident investigation be transferred from the CAB and that the CAB should be authorized to delegate certain of its functions, thus simplifying its administrative operations, it is believed that there is no need to increase its membership.

88. The salaries of the Civil Aeronautics Board should be increased to the present statutory limit of $12,000 per annum.

Difficulties experienced in obtaining men of caliber to discharge the important duties vested in the CAB demonstrate the urgent need for increasing the salaries of members to the statutory limit of $12,000 per annum as fixed in the Civil Aeronautics Act of 1938. This Board is sympathetic to the need of increasing the salaries of all top Government officials.

89. The Civil Aeronautics Board should be directed to appoint an Executive Director, subject to removal by the Board, who would have charge of the administration of civil air regulations promulgated by the Board, including the certification of airmen and aircraft and the issuance of air carrier operating certificates, subject only to policy direction of the Board.

The relationship between the Administrator and the Civil Aeronautics Authority lacked clarity in the Civil Aeronautics Act of 1938 and much confusion resulted from the uncertainty as to whether the Administrator was responsible to the Board or only to the President. By amendment, it should be made clear that the Executive Director is responsible for the day-to-day operation of the field inspectors administering and enforcing the civil air regulations relating to the competency of airmen and private air agencies, the airworthiness of aircraft, and the issuance of operating certificates. With reference to the Executive Director, the CAB should sit as a board of directors of a corporation, concerning itself only with matters of major policy that may affect the over-all responsibilities of the Board. In this manner the operative duties of the field inspectors will not be encumbered by dealing directly with a five-man Board primarily occupied by quasi-judicial and legislative duties.

90. The Civil Aeronautics Board should be authorized by amendment to the Civil Aeronautics Act to delegate such of its functions as it considers proper to individual members, panels, the Executive Director and other members of its staff, with the right of discretionary appeal to the Board, except that route and rate decisions should be made by a majority of the Board.

Vesting the CAB with adequate power to delegate functions to its members, panels and staff, and providing it with necessary appropriations to hire a competent staff will materially assist it in promptly discharging its important economic functions in a tempo equal to that of civil aviation. The CAB is presently 2 years or more behind in its work. Statutory authority to organize its work load under a competent Executive Director, and adequate power of delegation will relieve the situation.

91. An independent Director of Air Safety Investigation should be appointed by the President and confirmed by the Senate.

a. He should be responsible for investigation and analysis of civil air accidents and for submitting reports and recommendations to the Air Coordinating Committee, which should be required to make such reports public and to transmit them to the Congress, the Civil Aeronautics Board, and the Office of Civil Aviation in the Department of Commerce.

b. He should be responsible for promoting safety and certainty in air operations through educational means and by instilling a consciousness of the importance of safe operation in all echelons of air operations.

c. He should be required to coordinate with the military services to arrive at the most effective methods of accident investigation and to exchange findings and data with them.

d. The Air Coordinating Committee should be responsible for recommending to the Congress elimination of unnecessary duplication that becomes apparent from time to time between the Director, the Civil Aeronautics Board, and the Office of Civil Aviation, with a view to eliminating overlapping of field investigations.

e. To insure cooperation of both civil and military governmental agencies, the Director should be assisted by a special subcommittee of the ACC whose members should be charged by the statute creating ACC with the responsibility for assisting the Director in his activities, providing him with all needed facilities of their separate agencies, and of implementing the recommendations of the Director as appropriate.

Accident investigation and analysis is fundamentally an operating function. Because of its importance to the development of civil aviation it should be handled by an independent agency, properly staffed. A single director in charge of investigation of accidents is preferable to a board. The deliberations of a board are not compatible with focusing responsibility in a single office organized to handle expeditiously the important work of accident investigation and prevention. This is also true of the educational features of a safety program. For these reasons the Director should not be attached to any department or agency for administrative or budgetary purposes, particularly those charged with making and administering civil air regulations.

The increase in both civil and military flying and their common use of the same airways facilities, and in many instances the same airports, makes coordination of investigation of aviation accidents for mutual benefit increasingly important. Since the ACC is charged with coordination of military and civil aviaton policy, a subcommittee of ACC should assist the Director, as he may desire, in the investigation of civil air accidents and accidents involving civil with military aircraft. This subcommittee should assist the Director in his activities, provide him with all needed facilities of their separate agencies, and implement his recommendations as appropriate.

92. The Air Coordinating Committee should be designated to study the subject of development and coordination of air search and rescue over land and sea areas and formulate recommendations for achieving the maximum effectiveness in this field.

Air search and rescue over both sea and land areas is a factor vital to the development of civil and military aviation. In general, the United States Coast Guard conducts air search and rescue over Territorial and inland waterways and their adjacent land areas. The Navy conducts air-sea search and rescue in sea areas. The Air Force, the several States, and private interests conduct air search and rescue over continental land areas. There is incomplete coordination of those various agencies of search and rescue, hence the recommendation for a study of the problem by the Air Coordinating Committee. This study should review the following aspects of the problem:

(*a*) Statistics on search and rescue incidents.

(*b*) Technical data concerning research and development and design of search and rescue equipment.

(*c*) Methods and techniques of search and rescue, including the adequacy of facilities.

(*d*) Indoctrination, training, and advancement of safety.

(*e*) The establishment of rescue and coordination centers and rescue units.

(*f*) Liaison and cooperation of all agencies concerned.

INDEX OF RECOMMENDATIONS

THE QUESTION OF SUBSIDY

Discussion of the need for a minimum procurement level has sometimes been confused with the question of a subsidy. Industry's position in regard to this matter should be clear. What kind of an industry in size and number of units is required by the Government to support the national defense? Based on the information to date it is an industry which can support modern Air Forces in being, furnish them immediate replacement equipment in event of an emergency, and expand itself to meet the increasing requirements of the strategic mobilization plan. The survival of the industry is, as has been pointed out, of the utmost importance to the industrial mobilization plan, and thus to national security. Even so, we have never urged subsidization of the industry. We have simply pointed out the requirements to maintain the minimum industry called for under the mobilization plan. We ask that if the nation decides not to maintain this minimum industry that the decision be made, not as a matter of default, but as a result of deliberate national policy.

Excerpt from presentation of
Maj. Gen. Oliver P. Echols, USA (Ret.)

FOREWORD

The papers reproduced in this booklet are those submitted by member companies of the Aircraft Industries Association to the President's Temporary Air Policy Commission during hearings held in the months of September and October.

The President's Commission was appointed on July 17, 1947, and is charged with the following mission:

> "The Air Policy Commission should study, among other pertinent aspects of the problem, such questions as the current and future needs of American aviation, including commercial air transportation and the utilization of aircraft by the armed services; the nature, type, and extent of aircraft and air transportation industries that are desirable or essential to our national security and welfare; methods of encouraging needed developments in the aviation and transportation industry; and improved organization and procedures of the government that will assist it in handling aviation matters efficiently and in the public interest."

The Commission is to make its report to Mr. Truman by January 1st.

This presentation of the aircraft industry was intended to give the Commission a detailed picture of the industry's current conditions and its views on the problems being surveyed by the Commission.

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"THE RELATIONSHIP

of the

AIRCRAFT INDUSTRY

to

NATIONAL SECURITY"

by

MAJOR GENERAL OLIVER P. ECHOLS, U.S.A. (Ret.)

President, Aircraft Industries Association of America, Inc.

★ *General Echols served in the Army Air Corps from 1916 until his retirement in 1946. During World War II he served as Commanding General of the Air Materiel Command from March, 1942, to March, 1943, when he became Assistant Chief of Air Staff, Materiel, Maintenance and Distribution.*

OLIVER P. ECHOLS

"THE RELATIONSHIP OF THE AIRCRAFT INDUSTRY TO NATIONAL SECURITY"

VITAL ROLE OF AIR POWER

The aircraft industry welcomes an opportunity to appear before the President's Air Policy Commission to present its views on a national policy for aviation. Representatives of most of the major manufacturers, who design and produce military and commercial aircraft, will appear before you to present their viewpoint on the "current and future needs of American aviation" and the problems they face in carrying out their role.

The critical importance of air power has become well recognized. General Eisenhower put it tersely in a recent speech when he declared,

> "The War Department believes that the Air Force occupies a dominant position in war. We believe the air force represents the only immediate weapon available for retaliatory action if we are attacked. We must at all times have an air force—and a decent air force—in being."

This extremely vital role of air power naturally adds to the gravity of the problems being considered by this Commission in fulfilling its responsibility for the establishment of a national policy for the maintenance of air power. The three essential elements of air power are stressed in the President's letter establishing this commission. They are an air force in being; air transportation; and a nucleus of an industry to support the air force in being. An air force in being is of little value unless it is supported by an industry which can supply it with modern equipment in adequate quantities at the time required.

I. ROLE OF THE INDUSTRY IN PEACETIME

It is essential to any discussion of a national policy for aviation that the peacetime role of the aircraft manufacturing industry be thoroughly understood. The industry has three distinct assignments.
They are:

1. Develop Advanced Models

The industry is charged with responsibility for developing the advanced models of aircraft which must be supplied to the air force in being, if that air force is to be kept instantaneously capable of repelling aggression. It should be obvious to all that this responsibility daily becomes more challenging, and more difficult to fulfill.

We are only on the threshold of a revolution in almost all phases of aeronautical science. It is the responsibility of the peacetime aircraft industry to apply the results of research, and to generate progressive development of aircraft that can meet military needs, and be produced in combat quantities.

2. Supply the Needed Replacements

The second assignment is to supply aircraft that the air force and naval aviation require as replacements. These replacement requirements of the services will increase steadily. Planes crash and wear out during training and other operations, of course, and scientific progress makes for rapid obsolescence.

Currently, our air forces in being are largely equipped with surplus planes, and may be said to be "living off their fat." Replacement purchases of both services are far below the rate necessary to keep the groups operational with modern equipment.

This means, of course, that eventually the air force in being will have to be reduced sharply in size, or else that equipment purchases will suddenly have to be increased by a very large amount. What this policy of under-replacement will mean can be demonstrated best by actual figures.

If the air forces in being of the two air arms comprise 14,000 operating planes, but only 1,000 to 1,500 replacements are delivered each year, then after 5 years, the air forces in being would have less than 5,000 *modern* operable planes—allowing for a minimum attrition rate.

This steady deterioration of the air force in being caused by a policy of under-buying would be difficult if not impossible to remedy quickly. The cost in any one year of purchasing the equipment required to modernize the air force equipped with deteriorated equipment would be prohibitive under peacetime budgets. Furthermore, an industry starved on a diet of only 1,000 to 1,500 planes a year would be totally unable to produce the 6,000 to 10,000 deliveries of new modern equipment necessary to bring the force up to operational level within any period of time that strategic considerations are likely to allow.

Only a regular program of regular adequate annual replacements can be followed with safety in view of fiscal considerations and the time element. The deterioration in both the air force in being and in the industry resulting from current low levels of annual procurement is thus extremely dangerous and most uneconomical.

3. Maintain Ability to Produce Quantities Required in Emergency

The third task of the industry is to be constantly ready to expand and supply the huge quantities of new aircraft required by the Air Forces and Naval Aviation in an emergency. A major limiting factor retarding the rate of mobilization of our Armed Forces in the last two World Wars has been the supply of equipment. In view of the critical and primary role now assigned air power in our security, the ability of the aircraft industry to expand and supply the equipment called for under our strategic mobilization plan is unquestionably a major national problem.

I cannot emphasize too strongly the element of time. In research, in development, in tooling, in material supply and in final production, time is crucial.

World history and especially history of the last two decades proves that a progressive, competitive, privately-owned and financially sound industry is required to fulfill the three assignments required by national security. France resorted to nationalization and government-ownership of her aircraft industry in the years just before World War II. The outcome was disastrous to the performance of all three functions. Design and development of new types foundered to a halt, production of replacements required by the French Air Forces dropped away to a trickle, and the base for expansion, which was to be so sorely needed in 1939, vanished entirely.

Nazi Germany, according to the testimony of Armaments Minister Speer, and the testimony is confirmed by the records, found that the way to spur production of all armaments and particularly aircraft was to encourage and foster competitive enterprise. When such encouragement was given, after British and American air power began to be felt in 1942, German plane production increased, reaching a peak in 1943 and 1944 despite our bombings.

Finally it is significant that Great Britain, embarked on a socialist course of nationalization, has not considered nationalization or concentration of her aircraft manufacturing industry. Instead the policy is to encourage development and production in each of the numerous units of the British industry.

II. MEETING MOBILIZATION REQUIREMENTS

Of the three peacetime security assignments of the industry, that of fulfilling strategic mobilization requirements is the most vital. However superior and efficient a newly-designed model aircraft may be, it obviously cannot alone assure national security. Only the quantities of such planes called for by strategic plans, plus ability to produce the necessary replacements needed in an emergency, can safeguard us. That is why we feel urgent consideration should be given to the various factors that affect and determine our ability to meet strategic mobilization requirements.

(a) Long Development Cycle

We should pay particular attention to the long period and immense amount of engineering required to develop an airplane to the full operational combat stage. It is not unusual for the full developmental cycle, just from design to first quantity production, to require at least five years, so complex is a modern operational military aircraft.

No airplane used in World War II was developed during the war. All had been started on their way from the drawing boards prior to the war, and only now are the planes developed on the basis of war experience and changed strategic conditions being brought into limited production. These planes still require testing, evaluation, and modification to reach their full advantage. Refinement and possible re-design of these planes so they would be suitable for mass production is another time-consuming and costly engineering problem.

I would say from experience of World War II that we would encounter quite a number of production difficulties if tomorrow we had to tool for quantity production of any of the new type aircraft. With but a single exception, I might point out, none of the newer type aircraft is being produced in quantities that make it feasible for us to tool fully for high production. Without such tooling, it is not possible to determine the difficulties that might be encountered and the engineering modifications that undoubtedly would be required for assembly-line manufacture.

(b) Acceleration of Production a Slow Process

National reliance on the production "miracle" achieved by American industry in both World War I and II can become a dangerous soporific unless the true nature of that "miracle" in comprehended. The victory-winning production of 96,000 planes in 1944, and the monthly peak of more than 9,000 attained that year, were possible because of the many fortuitous circumstances that favored the expansion. They may never prevail again. Even under the most favorable circumstances, a period of more than five years passed before the peak was reached.

In January, 1939, production of military aircraft totalled 143, or more than we are producing today. In August, 1939 — reflecting orders from the French and British — some 256 were produced. In January, 1940, the rate still was only 254. This doubled in July of 1940 to 574, and had increased to 839 a month by December of that year, now reflecting expansion financed by our allies. In July, 1942, three and one-half years after the rise in production got underway, the rate had reached 4,107. A year later the monthly rate was 7,371 and in March, 1944, came the peak of 9,113.

I know of no reason to expect a more rapid acceleration of production now, should an emergency arise. Two years ago, the Senate Committee Investigating the National Defense Program estimated that even then, only two months after V-J Day, it would take two years to rebuild the aircraft industry to its 1944 peak. Needless to say, the situation has deteriorated even more — I question whether deterioration is the exact word. Timely orders from the French and British cannot again be relied upon. Safety from attack while all plans for expansion are initiated is another condition of the 1940's that never again will be duplicated. Yet, we have returned today to the 1939-1940 levels of military aircraft production. That is the "base" for expansion that we now have.

(c) Current Productive Ability Below Strategic Requirements

We can be certain that no future enemy will repeat the two mistakes of Germany or attack with the limited objectives of Japan. It has been proved that the industrial potential of the United States, given time for mobilization, will be the deciding factor in any global conflict. We may be certain that the first blow of any enemy will be launched against our industrial cities. No longer will the oceans or the air space of the Polar regions be a virtually impregnable obstacle. The range and mobility of weapons have been increased to inter-hemispherical caliber.

And we may be sure that an enemy of any military common sense at all would not attack us unless that country could mount an overwhelming and continuing daily attack against our industrial cities. No intelligent enemy would repeat the single-raid mistake of Japan at Pearl Harbor.

Therefore, we must realize and must bring the American people to the realization that when that attack comes, our defeat is inevitable if our immediate ability to produce is not equal to our minimum requirements for successful defense. The sole factor of an air force "in being" equipped with large numbers of operating planes, could be our Maginot Line, lulling our people into a false sense of security and condemning us to defeat by our own complacency.

Attrition necessarily would be extremely high and would increase with every day of attack. Normal rates of attrition including obsolescence in peacetime are approximately 25% a year. In combat in Europe at one time this attrition rate was as high as 25% a month.

This means that our aircraft industry must be able to meet the strategic requirements of the air forces almost immediately upon the onset of hostilities. During World War II, our ability to meet these requirements was not attained until 4½ years after we had begun our own aircraft industry expansion, superimposed upon the British-French expansion. That our ability to produce did not meet requirements was not directly harmful to this country only because the war was fought in foreign lands, and because our allies and our own forces contained the enemy until our industrial power could be brought into action as weapons of war.

We might again mobilize as "rapidly" as in World War II. That would not be enough. A mobilization attaining no greater immediate production might be

disastrous. Our expansion must be fitted to equal the minimum strategic requirements of the Air Force and the Navy's Air Arm if we are to avoid defeat. The industry must be capable of producing on time the planes and aerial weapons called for by mobilization plans. The ability to produce 100,000 planes after 4½ years cannot compare in any future emergency with the ability to produce **10,000 to 15,000** in a limited number of months after the emergency is declared.

III. ADEQUATE INDUSTRIAL PLAN RECOMMENDED

It might be said that the apparently ideal answer to this extremely serious problem would be to maintain a producing aircraft industry of great size. It is obvious that such an industry could support an unparalleled air force equipped annually with the newest type aircraft.

However, we in the aircraft industry do not feel that this is the solution. It would require unlimited funds to keep a huge industry in a state of active readiness. The industry does not feel this is necessary. And neither do we believe that the cost could be borne by the country without severe economic dislocations. The answer, as we view it, lies in adequate industrial mobilization planning. A proper planning program not only is essential, but the intelligent approach to a very complex problem. It is recognized, of course, that there is no panacea, and we would warn that an ineffectual industrial planning program would be even more dangerous than the current lack of a program, if that be possible.

A well-organized, properly maintained planning program is the only way to fully meet the problem of maintaining preparedness at a cost which the country can stand.

This, of course, raises a question — what are the requisites of an adequate industrial mobilization plan?

As we see them, they are:

(a) **Expenditure of the peacetime dollar in such a way that it will contribute most to wartime expansibility.** The most important single element in accomplishing this would be a continuing procurement program of a minimum of 5 years' duration. This is necessary in order to effect maximum operating efficiency and to permit maximum tooling for relatively low production. It follows from this that emphasis, both in development and procurement, should be concentrated on wartime producibility of airplanes required by the Air Forces and the Navy's Air Arm in any quantity justifying design for expansibility. Such a program also would require a distribution of orders allocated, in proper relation to the other factors, to maintain the greatest expansibility factor.

The major aircraft companies in existence at the outset of World War II were operating some 16 plants. They were able to expand their organizations to a point where they were directly supervising and operating 46 plants. At the same time they were able to "explode" sufficient know-how, design and engineering to enable many non-aircraft companies to get into production speedily and economically. The question may well be asked whether fewer companies in existence in 1939 could have managed so prodigious an expansion.

An industry expansible to meet strategic requirements must consist of an appreciable number of units engaged in vigorous competition for the available market. There exists a school of thought contending that it would be better to have three or four healthy large units than it would be to spread out available business so thinly that some of the companies might be forced into bankruptcy.

We feel such a premise, based on an assumption that bugetary conditions will force the spreading of business that thinly, is false and that it completely overlooks the reasoning behind mobilization plans. We feel instead that requirements of sound industrial planning should be explained fully, and that the consequences should be brought out forcefully. Enough production should be provided to maintain the number of companies required under the mobilization plan. This plan and this plan alone should determine the number of plants required for an expansible industry.

The concentration of business in a few big companies would also jeopardize aeronautical progress. Vigorous competition between a number of companies is the surest way of assuring introduction of new and more efficient aeronautical equipment. Such concentration in a few plants, from a purely military viewpoint, is obviously courting disaster.

(b) **An adequate industrial plan would enable the government and the industry to meet many wartime problems in advance.** The industry and the government would be able to determine material requirements, plant facilities, necessary tooling and material lead times, required stock piling and easy access to sources of basic supply. It would enable suppliers, such as the aluminum industry, to preplan conversion, and would determine the degree of labor training and sources of manpower needed in the succeeding stages of mobilization.

(c) **Adequate industrial mobilization would require an annual procurement level to maintain an active industry of a size and character that would enable it to meet minimum mobilization requirements.** This level would be determined by matching expansibility against current production and emergency requirements. The annual military procurement program should be of such proportions that it will fill the gap between commercial production and the required production level.

IV. DETERMINATION OF PROCUREMENT LEVEL

The determination of the required procurement levels under the mobilization plan proceeds in this approximate order:

The Armed Services' strategic mobilization plans reveal exactly how many aircraft will be needed in an emergency.

We know from experience the length of time required to expand production to that level.

Therefore, when we make our assumption of the amount of time we will have as a warning of any future emergency, we know the peacetime production level that must be maintained to preserve the required expansibility.

As a final step the plan requires the deduction from this minimum peacetime level of the probable commercial production volume, and that remainder is the minimum annual military production required.

Studies that will be presented to you will deal with the probable commercial volume and the measures that should be taken to achieve that volume. I wish to emphasize the importance of maintaining adequate annual procurement of military aircraft to fill the gap between commercial production and the minimum level of peacetime output required under the mobilization plans.

This adequate procurement program, if an integral part of a long-range five year plan subject to annual review, without question would result in

(a) reduced aircraft costs
(b) a more efficient and stable aircraft industry; and
(c) a sounder base for industry preparedness planning.

Discussion of the need for a minimum procurement level has sometimes been confused with the question of a subsidy. Industry's position in regard to this matter should be clear. What kind of an industry in size and number of units is required by the Government to support the national defense? Based on the information to date it is an industry which can support modern Air Forces in being, furnish them immediate replacement equipment in event of an emergency, and expand itself to meet the increasing requirements of the strategic mobilization plan. The survival of the industry is, as has been pointed out, of the utmost importance to the industrial mobilization plan, and thus to national security. Even so, we have never urged subsidization of the industry. We have simply pointed out the requirements to maintain the minimum industry called for under the mobilization plan. We ask that if the nation decides not to maintain this minimum industry that the decision be made, not as a matter of default, but as a result of deliberate national policy.

V. INDUSTRY TODAY FAR BELOW REQUIREMENTS

The industry, as it exists today, does not meet the requirements I have outlined to you.

As I have pointed out, almost two years ago the country was warned that it would take two years to rebuild the industry to its wartime level. The situation since that time has been one of deterioration. Expansibility simply does not exist insofar as meeting the realities of the situation are involved.

Production for 1946 and 1947 is less than one-half of the recommended minimum contained in the exhaustive study of mobilization requirements issued by the Air Coordinating Committee in October, 1945. This Air Coordinating Committee absolute minimum of 3,000 military airplanes assumed world peace was well assured and pre-supposed a twelve months' warning of impending war.

The toll on the industry's financial and manpower resources exacted by the present low level of production is severe. Employment is now less than 170,000 (airframe, engine and propeller plants) compared with the wartime 1,350,000. Financially the industry operated at a loss in 1946 and the major companies are still reporting serious operating losses this year, despite the still favorable access to tax carrybacks. Losses without advantage of carryback would have meant liquidation of some companies.

Eight out of fourteen reported losses in 1946 even despite tax carrybacks aggregating \$69,907,000. So far in 1947 only 8 companies have issued interim reports and of these 8, two were able to report profits after taking advantage of large carrybacks. The others experienced losses even after the carryback.

These losses, if continued, jeopardize survival of the industry and thus threaten to erode the base for expansion of aircraft production. The record is grimly reminiscent of the 1919-25 era when losses caused the gradual liquidation of the war-born aircraft industry until by 1926 only 3 of the 18 companies active in 1918 were still in existence.

"INDUSTRY TRENDS SINCE THE END of WORLD WAR II"

by

MUNDY I. PEALE

President, Republic Aviation Corporation, Farmingdale, L. I., N. Y.

★ *Mr. Peale has been associated with Republic since 1939, and during World War II directed Republic's plant at Evansville, Indiana. After the war he became vice president in charge of sales, and was elected President of the company early this year.*

"INDUSTRY TRENDS SINCE THE END OF WORLD WAR II"

GENERAL TRENDS

I APPRECIATE this opportunity to present the following personal impressions to the President's Air Policy Commission. From time to time, in this presentation, I will employ figures which are those of my own company. Nevertheless, I believe they are typical, if not average, of most companies in the aircraft industry.

During the course of your hearings, you will have recalled for you the predictions made by such agencies as the Air Co-ordinating Committee two years ago that certain irreducible minimums of military production were needed to maintain air forces in being and industry in readiness. You may also remember that great emphasis was placed on the forecasts for commercial and private airplanes and their integral part in a balanced program. Now we all know that, just as the military needs recommended were not met, the commercial expectations also never quite came true. Many transport plane orders were cancelled, due, I believe, both to lack of sufficient profitable passenger business and inability to finance the production and purchase of the huge new types of equipment needed. The early post-war estimates of almost unlimited demand for small, private airplanes have, for one reason or another, all proven to be either in error or premature. These events have contributed in no small way to weakening the industry — financially — in loss of manpower and engineering — in the loss of subcontracts and facilities — to the point where not only is the possibility of quick mobilization questionable but the very existence of such a vital industry is seriously threatened. Not only have large financial losses been experienced, but in many cases, badly needed working capital has dwindled to an almost marginal figure. It is true that new 1948 appropriations will be helpful. It is also doubtful that a single shot in the arm will cure the patient.

ABANDONMENT OF BRANCH PLANTS

Early in 1946, my company returned to the Government a branch plant we had operated during the War at Evansville, Indiana. Even though Republic had planned a diversified production program, and had hoped to utilize the Evansville facility in our peacetime plans, it was determined that it would be impossible to do so. The plant is now being operated by the International Harvester Company. At Evansville, we had built six thousand of the fifteen thousand P-47 Thunderbolt fighter planes Republic produced during the war — incidentally, the largest number of fighters built by a single company during the War. It is an excellent plant, admirably suited for aircraft manufacture and was equipped with the most modern tooling for mass plane production. The tools were returned to the Government and were either sold as surplus or scrapped.

Most other companies acted as we did; others attempted for a time to utilize some branch plants but ultimately found it impossible. Comparatively few branch plants, built specifically for airplane production are now in operation by the aircraft industry. The Air Force, I believe, still holds title to a few and maintains them in standby status.

However, much of this was anticipated by the Air Forces and industry and has no major bearing on industry's current problem except insofar as it reflects future policies concerning expansion which your Commission is scheduled to consider. Republic, in its Industrial Mobilization Study for the Air Materiel Command, has made certain recommendations concerning Standby and Licensee plants and I am told that such studies are to be made available to you as a part of these hearings.

SHRINKAGE OF SUBCONTRACTING

Subcontracting proved to be one of the most vital aids to large scale production in World War II. Today, it is entered into according to the capacity of the main production plant and/or its ability or lack of it to produce completely within its own facilities. Republic subcontracted the percentage (shown below for the P-84) in the earlier anticipation that its combined production would require a larger portion of company facilities. That figure would be reduced further if additional military business to take up the home plant slack were not forthcoming. In such an event, further deterioration among subcontractor sources of supply would occur. Republic, however, believes it imperative that a nucleus of subcontractor sources be considered just as important as a nucleus of prime manufacturing sources.

PERCENTAGE OF REPUBLIC P-47 SUBCONTRACTED DURING WAR YEARS

— all figures Farmingdale plant —

December, 1941	10%
December, 1942	20%
June, 1943	44%
December, 1943	52%
December, 1944	68%

(Peak monthly unit deliveries were made in December, 1943 — 415.
Employment in that month was 16,525 — 8,604 direct.
Employment in December, 1944 was 11,872 — 6,046 direct.)

PERCENTAGE OF REPUBLIC P-84 SUBCONTRATED TODAY

September, 1947	24.6%

(Unit production 1 per day.
Present P-84 employment 4,355 — 2,328 direct.)

Subcontracted equipment and parts include certain sections of fuselage skins, glass for windshield and canopy, sections of wings, ailerons, tip tanks, spars, ribs, some hydraulic controls, landing gear, empennage, power plant equipment, armament.

Already, the war's end has resulted in the withdrawal of many subcontractors from the aircraft field. They had previously been established in other industries and believed there was not sufficient airplane business to warrant their expanding to continue to supply the aircraft field as well. Others engaged for a while in parts and accessory business but diminishing returns, commercially and militarily, hastened their departure from the scene. While, perhaps, sufficient subcontractors remain for peacetime production, duplicate sources for many items are a thing

RETURN TO HAND PRODUCTION METHODS AND LOWER OUTPUT PER WORKER AND PER FOOT OF FLOOR SPACE

The following figures represent some of the tangible losses sustained through lower output caused by a peacetime abandonment of tooling skills and a return to hand production methods.

In December, 1943 (peak period) the following figures prevailed for the P-47 Thunderbolt:

1.21 manhours per pound
2.54 lbs. per square foot of floor space
115.7 square feet per direct worker, largest shift

85th unit — 6.60 manhours per pound.

85th unit of the present P-84 — 4.68 manhours per pound.

.25 lbs. per square foot of floor space
170.0 square feet per direct worker, largest shift.

A further comparison can be made, using certain typical points of assembly. For example:

WING ASSEMBLY (Main Jig)

1945	P-47 Thunderbolt	24 panels in 9 hours, or 2⅔ per hour 261 men, or .0098 panels per manhour
Today	P-84 Thunderjet	2 panels in 8 hours, or ¼ panel per hour 95 men, or .0026 panels per manhour

LEADING EDGE

1945	P-47 —	12 panels in 9 hours, or 1⅓ per hour 83 men, or .0160 panels per manhour
Today	P-84 —	2 panels in 8 hours, or ¼ panel per hour 49 men, or .0051 panels per manhour

TRAILING EDGE — INBOARD AND OUTBOARD

1945	P-47 —	12 panels in 9 hours, or 1⅓ panels per hour 72 men, or .0184 panels per manhour
Today	P-84 —	2 panels in 8 hours, or ¼ panel per hour 43 men, or .0058 panels per manhour

WING ASSEMBLY (Final)

1945	P-47 —	12 panels in 9 hours, or 1⅓ panels per hour 84 men, or .0158 panels per manhour
Today	P-84 —	2 panels in 8 hours, or ¼ panel per hour 86 men, or .0029 panels per manhour

of the past. This, in some cases, contributes to increased costs through lack of competition.

Under today's conditions, Republic would need to add only a third more employees, theoretically, to eliminate subcontractors for the P-84. In World War II, it would have been necessary to triple our then large force to meet such an eventuality. Moreover, it would have been extremely impractical, if not impossible, to provide the required skills capable of creating the specialized equipment, let alone the facilities. Our present subcontractors, by and large, provide excellent workmanship and are conscientious in meeting their schedules. But this Commission cannot fail to study the plans drafted by the Air Forces and the industry in considering the vital importance of assuring that subcontractor sources, in sufficient quantity, are not dried up. They supply a constant source of manpower and management, and a ready stockpile of facilities and equipment.

While it is acknowledged that, to a certain extent, P-84 wings present some additional complexities due to the fact that modern jet airplanes contain more wiring, hydraulic controls and more advanced equipment than wartime models, the difference is not considered enough to warrant reconciling the figures. The point to be observed is that any indicated efficiency over early wartime production is due largely to added experience obtained since 1941. Offsetting this are increased costs, more complex equipment and the inability to plan production on anything more than a yearly, or low schedule, basis because of lack of volume orders and the necessity to plan each year's appropriations separately.

Other production problems may result through various peacetime procurement policies. Since your agenda includes discussion of procurement legislation recommendations, I will not bring up such recommendations here. But, in the matter of both legislation and administrative regulations, care should be taken to maintain sufficient flexibility to permit the procurement agencies to administer wisely in peacetime in order that future expansibility will not suffer. This is important for the prime contractor and the subcontractor. Perhaps it would be wise if specific mobilization procurement legislation be included in any bills that will be written or recommended for peacetime operation, in order to assure that no time will be lost if mobilization becomes necessary. Again, Republic, and I presume other companies, have made certain proposals in the Industrial Mobilization plans recommended to the Air Materiel Command. These might have some value in your investigation.

DISAPPEARANCE OF ENGINEERING STAFFS

In the years 1943-1944, Republic's complete engineering staff, including administrative and clerical employes, numbered under 650. Various models of the P-47 Thunderbolt occupied the activities of the majority of these, while a smaller number was beginning to concentrate on the XF-12, a four-engine photo reconnaisance plane and a few others worked on other development projects for military use. But, in December, 1945, with the war ended, Republic's engineers were at work on no fewer than 6 major projects, plus secret development engineering. The following is a breakdown of engineering manpower since that time.

DECEMBER, 1945 — Total number 815. (Certain personnel divide their time on more than one project, thus the numbers will contain fractions. All figures represent man power, not man hours.)

P-47	XF-12	P-84	Seabee	Rainbow	C-54 Conversion
7.31	88.06	198.16	33.82	162.81	63.28

Development Eng.	
34.80	(Rest is overhead and clerical.)

DECEMBER, 1946 — Total number 1161.

P-47	XF-12	P-84	Seabee	Rainbow	Guided Missile
None	68.18	256.90	20.19	423.78	56.46

New Fighter (Secret)	Dev. Eng.	
51.36	35.60	(Rest is overhead and clerical.)

Late in February, 1947, the Rainbow, a promising entry in the commercial transport field, was dropped, reducing the total number of engineers to 616.

SEPTEMBER, 1947 — Total number 493.

P-47 (Spare Parts)	XF-12	P-84	Seabee	Guided Missile
1.57	18.16	163.87	.07	24.58

New Fighter (Secret)	Dev. Eng.	
124.03	49.15	(Rest is overhead and clerical.)

As can readily be seen from the above, Republic's engineering staff has been radically reduced during the past year, despite an increase in projects over wartime and despite the fact that these projects are a great deal more complex. This reflects general decreases in our total employment. Following V-J Day, employment dropped from 10,000 to 3,700, went up to 8,500 late in 1946 and is now at 5,080. Republic's hope to maintain a ready staff of engineers by assigning some to commercial projects was defeated when commercial business did not materialize as hoped for. Immediately after the war's end, many capable engineers, believing there was small future in aircraft, left to enter other industries, such as automotive, heating, plastics, refrigeration, to mention a few. Continued pessimism about the future of our business led others to leave the engineering field entirely. One I know now operates a coal yard and stove company; another is selling ladies' handbags, still another is engaged in advertising design and layout work. These men are good engineers — they have been trained in the industry over many years in specialized problems — and their loss to the industry at a time when so many new problems have arisen and cry for solution is a sad state of affairs. But, without security over a long term, many would hesitate to come back even if new plane contracts were available.

The complexities of developing new types of aircraft, using recently discovered methods of propulsion and the speeds now being considered, present many difficult factors in developing and producing satisfactory equipment. With the present depreciation in the quantity of engineers available, such problems may be delayed beyond a safe margin. Add to that, possible needs for quick expansion and it is easy to understand that such expansion could, if the present trend is allowed to continue, become impossible in any length of time. Engineering is one field where a nucleus is not sufficient. When current problems are facing us, it is frequently necessary to have a larger staff of engineers on a given project than might be necessary once the project is fully developed. In addition, the problem of training new engineers even if they were available, is greater since it means diluting the experienced staff to provide instructors for the trainees who cannot become efficient until they have undergone a great amount of such training on specific projects. Thus, the example quoted in Republic's figures on engineering man power for 1946 and 1947 is worthy of close study and, I believe, may be typical, throughout the industry.

SUMMARY

No attempt has been made here to forecast peacetime aircraft production based on tactical or strategic needs of the air forces. That, it is believed, is a Government responsibility. My purpose, rather, is to emphasize the need for peacetime orders which are sufficient to provide a potential expansibility, in order that industry will be ready to step up production rapidly and efficiently in the event we are called upon to do so.

At the rate we are going now, such expansibility would take much longer than the air forces consider safe for the defense of the country. Present production orders are not sufficient, for the industry generally, to permit proper pilot tooling for quick expansion. They are too small to guarantee the retention of a subcontractor force of sufficient size to be able to swing quickly into action. Engineering staffs are now too thin to provide for the complexities of today's design, development or production engineering requirements. Supervisory personnel cannot be maintained at proper levels if production rates do not warrant their retention in large enough numbers for expansibility, both for prime plants and for standby or licensee plants. New developments in aircraft are affected in that they move more slowly onto the production lines. And, lastly, there is evidence that not more than a few companies can be supported over the next few years for military manufacture if appropriations continue in the present pattern. This could result in artificially freezing developments and reducing sources of aircraft supply to a point comparable to that reached by the German Air Force during the war. It is widely recognized that lack of flexibility in production, despite excellent design ability, contributed much to the loss of their initiative in the air war. In other words of Aesop "He is wise who is warned by the mistakes of others."

The actions of the President of the United States and the Congress in establishing such study groups as yours represent the best hope this country has for a sound, efficient and economic permanent aviation policy.

"INDUSTRIAL PLANNING for PRODUCTION EXPANSION"

by

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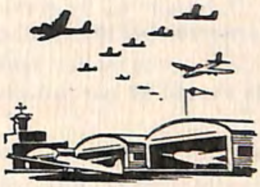

★ *Mr. Ward has been President of Fairchild since 1940. Prior to that he had been Vice President of United Aircraft Corporation and General Manager of its Pratt & Whitney Aircraft Division. He was in charge of the advisory mission to French government on airplane engine production in 1940 and member of the War Production Board Mission to Great Britain in 1942.*

"INDUSTRIAL PLANNING FOR PRODUCTION EXPANSION"

SUMMARY

1. Relationship between National Air Policy and National Defense.
2. Some essential elements of an Air Power Policy.
3. The stream of development must be maintained.
4. Translation of military needs from tactical and strategic studies to specific items.
5. Recognition of rapid aircraft obsolescence.
6. Air Transport — the handmaiden of the Armed Services.
7. National Air Policy cannot be independent of National Defense.
8. Atomic energy now holds a key position.
9. Reliance must not be placed upon a single weapon or a single strategy.
10. War plans need an industrial implementation.
11. Aeronautical engineering and the sciences a newly developing team.
12. The aircraft industry is a creative industry.
13. The need for a flexible government procurement policy.
14. Export of aviation products should be encouraged.
15. An alert Air Force requires an alert aircraft industry. Current procurement must be geared with a constantly current industrial preparedness plan.
16. Present aircraft procurement level is inadequate.
17. Present procurement flows to too few companies.
18. We are now only in the planning for planning stage.
19. Planning must be integrated into the top military echelons. It must not be "outranked."
20. There can be no real Air Power Policy without effective industrial planning.

POLICY MUST BE IMPLEMENTED

In approaching the question of a national air policy, it seems entirely obvious that such an air policy must in turn be integrated into an overall national defense policy, of which it is obviously a vital part. Air policy, to be effective, must be more than a mere statement. It must be implemented. The Morrow Board of 1926 performed a great national service in presenting its recommended air policy, but this in turn was largely defeated by the failure to implement.

Air policy concerns itself with the national strength and, as such, is concerned with the actualities and potentials of the Armed Services, the aircraft industry as the supply for the Armed Services, the air transport industry as an auxiliary arm of the Armed Services, and the civil aviation agencies of the Government, without which the air transport industry, private operation of airplanes, and the general development of all civilian aspects of aviation would be ineffective.

PROFESSIONAL COMPETENCY

It is obvious that the Navy, the Ground Forces, and the Air Forces of the United States cannot in an emergency spring into action if their professional competency is not maintained on a high standard in normal peacetime. Such military strength is closely tied up with the need for peacetime universal military training. It is also closely tied up with the continued stream of development that has been the outstanding characteristic of the field of aeronautics. This presupposes active research agencies, coupled with proficient teams of designers and manufacturers who can take the new scientific developments in the field of aeronautics and fashion them into the latest instruments for national defense.

It is the traditional American viewpoint that if war comes, it should be fought to the maximum extent possible with the conservation of American manhood and the use of the most efficient machines and materiel of war. This can only be done by the statement of a clearly defined national policy, implemented with a high standard of professional military men translating their needs from tactical and strategic studies into specific items of air materiel. This includes airplanes, power plants, accessories, armaments, means of communication, and all other closely allied scientific developments that will improve their techniques.

OPERATING UNITS

Thus, a national air policy means authorization for a given number of air operating units by the various military branches. This, of necessity, means fairly rapid obsolescence in order that the newer developments will always be in the hands of the Armed Services, undergoing military refinement and use and the development of efficient tactical plans and conceptions.

Even for such units to spring into full maturity in the event of a national emergency, there must be a mechanism for rapid growth that must stem from an alert conception of a war mobilization plan carefully worked out under such an agency as the Joint Army-Navy Munitions Board. It must concern itself with potential military manpower, expansion of industry, and the utilization of national resources from the mine and the strategic material stockpiles up to the finished products. Civilian agencies competent to deal with this expansion and military agencies competent to deal with military expansion should be operating on a skeleton basis at all times to safeguard our country and to stand ready in an emergency to carry out the objectives of the national air power policy, when determined.

AIR TRANSPORT INDUSTRY

Much as the Coast Guard becomes an instrument of the Navy in time of war, so should the air transport industry become the handmaiden of the Armed Services, and the procedures for effecting such a transition should not only be worked out in advance, but, again, there should be a trained nucleus that can serve as the foundation for a rapid expansion of trained personnel to carry out such a mission.

At this point, it becomes clear that a national air policy cannot exist wholly independently of a national defense policy. In World War II, twenty percent of the war expenditure dollars went for aircraft and their use. Such a large segment of the economy cannot be planned for alone, but must dovetail into the national defense needs of all other segments of the national economy.

ATOMIC ENERGY

The new development of atomic energy cannot be left out of this approach. It is not enough to have atomic bombs, but it is equally important that we have the means of delivering them where they are most needed with least chances of their ineffective use or waste. It is entirely conceivable that while other means of delivering atomic bombs must be developed and would be needed in a major world conflagration, should one ever occur, nevertheless, it will be by air and by air alone that the first blows would be struck.

Seldom is it that the people of a nation declare war or go to war as an aggressor. Such wars are introduced by powerful political leaders or by totalitarian demagogues who hurl their nations into war, always with the thought that it will be a brief strike and they will have gained their ends. While history records this is seldom the case, nevertheless, historical records indicate that dictators wage wars only after they feel that all of the high cards are on their side and that the game will be a short one.

In the past, these leaders have been safe, far behind the lines, with no personal insecurity. The atom bomb can change all this, and if America had the means of delivering a limited number of atom bombs with precision wherever the seedbeds of such war efforts are germinated, it is highly doubtful that the dictators would flash the order to their armies.

BRIGHTEST HOPE

Thus, the Air Forces and the atomic bomb are, in this phase of our national relations, the brightest hope for keeping the peace. However, it would be unsafe for our country to formulate a national air policy on such an eventuality, since the history of practically all major wars has indicated that there should be no reliance upon any single weapon, any single strategy, or any single tactics. The Hitlerian assumptions now revealed in the official records for war study are a testimony to the fallacy of such an approach.

And so, while a national air policy set up with the approval of the Congress, the Administration, and popular support is the only framework for true national defense, nevertheless, it is through the planning of the various Armed Services that such a policy depends for its effectiveness. In the past, the military mind has been devoted to the art of such war planning, but has heretofore failed to evaluate on equal terms the problem of the harnessing of the peacetime economy, necessary to make any given set of war plans effective. This is a monstrous and equally difficult task. Thus, war plans are generated on high military levels that have never been implemented on industrial levels which take into account the problems of industrial expansion, the training and all the other aspects of industrial manpower, the harnessing of technical resources, the gathering together of vital materials, the transportation needs, the housing needs, and the sheer economics which form the background for any modern war effort.

UNREAL PLANNING

Such military planning is unreal when it is carried on in the absence of and without competently trained industrial leaders who in turn must operate in peacetime just as the military planning activities must operate in peacetime, if the national air policy is to be up-to-date and take into account the disturbed factors of world relations. There has been a dawning realization of this fact, but not as yet has there been an effective solution of the problem.

Specifically, the aircraft manufacturing industry is as much a servant of the Government as was the old system of arsenals, which were supposed to dominate in the field of ordnance and ordnance supplies. The aircraft industry is the modern instrument of the American system of enterprise on which ultimately the national air policy will have to be based. There is no intention to over-emphasize the importance of the manufacturing industry as related to the other elements of overall aviation, but it is the only one that supplies the tools that all other fields of aircraft actively use for carrying on their tasks, whether it be civil air transport, civil aviation, or military aviation.

CANNOT EXPECT SUBSIDY

Unlike the arsenals, the aircraft industry cannot expect to be subsidized, but must depend upon the demonstrated efficiency of its operations for support. It must prove that it can take the latest fruits of research, apply them to aircraft needs, and produce usable materiel, superior to that which has existed. To do so, it must have some element of stability, not by individual companies, since they must struggle for their individual place, but by the industry as a whole. It must not be subject to year-by-year whims and political currents that require large corps of engineers and technicians under one budget allocation, and a fraction of them under another.

It has been shown many times that airplanes, engines, and accessories are all fruits of years of development and cannot be brought quickly into being in the absence of trained staffs who are acquainted with the highly specialized and highly technical problems upon which this industry is founded.

Aeronautical engineering, as an art, and the underlying physical sciences are becoming a closer matched team than ever before, in the light of the rapid pace set by scientific research. These teams are personalities and are formed of men of unusual training, experience, and, at times, genius, and they cannot be summoned into being overnight, no matter how great the national emergency. In turn, they must be supplemented by practical men who know how to turn their specifications and drawings into workmanlike articles that can be manufactured in quantities, should the sudden need arise. All must be under the guidance of men who have learned the hard way of the complex management and financial problems for an industry which must live by its constant inventions, designed to meet the highly specialized and extraordinary uses to which military equipment is put.

CREATIVE INDUSTRY

In a word, the aircraft industry is a creative industry and not a production industry, and its major demand is the one placed upon it by national policy through the branches of the United States Government. Military demand continues to dominate the industry, and civil transport and other civil demands are a highly important but minor market. There should be no thought that civil demand can maintain an aircraft manufacturing industry that would support the Government in a national military emergency.

Because of the years of development that are required in the perfecting of a single aircraft development to the point where it is usable by the military services and capable of quantity production, the aircraft industry requires, in order to be effective, a procurement policy by the Government that is designed to meet these fundamental needs. This, it has lacked. The procuring agencies of the Government should be given the responsibility for the selection of the design and production team to solve each of its various problems and not be hampered in its procurement procedures. This authority carries with it the responsibility that the procurement services must be able to point to a demonstrated record of design and production ability on the part of such manufacturer in order to warrant the flexibility given them in their procurement.

EXPORT NEED

The Government should also set up procedures that will encourage the export of American aviation products wherever it is not clearly against the national interest. Export demands for American military and civil equipment have, in the past, been the means of preserving the industry by supplementing peacetime Government procurement. The financial strength that returns through these sources encourages more original effort in scientific developments for our own Armed Services and civil use. These financial abilities are not present in a financially weakened industry.

Therefore, to implement the above and make National Air Power effective there must be realistic industrial preparedness planning. The military forces will work out the character and number of each item of aircraft procurement from military plans, and then must be able to contract with the industry to prepare the necessary industrial plans. In addition, current procurement must at all times be geared together with industrial planning for current procurement. These plans will include, first, who will produce each article and then by the selected manufacturer; how it will be produced; what resources will be required; and finally, by the Army-Navy

Munitions Board or some similar Government agency, how those resources will be made available.

FACTS OF WORLD WAR II

To those individuals who cite the industrial miracle of World War II and believe in the theory that we will muddle through a national emergency, the following facts should be pointed out:

In the last war records show that it took 4½ years from the start of the President's Aircraft Program in 1940 to peak production in 1944. During this period the military forces had to work with inferior equipment and insufficient equipment, which increased the loss of American manpower and increased the duration of the war materially. Secondly, it should be pointed out that no airplane extensively used in World War II, even including the B-29 that came into use only at the end of the war, was a fruit of wartime original design. The design conception of what later turned out to be the B-29 was, as a matter of record, started in 1938. In peacetime, it went through a series of design modifications and, in spite of maximum development acceleration during the war, it was not ready for active use in combat until 1945.

The next world war, if it occurs, will find the United States as a prime target of the aggressor. It is unlikely that there will be a Britain and a France as in World War I, or a Britain as in World War II to give to us the time for our preparation. It is highly probable we will be attacked through the air by aircraft, without warning. This indicates the tremendous importance of an active, alert American intelligence system that will give a maximum of warning to our Government and to our country when war clouds are gathering.

However, historically a democracy never declares war first, nor does it actively arm until it is certain of attack. This is the reason for the urgent necessity for an alert air force and industry, capable of rapid expansion. It is not always appreciated that this would require in the order of a 12-fold expansion overnight, just to maintain an air force in being at military M-Day strength. Experience shows that under war conditions, there is needed 25% a month wartime replacement for certain aircraft materiel.

CAREER APPOINTMENTS

The close relationship between military preparedness and industrial planning has already been pointed out. They cannot be separated, and there must be career appointments in the field of military industrial planning available to qualified officers, equivalent to those available for combat officers.

That the present level of aircraft procurement is inadequate is brought out in the Air Coordinating Committee Report of 1945 and its conclusions have been greatly publicized in the American press.

There must at all times be a sufficient base of trained workers in the aircraft production arts; of trained management in the field of aircraft administration and financing; of scientists, engineers and technicians who can develop and originate aircraft; and of suppliers of all the specialized material and equipment entering into aircraft. These have been threatened, since the termination of the war, by the low level of procurement in the past two years, a level that is only half the minimum recommended in the Air Coordinating Committee Report of 1945. Also at the time the report was written, it was not presumed that international conditions would remain as disturbed as they are today.

CURRENT PROCUREMENT

A serious factor in current production procurement is that ¾ of all of the Army Air Force funds for aircraft procurement have largely flowed into three companies, while the balance of the industry has struggled to maintain its essential organization without too serious financial losses. This has been caused by a combination of the need for heavy bombers and of insufficient funds coupled with a lack of understanding of the consequences to National Air Power.

While it is gratifying to find that there is much discussion of the need for adequate industrial planning, nevertheless, the Army-Navy Munitions Board, the joint Services, and the aircraft companies are a long way from the practical realization of this objective. It must start with the Army-Navy Munitions Board, which, as yet, is in the stage of largely planning for the planning. This is in part due to the lack of concrete military plans. Further, there has been insufficient progress in integrating the military and industrial manpower planning. Many in the aircraft industry feel that the War Department's recent "Affiliation Plan" illustrates a lack of industrial contacts and experience, although sound in its ideals.

The air services of the Army and the Bureau of Aeronautics are to be commended for their interest in industrial planning. However, it is not yet fully integrated into top military planning by the Navy Department and the War Department. In addition this will now be a task for the U. S. Air Force as the third branch of the National Armed Services.

COMBAT PLANNERS

Military combat planners should more clearly vision the fact that trained men and the planning for the use of advanced weapons can only be implemented if the weapons can be furnished in time in the quantities needed.

In a few words, industrial planning cannot be outranked in importance by any other peacetime task if air power is to be implemented. Comprehensive intelligence and strongly supported industrial planning can contribute more to rapid expansibility in an emergency than any other factor outside of actual high-level peacetime production. Such high-level peacetime production is impractical. The only substitute is an adequate minimum production level which will serve as a suitable base for wartime expansion.

It is recognized as a fundamental that as world conditions change, military and, hence, industrial plans will change. Thus, there must be continuing peacetime activities. To be ready for an emergency, each major manufacturer should at all times know what his job is going to be and should have plans in existence on how he will do it. In turn, the services should know when they can count on getting the materiel, as a basis for their own planning. Government sponsoring agencies and suitable working procedures should be in peacetime existence that will provide the necessary impetus and controls for such procurement.

All of the above implies recognition of the essentiality of such effective peacetime industrial planning on the part of our national leaders. Without it there can be no real Air Power Policy.

"THE OUTLOOK for CARGO PLANES"

by

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"THE OUTLOOK FOR CARGO PLANES"

SUMMARY

1. Expansion of an air transportation industry adequate to the needs of our commercial and postal service is today dependent on the economic development of air cargo. The country's commerce demands facilities, by 1950, for two billion ton-miles of air cargo movement, and five billion ton-miles per year by 1952. This service to industry can only be provided through the economical operation of efficient cargo airplanes developed for this specific purpose.

2. Approximately 750 operating cargo planes will be needed by 1952. Two-thirds of these should be of transcontinental and over-ocean type (110,000-120,000 pounds gross), and one-third of inter-city type (65,000-70,000 pounds gross.)

3. Such cargo planes should be designed for a dual purpose: (a) to provide the most efficient service for transportation of commercial cargo, and (b) to be immediately adequate without conversion, to the needs of military transportation.

4. Cargo planes should therefore be designed to joint specifications of military and commercial operators. These specifications should be coordinated by a government agency representing all interests.

5. Transportation by air is an integral and vital part of adequate armed defense and offense. Our jet-speed striking power can not be maintained by a main force moved at the last war's speed.

6. The cargo plane must be included in any plan for improving and sustaining American air power, both military and commercial.

7. Government financial support is essential because of the high development costs. The Government should take the initiative in the program, in order to provide for the vital needs of its defense and for the operation of an adequate air transportation industry.

8. In the economic interests of the industry, the civil authorities should provide specific regulations for air cargo operations, including a separate category for cargo airplanes.

L. B. RICHARDSON

I. DEVELOPMENT OF AIR CARGO BUSINESS

THE DEVELOPMENT of air cargo business started in the winter of 1919, and during the latter part of the 1920's the development of air express was stimulated by the transfer of the air mail service to private carriers. Rates in effect under early agreements were extremely high. For example, under the first tariff the rate per ton-mile averaged $2.72. Little effort was made to establish a pure air express operation until 1931, at which time some of the major airlines began to take an active interest in air express and a rate of approximately 24 cents per ton-mile, or about twice that for rail express was inaugurated. In the latter part of 1932 a group of airlines formed an organization known as General Air Express. This organization was formed to enable these companies to act as a unit in the solicitation and handling of air express. The competition stimulated both as to service and as to rates, forced a reduction of rates by the Railway Express Agency, and shortly thereafter the General Air Express organization was abandoned in favor of a satisfactory arrangement with the Railway Express Agency.

During the period 1937-1945 little effort was made to really develop air express traffic, because the airlines looked upon it primarily as a fill-in to their regular passenger and mail traffic.

War Cargo Record

The physical practicability of mass movement of air cargo was well established during World War II by the Air Transport Command, its contract carriers and the Naval Air Transport Service. The number of ton-miles of cargo operations were at the rate of several billions per year during the last two years of the war.

Upon termination of hostilities a new group of operators with their air-freight carrying experiences during the war as a background, obtained surplus cargo type airplanes and started air-freight operations.

The year 1946 saw the movement of a total of about 90,000,000 ton-miles of air-freight and air express, divided about evenly between independent and the certificated carriers. This represented a tremendous expansion over air cargo volume in 1945.

By spring of 1947, the laws of economics had narrowed down the number of independent carriers to only those who had strong financial backing and sound management. Their position was further recognized by the CAB's action in May of this year which granted several of these operators temporary common carrier status.

Meanwhile the scheduled passenger carriers introduced an industry-wide consolidated air-freight tariff, effective August 1, 1947, involving a 20% reduction in rates. Hardly was this tariff distributed when two major passenger carriers announced freight rates ranging down to twelve cents per ton-mile.

With the new low freight rates of the scheduled passenger carriers and the recently published tariffs of the independent freight carriers, the last few months of 1947 should be a period of tremendous expansion.

II. SOURCES OF AIR-FREIGHT

The potential of the air-freight business is practically unlimited. As the system grows and gains a background of financial and operating experience, and as new and more efficient operating equipment becomes available, it is certain that costs will decrease considerably below their present figure. As the ingenuity of man has perfected new and more efficient means of transportation, new markets have been opened, and the pattern of the world's business has radically changed. This change will be reflected in the future of world business as the airplane assumes its appointed role as a primary carrier of world commerce.

A large source of cargo for the air-freighters of the future is that of the new business — now perhaps only an idea — which will be built up around the speed and efficiency of the airplane as a carrier. Examples of these sources of cargo are the nation-wide distribution of perishables such as cut flowers, ripe fruits and vegetables, fresh meats, frozen foods, drugs, etc.

Because of the absence of frequent shocks and jolts, starting and stopping, and en route handling, the airplane is much more efficient in the moving of sensitive and delicate items. Also of importance to the shippers is the fact that, due to the airplane's relatively fragile structure, cargo must of necessity be handled carefully during loading and unloading. For these reasons another field is open to the air carriers. Scientific and medical equipment, cameras and projectors, watches and clocks, radios and electronic apparatus, glassware, and similar commodities make up a sizable portion of air-freight cargo.

One of the largest fields for the air-cargo industry will develop from the proposed movement by air of all first class mail, and parcel-post which travels more than 400 miles. It is estimated that a billion ton-miles of mail and parcel-post are transported annually over distances exceeding 400 miles.

III. AIR-CARGO POTENTIAL

When more than one type of transportation is available, the shipper uses the one that provides the greater benefits. This choice may be based on cost, speed, convenience, regularity or better advertising. Air Cargo in the past had only higher speed to offer and lack of regularity often offset this advantage.

The appended curves "Air Cargo, Historic and Future" show various predictions for the amount of air-freight that will be available in the future if certain rates are in use and the sources of these predictions are shown. These data indicated that in 1950, an annual air-cargo volume of 2 billion ton-miles will be available. This volume includes the new business that will be generated by the basic rapidity of air transportation as well as penetration of the traffic presently handled by ground transportation means. Two years later, in 1952, under their initial impetus, the annual ton-miles will have grown to 5 to 6 billion at average rates below 10 cents per ton-mile, which is directly competitive with expected ground service rates for all commodities feasible for air transportation.

IV. SIZE, TYPE AND NUMBER OF CARGO AIRPLANES

At the start of World War II, this nation was inadequately prepared in the air transport field. Existing designs of commercial passenger airplanes were altered to permit their use as military transports for cargo and personnel. Upon cessation of hostilities, a portion of these same passenger-cargo planes were put to use in the post-war air-cargo field. With this type of equipment, a marked reduction in air-freight rates below those now in effect cannot be anticipated. This can only be achieved by the development, production, and operation of airplanes designed specifically for cargo handling, considering both commercial and military aspects of the problem. Combined passenger and cargo airplanes cannot best serve either function because of the differences in scheduling, loading and range requirements.

LIMITATIONS ON SIZE

Engines

Extensive analyses have shown that the most rapid decrease of direct operating costs per cargo unit results from increase in airplane weight carrying capacity. However, there are many practical limitations on expansion of airplane size. Aircraft engine powers have developed at a remarkable rate over the past years and will probably continue to increase in the future, yet these increases in unit engine power have not precluded the necessity of installing greater numbers of engines in new airplanes to meet the overall demands of power. Increasing the number of engines in an airplane, however, unavoidably increases the complexity of operation and maintenance requiring the employment of an increased number of both flight and ground personnel. Probably any greater number than 8 engines per airplane would increase this complication to a definite uneconomical degree.

Airports

Another limit on airplane size at present arises from airport size, runway strength and hangar facilities. Obviously, the extent of this limitation is influenced by consideration of presently available and planned construction, but unless development and expansion of these facilities greatly increases in rate in the future, airplane size will continue to be limited by runway lengths, hangaring space and other airport installations.

Loading Time

Airplane size, as represented by its payload capacity, reaches a practical limit when the loading time begins to reduce the operational utilization of the airplane and the service supplied to the shipper. Future air cargos will probably not change substantially in character from the present accumulation of individual shipments weighing on the average not more than several hundred pounds. As a matter of fact, predictions of air-freight for the coming years indicate that the average weight of a single shipment will decrease as the development includes a wider base of commodities. In the predictable future bulk shipments by air appear unlikely, according to all available estimates. Hence the cargo loading problem is receiving increasing attention during the design stages of new airplanes, in order to achieve the ultimate objective of high-speed, economical air-freight transportation.

Multiple loading doors, truck bed height floors, full end loading, rectangular cargo compartments and specialized cargo handling equipment are results of this design emphasis. However, even with these features as well as with palletized loading, fuselage compartmentation and other forms of semi-automatic loading, the total loading time will increase beyond the economical limit as payload is further extended. This imposes limit on the size of the cargo compartment and therefore on the airplane size. It appears reasonable to assume that each design should allow the full cargo compartment to be loaded in no more than one hour for a typical cargo. Greater time allowance than this in the design stages would rapidly reduce the basic speed advantage of air transportation of freight.

Types of Cargo

An additional size factor in cargo airplane design is concerned with handling certain heavy and large size shipments, principally large vehicles and other heavy machinery. Although normal air commerce may not involve these items to an appreciable extent, the size, dimensions and arrangement of new cargo airplanes should provide for the transportation of this equipment under emergency or other special conditions. Thus it is basically essential that a high degree of convertability be designed into all commercial cargo airplanes to achieve full realization of the national advantages of a large scale, vigorous air-cargo fleet. Emphasis on convertability or adaptability to military use may result in some compromises to commercial requirements and may rule out certain very specialized military uses. However, a good commercial cargo airplane can perform all but a very few kinds of military missions.

Range

In addition to payload capacity, the required range of an airplane is a fundamental factor in determining its overall size and weight. Necessary fuel loads for optimum economic operation generally exceed 50% of the payload itself in weight, and may actually equal the payload under many operating conditions. It is believed that two range categories will be necessary to satisfy the full traffic demand. The medium range airplane will be operated on an inter-city and off-line basis, carrying generally first class mail and a type of cargo now termed "air-express," with a design range near 1000 miles. The long range machine will engage in area transportation of goods, with a greater percentage of full plane-load lots, and will be designed for non-stop transcontinental and over-ocean operation. This airplane should be designed for a range of at least 2500 miles for over-water operation (at a certain reduction in payload), and must be capable of making at least 1500-mile trips non-stop with maximum payload, for domestic operation.

Speed

The transcontinental type of airplane should be capable of attaining a speed to permit over-night deliveries between any two points in the United States either non-stop or with one stop, depending on the total distance to be traversed. For this requirement, the most critical case is the West-to-East transcontinental trip where the change in time zones has an adverse effect upon scheduling. This will require average speeds of 250 to 300 mph. Any further increase beyond such speeds is not considered necessary for the present, since they will permit round-trip transcontinental trips within a 24-hour period. Economy of operation at these speeds can be obtained by designing for aerodynamic cleanness and efficiency, still maintaining good functional characteristics and minimum time on the ground. Normal cruising should be at moderately high altitudes, say 20,000 feet, using internal combustion engines.

The second type of air-cargo airplane will be used in inter-city operation and be designed for shorter ranges and less payload. Because of the localized nature of such operations, the economic necessity for high average speeds is no longer as great. However, since this smaller airplane will undoubtedly have fewer engines than the larger airplane, present Civil Air Regulations will dictate a design with speeds in excess of that required from operational considerations alone, i.e., where 200 to 250 mph. would be adequate, average speeds of 250 to 300 mph. would probable be attained. This characteristic will augment the value of the airplane as a short-range military transport.

Airport Facilities

Due to the shorter ranges encountered, cruising altitudes of 10,000 to 15,000 ft. would produce about the best compromise between schedule reliability and the added cost of mechanical complexity required for higher altitude flight. Because of the necessity of frequent stops, the airport facilities available will be average to below-average and will require design consideration of take-off and landing runway lengths of 3500 to 4500 feet.

Up to the present point the discussion has been predicated upon the use of internal combustion engines only. While it is believed premature to introduce turbo jet power plants into this text, a few comments relative to the gas turbine-propeller combination are believed in order. Continued development should make the "turbo-prop" units attractive from an economic point of view in the not too distant future, because of the reduced unit fuel cost and an approach to equivalent fuel economy of internal combustion engines. However, higher cruising altitudes will probably be required, with some added complexities in the airplane designs.

Sizes

Based upon the above discussion, and extending present experience in line with available predictions, it appears that cargo airplanes of the next five to ten years will have the following characteristics of payload, gross weight, and power:

Transcontinental and Over-Ocean Operation

Payload Capacity	16 to 18 tons
Gross Weight	110,000 to 120,000 lbs.
Total takeoff power	10,000 to 12,000 BHP

Inter-City Operation

Payload Capacity	8 to 10 tons
Gross Weight	65,000 to 70,000 lbs.
Total takeoff power	5,000 to 6,000 BHP

Cargo Space, Etc.

These airplanes will have cargo compartments specifically designed for the most efficient cargo handling possible. The interior volume must be no smaller than that corresponding to a cargo density of 6 pounds per cubic foot, which will allow plane-load transportation of all large volume categories of air-freight. The cargo floor must be level and at truck bed and loading dock height, which feature will result in an estimated $2.50 per ton savings in cargo handling costs. Multiple, large size doors must be provided for rapid trans-loading as well as for efficient terminal cargo handling. The compartment should be essentially rectangular to allow stowage and tie-down with a minimum of unusable space. Finally the cargo space must be provided with efficient heating and refrigeration equipment, with provision for segregation of cargo types so that simultaneous heating and/or cooling are available for specific areas.

None of the airplanes presently available for air-cargo transportation meet the above requirements completely enough to achieve the basic objective of air-freight transportation at the low rates necessary to develop the great potential traffic volume available. A development program concentrated around the above design objectives and requirements, if firmly implemented, will provide equipment capable of delivering mass air-freight transportation on a profitable basis in peace, and adaptable as an invaluable part of our military strength in war.

Number

The potential cargo volume which will be available to the new-design all-cargo airplanes will justify at least 200 aircraft in the long range category by 1950 and will necessitate 2½ times that many, or 500 airplanes by 1952. This cargo fleet will be augmented by a fleet of inter-city airplanes of approximately half these numbers. This total fleet of 750 all-cargo airplanes, designed for the most economical operation possible, will form the basis for the expansion of this new industry, supplyine one of the most fundamental services required by a developing industrial economy. If the cargo planes are so designed that they will be fully adaptable to military cargo carrying, this fleet will form the necessary reserve for the rapid transportation demanded by military requirements, as well as providing a huge pool of trained technicians to operate the equipment. On this basis, the air cargo industry is seen to assume its appropriate and major position in the national economic and strategic pattern.

V. INTERRELATION OF MILITARY AND COMMERCIAL REQUIREMENTS

That there is a close interrelation between Army, Navy and commercial cargo airplane requirements is obvious from the experience of the late war, for which there were no true cargo planes in existence. Consequently, practically all airborne cargo was carried in adapted passenger-type aircraft which were comparable to a situation of carrying rail freight in Pullman cars.

Commercial freight carrying airplanes, as previously stated, must operate at a sufficiently high degree of overall efficiency to support themselves financially in a competitive field. Thus they must be of high aerodynamic cleanness and demonstrate their efficiency by a low realized ton-mile cost. These factors are likewise essential to a military cargo operation, although not commonly expressed in the same units of cost.

The advantage from the military standpoint of having certain basic types of cargo airplanes commonly used by all operating services is obvious. It will provide a reserve of equipment to utilize in emergency, and the maintenance of an active production line permitting ready expansion as needed is of inestimable value.

It must be realized that the time required to develop and put a cargo airplane into production differs little from that of a bomber of like size. Consequently if cargo development programs are deferred until after the active fighting types are produced, we will have an unbalanced air force because of obsolescent cargo aircraft.

VI. NEED FOR SEPARATE CARGO CATEGORY

Since air-cargo deals with the transportation of goods only, there is a definite need and justification for a separate category of airworthiness and operations requirements which are compatible with equivalent safety for this type of aircraft as contrasted with that necessary when the air transportation of passengers is involved. Experience in air freight operation has not indicated as yet the detail technical characteristics which should distinguish an air cargo category from the passenger transport category. However, the principles involved show that rules should permit operation of all-cargo airplanes at somewhat higher gross weights than passenger transports.

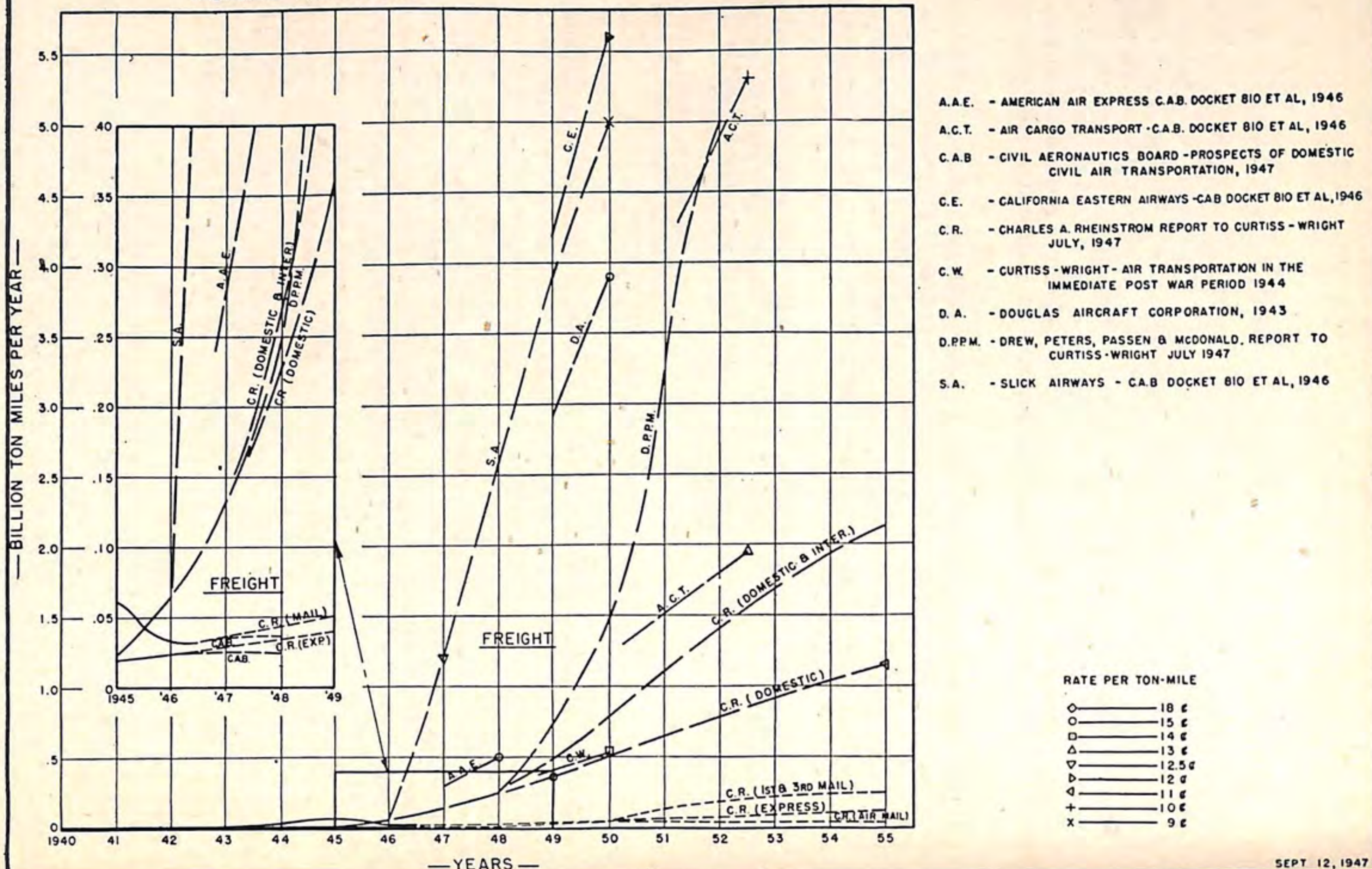
Analysis of a typical modern cargo airplane indicates that, say, a permitted increase of only 5% in gross weight by the introduction of a separate cargo category would result in an increase of approximately 15% in revenue payload per plane for practically the same total operating cost. The effect of this 15% increase in payload would be reflected in a corresponding rate reduction for the same margin of percent profit on gross revenue.

It is evident from the foregoing simple analysis that large benefits will accrue economically to air cargo operations if the establishment of a separate cargo category for airworthiness and operation would afford even the suggested nominal increase in allowable gross weights of only 5%.

VII. FINANCIAL ASPECTS

Nothing has been said here regarding the costs of the new cargo airplanes, but it is evident that they will be nearly equal to costs of passenger airplanes of equal size and performance. The savings on passenger accommodations will be largely offset by extra costs of cargo facilities. The development costs will also be comparable. Government financial support for the development of cargo airplanes is therefore needed, and justified, for exactly the same reasons and with the same urgency as for passenger airplanes. The Government should take the initiative in a program which will bring cargo plane development abreast of other types in the military and civil aircraft fields.

AIR CARGO
HISTORIC AND FUTURE



"THE FUTURE of PERSONAL AIRPLANES"

by

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DWANE L. WALLACE

"THE FUTURE OF PERSONAL AIRPLANES"

I. PLACE OF PERSONAL PLANE INDUSTRY

THE PERSONAL plane segment of the aircraft industry is one of great importance in viewing the future. There appears to be a definite limit for transport planes and the military market is tied into the amount of Government purchases but the personal plane market is the only one which has **unlimited potential** if properly developed.

II. BACKGROUND

The personal plane industry as presently constituted is relatively small when compared to the military and transport companies and other major industries of our country; however, its growth has been rather astounding. In 1933 only 467 personal aircraft were produced while in 1941 there were 6,597 units produced. In 1946, the first year of post war production there were approximately 35,000 personal aircraft sold with an additional sale of more than 30,000 surplus aircraft for civilian use. Production of aircraft in the first seven months of 1947, however, only totals 11,695. While this is a very disappointing drop in volume, it is far in excess of the best prewar year and these figures reflect the growth of the industry despite some serious handicaps which will be brought out later in this paper.

III. CONTRIBUTION TO THE WAR EFFORT

The Personal Plane Industry played a very vital role in the overall war effort of the aircraft industry.

The need for pilot training on a large scale was recognized early and the Civilian Pilot Training and the later War Training Service program furnished the primary training for thousands of our military pilots. "Off the shelf" airplanes supplied by the Personal Plane Industry made a large contribution to these programs for it was only by the use of airplanes already in production that this need could be met.

Likewise, it was with "off the shelf" twin engine airplanes supplied by the Personal Plane Industry and already in production that most of our "multi-engined" pilots, navigators and bombardiers were trained.

When the need for more and more liaison airplanes by the Army Ground Forces developed, it was met by the Personal Plane Industry with the basic airplane which they had been producing. Similarly, personnel transportation requirements were filled by the adaptation of commercial single and twin engine aircraft already in production.

As the needs of the military for pilot training and liaison airplanes were filled, the plants of the personal plane companies and their many thousands of trained workers were immediately utilized in the supplying of major component parts for military planes and meeting of special demands such as glider production. For example, Beech Aircraft supplied 1,635 of A-26 wing assemblies, several thousand gliders were supplied by Waco, Cessna and other personal plane companies.

Cessna supplied empennages and other assemblies for 1,650 B-29's, as well as the landing gears and engine cowling for 2,050 A-26 Douglas Bombers. These are but few of the parts and assemblies by which the personal plane companies supplemented the military plane producers and with their previous experience and their trained workers they were ideal subcontractors in the military aircraft program.

IV. FUTURE MILITARY VALUE

In analyzing what value the personal plane industry can have to the military in the future it is obvious that much can be learned from the experiences of World War II.

There will again be a big and immediate need for the training of pilots. It is only logical that the Personal Plane Industry should supply the volume of primary trainers which will be needed. Likewise, the need for liaison airplanes for the Army Ground Forces will be immediately accelerated to tremendous heights and the Personal Plane Industry, well acquainted with the production of small planes **in volume**, should be looked to in order to fill this need.

Development of trainers and liaison airplanes for the specific needs of the military should be placed with the Personal Plane Industry so that there will be close cooperation at all times between the military and the Personal Plane Industry in the meeting of future needs in the event of an emergency. Military plane companies should be relieved of this type of development so that they can concentrate on the research and production problems of combat aircraft. This has not been the practice in the past.

It is reasonable to expect that a much larger use of small personnel transport aircraft will be used in the future as airlines and railroads are not adequate in a fast moving war. Time is all important and good dependable air transportation will be a necessity. To meet this need the use of commercial aircraft is preferable to combat aircraft as it can be procured quicker, is less costly and less expensive to operate. The Personal Plane Industry can be of great value in meeting this requirement.

Just as in the past war, the plants of the Personal Plane Industry and their many skilled workers can be used to supplement the production of the military plane companies in the event of an emergency more easily than by the use of any other facility in the country.

V. FUTURE COMMERCIAL PROSPECTS

The large post war demand for personal type airplanes experienced in 1946 was largely stimulated by the G. I. training courses. This demand has been largely met by past production and volume has been decreasing at a very discouraging rate. While this decline is very disappointing, the interest in the G. I. Program indicates the general interest in aviation and its future potential if its many problems can be solved. Even today there are over four registered pilots for every registered airplane. But the industry at present is necessarily concentrating its effort on the business, professional and farmer markets where the present airplane offers its greatest utility.

But to expand the market potential, it is necessary to constantly improve the general utility of the personal plane. Just as the early automobiles were of high cost and low utility the constant development toward lower cost and greater utility expanded that market to its present great place in the American economy so it will be necessary to develop the personal plane. The industry, however, is not in the financial position to make such developments at a rapid rate. There has been no extensive development in the past six years in the personal plane field due to the war and the immediate post war readjustment period and there was no development in this field financed by the Government during this period. As a result, the technological advances have been somewhat limited to date. But the constant evolutionary improvement on personal plane design must be continually made to have this industry progress as desired. Too much publicity has been given the revolutionary changes that are supposedly just around the corner. As in every other business and particularly in the aviation business with its many complexities, **the improvements must be evolutionary and not revolutionary.**

There are many other factors which are hindering the general acceptance of personal aircraft more than any criticism of the planes themselves. Not until there are adequate airport facilities in every community tied into a nation-wide airport system can full utility of personal aircraft be achieved. Aids to navigation should follow concurrently with this airport development. It is in these fields that real aid can be rendered the Personal Plane Industry by Government co-operation.

While there is a great need for help in airport and navigational problems, the industry itself is being smothered with Government regulations. **The Personal Plane Industry has no parallel in any other industry with respect to Government control.** A planned program of continuous simplification of the Civil Air Regulations should be carried out which would result in benefits to the industry, the personal plane owner and would obviously effect economies to the Government through the reduction of administrative requirements.

VI. RECOMMENDATIONS

A. In order to assist in the evolutionary development of personal planes that the N.A.C.A. devote more of its time and funds to specific research in the personal plane field and provide more detailed reports of research studies geared to personal plane engineering skills. This will supply basic research data to the industry which it can use in its engineering programs.

That the industry be awarded development contracts by the "user" branches of the Government such as the military services. Such development contracts would hasten the perfection of many improvements of value to the military and other branches of the Government and would be equally beneficial to commercial operations. The industry is not receptive to development programs conducted by the C.A.A., which is primarily a regulatory agency.

As an industry we are opposed to an out and out Federal subsidy but do desire development contracts which are directly beneficial to the contracting agency of the Government and the industry.

B. From the standpoint of the Personal Plane Industry's contribution to National Security, it is felt that the military should give concrete recognition to the industry's place in overall National Security setup and be definitely included in the mobilization plans of the military in the event of an emergency. The industry should be called upon to assist in the development of the type of aircraft which it will most logically be called upon to produce and be kept closely in touch with the demands that will be placed upon it so that proper preparation can be made.

C. In the commercial future of the industry, it would appreciate a greater concentration on the part of the Government in fostering the development of airport facilities, navigational aids, etc., just as was done by the highway building, road marking, traffic control, etc., for the automobile industry. On the other hand, there should be a constant reduction in the amount of industry regulations and corresponding increase in the placing of the responsibility in these fields on the shoulders of the industry. Complex Government regulations on the manufacturer and owner of private planes can well retard the growth of the industry.

CONCLUSION

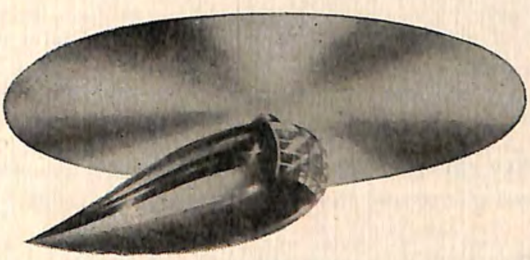
In conclusion, the expansion of the personal plane to its fullest potential can mean a great deal to the national economy. Every major surge in the growth of our national economy has coincided with the introduction of a new method of transportation and it is significant that each has been a faster method of travel. The airplane presents the next major step forward in fast transportation and if the proper kind of assistance can be rendered at this crucial time it may mean the possibility of a tremendous self-sustaining industry which will provide the livelihood of many thousands of Americans in the future and insure a large healthy industry which will be of inestimable value to security of this Nation.

"THE FUTURE of the HELICOPTER"

by

LAWRENCE D. BELL

President, Bell Aircraft Corporation, Niagara Falls, N. Y.



★ *Mr. Bell's aviation career dates back to 1912, when he was a mechanic for exhibition fliers Lincoln Beachey and Grover Bell, his brother. In World War I, he was vice president and general manager of the Glenn L. Martin Co. He held the same title with the Consolidated Aircraft Corp., from 1929 to 1935, when he organized his own company. The Bell helicopter was the first commercially certificated.*

"THE FUTURE OF THE HELICOPTER"

SUMMARY

Armed Forces, other government agencies, manufacturers and commercial operators have demonstrated remarkable utility of helicopters during postwar operation.

Today the American helicopter industry is in a position of world leadership. Necessary research, development and production programs place a terrific burden on the two companies (Bell and Sikorsky) now manufacturing commercial helicopters. If we are to hold our present leadership, government must assume a major role in cooperation with helicopter manufacturers and operators.

Recommendations: Army, Navy, Air Force and NACA should assist in research, development and production programs for military helicopters.

Army, Navy and Air Force should establish a national training program to train reserve of operating personnel in event of emergency.

The Post Office Department should expand as rapidly as possible helicopter mail service in all principal metropolitan communities, this service to be operated by private companies.

The Department of Agriculture should buy or lease helicopters and contract with manufacturers and operators for development of pest and plant disease control.

The Forest Service should procure or contract with operators for necessary helicopters for forest patrol and fire control.

National Guard unit should be equipped with helicopters.

At least two helicopters should be permanently located at each Coast Guard Station.

Helicopters should be available to the Red Cross for disaster relief.

Ambulance type helicopters should be developed by the Armed Services.

The State Department should assist in the sale of helicopters to foreign countries. Regulatory agencies should develop legislation and regulations covering design and operation of helicopters to permit manufacturers and operators to develop maximum utility consistent with safety.

YOUNG INDUSTRY

ϕ COMMERCIALLY the helicopter is a post-war product. Technically the design of a rotary wing aircraft traces back more than 400 years to Leonardo daVinci.

In 1937 the Focke-Achgelis helicopter was flown in Germany and can probably be called the first successful modern helicopter.

Today the United States is leading the world in helicopter development and production, rather a remarkable situation when it is remembered that the first successful full-scale helicopter in this country was test flown only a little more than seven years ago.

Despite the many companies presently engaged in helicopter development and experimentation in this country, only two companies are building commercial helicopters for which the Civil Aeronautics Authority has granted NC Airworthiness Certificates — Bell Aircraft Corporation and Sikorsky Division of United Aircraft Corporation.

The first NC helicopter license in the world was granted March 8, 1946 for the Bell Model 47 two-place helicopter. Since then, our company has received additional NC licenses for an improved two-place cabin ship, both for wheels and floats, a crop-dusting agricultural machine, both for wheels and floats, a specially modified cabin type for geophysical survey, as well as a permit for night flying operations.

Thus it can readily be seen that while our armed services had enough experience during the war with Sikorsky machines clearly to demonstrate the special utilities of the helicopter and its value as a transportation vehicle, commercially the American helicopter industry can be said to date from March 8, 1946.

DEVELOPMENT

Of course, behind the present day Sikorsky and Bell machines lie many years of research and development on the part of Igor Sikorsky and of Arthur M. Young, who designed our original Bell helicopter.

Prior to the first commercial and military deliveries of Bell helicopters in December 1946, approximately 1,000,000 manhours of engineering and labor, and nearly 5 million dollars of Company funds had gone into our own helicopter research and development program since its inception in 1941.

The necessary program of research, development and production, which in a true sense is founding a new industry in this country and in the world, places a terrific burden on the two companies now manufacturing commercial helicopters. In almost every case where a commercial machine is sold we have had to train pilots and mechanics for our customers; research and development of new commercial models have been entirely at our expense; development and demonstration of special apparatus for crop dusting and crop spraying, magnatometer equipment for geophysical survey and countless demonstrations in many fields of helicopter utility also have been at our own expense. In many cases this expense has been greater than the total sale price of the resulting machines.

Technical progress and simplification are inevitable. Time and money are the chief factors, and the required length of time depends almost directly on the amount of money available for continued research and development.

DEVELOPMENT COSTS

Larger machines are likewise inevitable, but development costs of larger helicopters like large fixed wing airplanes are prohibitive if borne by private companies.

Bell helicopters are now being operated by the Air Force, Army Ground Forces, Navy, Coast Guard and by private commercial operators in England, Canada, Sweden, Argentina and in this country in the states of Arizona, California, Connecticut, Illinois, Louisiana, Maine, Massachusetts, Minnesota, Missouri, New Jersey, New York, Ohio, Oregon, Rhode Island, Texas, Vermont and Washington.

The experience gained by these users in flying Bell helicopters more than 8,000 hours during the first nine months of this year, which is the first nine months of their use, and by our own company in flying more than 4,000 hours of experimental test flights, has furnished conclusive evidence of the special utility and unique ability of the helicopter to perform important work — in many cases **better than the same work can be performed by any other form of machine**, and in many other cases **work than can be performed by no other type of machine.**

Much of this work has been performed under the most severe conditions, ranging from 55° below zero in Alaska to 120° above zero in Arizona, from prospecting over the muskeg swamps of northern Ontario to spraying dense hordes of locusts in the Argentine, from the potato fields and the cranberry bogs of New England to fire-swept national forest peaks in California, from patrolling Bonneville power lines in Washington to serving as a flying platform for movie cameramen.

Owing to the small number of helicopters delivered to date, the selling price of each machine is necessarily high, which limits the immediate market to specialized commercial, agricultural and industrial activities and to government agencies and the armed forces. The potential personal market for the helicopter is in the future, as only through volume production can unit cost come down.

UTILITY

The helicopter, however, even at its present price, has demonstrated conclusively its economic value as well as technical performance over a broad field of government and civilian activities.

The helicopter's extreme maneuverability, its amphibious ability to operate from land, water or marshes and swamps, in places completely inaccessible to all other forms of transportation, the lack of subsidies in the form of expensive landing fields and aids of navigation and extensive weather service and reporting, make its operation from a standpoint of economics almost as remarkable as from a standpoint of utility.

Government uses where the unique characteristics and capabilities of the helicopter make it especially adaptable, include:

Coast Guard patrol and rescue work
Air Mail
Geodetic survey
Agricultural dusting, spraying and seeding
Border patrol

Fish and Game conservation activities
Navy — ship-to-ship and ship-to-shore use
Photograph and survey work
Army Ground Force liaison and observation
Air Force operation
Rescue and evacuation
Police patrol and traffic control
Law enforcement
Harbor and river patrol and inspection
Pest control
Forest fire patrol and control
Forest survey and re-seeding

AIR-SEA RESCUE

The Air Force has found a helicopter invaluable for air-sea rescue work, for evacuation from inaccessible areas and for general liaison and utility flying. A small helicopter can be stowed in a large, fast transport, with practically no dismantling, flown thousands of miles to an airfield nearest a disaster, then unloaded and flown into inaccessible spots for rescue, all in the space of a few hours.

The Navy has had highly satisfactory results from the helicopter in air-sea rescue work from both shore bases and ships, for ship-to-ship and ship-to-shore transportation and liaison such as mail delivery, staff transport and general utility. Particularly with a fleet at sea, and during hostilities when radio silence is imperative, the helicopter's ability to land on practically any vessel with a small cleared deck area or even on a gun turret, makes the machine of tremendous value. In many cases it does in minutes the work done by a destroyer in hours.

The Coast Guard was one of the country's earliest exponents of helicopter use, particularly in sea and shore patrol, liaison flight and rescue work.

GROUND FORCES

The Army Ground Forces, particularly in the field of liaison, for evacuation of wounded and general transport work, for observation, fire control and artillery spotting, have found the helicopter to possess remarkable utility. I would respectfully suggest that the President's Air Policy Commission consult the Commanding General of the Army Ground Forces on this subject.

Commercial helicopters have already demonstrated a high degree of utility in the following fields:

Agricultural spraying and dusting; pest control
News and Photo coverage and newspaper delivery
Movie photography
Aerial photography and Aerial mapping
Pipe line, Power line, Irrigation patrol
Mail delivery
Ship-to-shore transportation
Fish and Game conservation
Forestry patrol and forest fire control
Aerial ambulance

FOREST FIRE

As an example, two commercial Bell helicopters in Southern California performed a truly remarkable job for the United States Forest Service during a fire in the Angeles National Forest:

The two machines:

- Flew more than 80 hours during the 5-day fire
- Flew 19½ hours in a single day
- Rescued more than 20 men
- Transported 80 men to a mountain peak
- Brought 60 men back to the fire fighting base
- Took 4 minutes for each round trip instead of several hours on foot, the only other alternative
- Made landings and take-offs with full loads at altitudes as high as 6500 feet
- Operated at times in temperatures of 120° F
- Easily placed fire-fighting crews at working points in the fire lines, inaccessible except by helicopter
- Supplied these crews with food, water, tools and bedding
- One of these helicopters flew 11 hours 52 minutes in one day

Forest Service officials told the operators that **helicopters put in supplies exactly where they were needed at approximately half the per-ton cost of parachuting the supplies from fixed-wing airplanes,** assuming perfect parachute drops in every instance. All dropping and reconnaissance from fixed-wing aircraft was stopped after the helicopters started operating.

It can easily be seen that many of these uses offer an almost limitless potential, for example, in the field of agriculture, air mail, patrol and survey work. The unique ability of the machine to fly low and slow — to hover stationary — to fly straight up or straight down — to fly backwards, forwards or sideways — to fly in 60-mile gusts and low visibility conditions — to land on an area little larger than the machine itself and its rotor span — make it a machine of truly unlimited utility.

TRAINING

Contrary to uninformed popular belief, the helicopter is not abnormally difficult to fly or to learn to fly. Our Bell helicopter training school gives a student from 6 to 8 hours of dual instruction before he is permitted to solo, although in one case a student soloed after 3½ hours of instruction. The entire training course averages 25 hours of flight time, approximately one-half of which is dual instruction and one-half is solo time.

Our usual training school term is 30 days, but after a student graduates, unless he secures a pilot's job with a manufacturer or a commercial operator, it is difficult and expensive for him to secure additional flying time because of the few machines available in the country for instruction purposes.

As we multiply the commercial uses of helicopters we will also multiply the problem of flight and maintenance training.

REGULATION

The problem of helicopter restriction and regulation by federal, state, county and municipal authorities is a major one. The fixed-wing airplane was developed for 25 years before regulatory restriction was imposed. Twenty years later the helicopter arrived and was promptly defined along with the airplane as an "aircraft." As such, it automatically became subject to the identical restrictions and regulations which had been drawn with no thought of the helicopter or its special characteristics and abilities.

Both the Civil Aeronautics Board and the Civil Aeronautics Administration have been aware of this problem and have been extremely cooperative in attempting to find solutions. The action of the CAB on August 8, 1947, in revising its Air Traffic Rules to give special recognition and exceptions to the helicopter is a particularly noteworthy example of government recognition of the regulatory problem.

However, much work remains to be done with state and local authorities and the cost of this work is now borne by a few private helicopter manufacturers and operators. The helicopter must be separated from the fixed-wing airplane in the minds of regulatory officials; its special characteristics permit special utility and this utility potential can only be realized through special treatment.

LEADERSHIP

Today the American helpicopter industry is in a position of world leadership. German development of course has ceased. We are informed by our British representatives that the British government and aircraft industry have become vitally interested in helicopter development and several development projects are now under way with government sponsorship. France and several other European countries are likewise known to be sponsoring development programs. What the Russians are doing in this field we do not know.

If we are to hold our present position of leadership and to continue in the forefront of developing the helicopter as a military, naval and economic machine that in time can emerge into a very substantial new American industry, it is highly imperative that government assume a major role in cooperation with helicopter manufacturers and operators.

RECOMMENDATIONS

We recommend to the President's Air Policy Commission a well organized and closely coordinated program to be immediately launched along the following lines:

I. The Army, Navy, Air Force and NACA should assist helicopter manufacturers in research, development and production programs for military helicopters. Funds should be made available for the procurement of the necessary number of helicopters per year to meet Army, Navy and Air Force needs in different fields of helicopter application. Such procurement should be based on a long range continued program rather than on a year-to-year basis in the interest of economy and coordinated planning.

II. The Army, Navy and Air Force should establish a national training program designed to train a large reserve of operating personnel to be available in event of national emergency, in the same manner that the government has for many years through war-time and peace-time trained airplane pilots so that the supply is no problem for the airplane manufacturer or commercial operator.

This training program, to produce both pilots and mechanics, should include regular training schools operated by the armed services, as well as contract training programs with commercial operators designed to give pilots from 50 to 100 hours of solo flight training in addition to necessary dual instruction.

III. The Post Office Department should expand as rapidly as possible helicopter mail service in all principal metropolitan communities of the United States, this service to be operated by private companies. The Post Office Department and helicopter manufacturers have already conducted extensive tests which have demonstrated the feasibility and economy of such operation. It is respectfully suggested that the President's Air Policy Commission consult the Post Office Department on this subject.

IV. The Department of Agriculture should be provided with necessary funds to buy or lease helicopters and to contract with manufacturers and commercial operators for further development of the best techniques of pest and plant disease control and crop conservation through dusting and spraying.

V. The United States Forestry Service should procure or contract with commercial operators for necessary numbers of helicopters for forest patrol and fire control to protect our national forests and national parks and for re-seeding devastated areas.

VI. All national guard units in the United States should be equipped with helicopters as a part of National Defense, as well as to have available throughout the country helicopters for local emergency rescue and disaster relief.

VII. The Coast Guard should be provided with funds so that at least two helicopters could be permanently located at each Coast Guard station for patrol and rescue work.

VIII. The Red Cross should be provided with a sufficient number of helicopters or have stand-by lease arrangements for helicopters to use in its disaster relief program.

IX. Special emphasis should be placed by the Armed Services on the development and procurement of sufficient ambulance type helicopters for the evacuation of wounded from remote places to field hospitals and from field hospitals to base hospitals.

X. Special assistance should be rendered by the State Department in the sale of helicopters to foreign countries, particularly the types for rescue work and for pest control in agriculture and forestry work.

XI. Government regulatory agencies should be directed to develop legislation and regulations covering the design and operation of helicopters to permit manufacturers and operators to develop the maximum utility of this new type of vehicle consistent with safety. Warning should be sounded of the danger of over-legislation and over-regulation.

"POTENTIALS of HELICOPTER DEVELOPMENT"

by
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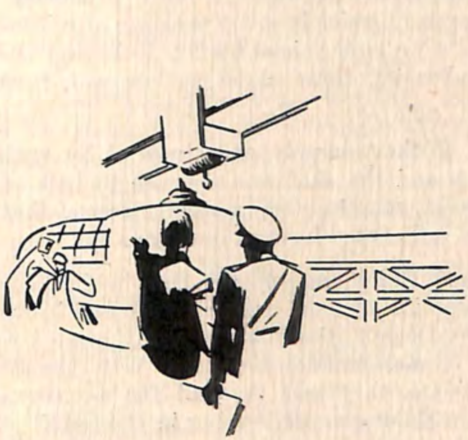

★ *Mr. Sikorsky built and flew, in 1913, the first multi-engined airplane and built and managed an aircraft plant in his native Russia until 1918. His amphibian design transports pioneered many world air routes. Mr. Sikorsky designed and flew the first successful helicopter in the western hemisphere.*

IGOR I. SIKORSKY

"POTENTIALS OF HELICOPTER DEVELOPMENT"

HISTORY

To EVALUATE the present and the future of the helicopter in the aircraft program of our nation, it will be helpful to briefly review the highlights in the development of this newest of man's vehicles.

The fundamental principle of the helicopter is that all lift is obtained from one or more engine-driven horizontal rotors which pull the aircraft straight upward into the air. This principle is simple but its conversion into practice required the solution of a number of problems so difficult that for a long period it was doubtful if a successful helicopter could ever be designed.

In September, 1939, Igor I. Sikorsky made the initial flights with the first successful single-main-rotor helicopter in the world. It was entirely fitting that Mr. Sikorsky should lead aviation into this new development. For thirty previous years he had been a leading designer in aeronautics with particular fame as the creator of the flying boats with which much of the overseas airline pioneering was done.

The possibilities of the new rotary-wing aircraft were immediately apparent to wide awake minds in the military establishment, and on the basis of the performance of this early model, a contract for a two-place side-by-side experimental design was placed by the Army Air Forces.

This was followed in 1942 by a small production contract for the R-4. The R-4's, still a highly experimental aircraft, were produced in limited quantity. They later went into active service in many theaters of military operation. A total of 130 R-4 helicopters were later joined by 209 R-6's and 60 R-5's. In all, a total of over 400 units embracing these three models was furnished to the armed services.

These aircraft, all of them largely experimental by customary standards, in spite of their newness and the shortcomings due to lack of experience both in production and operation, soon built up a service record that established the special usefulness of the helicopter beyond question.

In India, Burma and China, helicopters flew behind enemy lines to terrain impossible for the operation of fixed-wing aircraft and brought out wounded and injured. In the Pacific Islands, they flew urgently needed repair parts to B-29's grounded in advance of maintenance facilities. With the British Fleet Air Arm and the Royal Air Force, they met the call for an aircraft that could effect rescues on tidal flats without ground-looping in the mud.

In the United States, the Coast Guard became a leader in the development of helicopter rescue technique and rapidly built a record of unusual rescues. Its contribution to the program included the development of a special light-weight hoist which has already been instrumental in saving many lives.

POSTWAR MILITARY PERFORMANCE

Since the war additional helicopter experience has been gained by the Army Air Forces, the Navy, the Coast Guard and the Marine Corps, using for the most part the same wartime models with which the program started.

None will soon forget how the Coast Guard took an R-4 into Labrador to rescue the crew of a crash-landed Canadian transport. Or how at Gander, Newfoundland, a Coast Guard R-4 and R-6, flown north by Air Transport Command, were hastily reassembled and brought out eighteen survivors of a civilian transport crash. Army, earlier this year, flew an R-5 from Florida to Nicaragua to locate and rescue from the jungle the eleven scattered survivors of another crash. Newspaper accounts of the navy's use of helicopters with the Byrd Expedition described flights made under hazardous conditions to find safe channels through the ice packs to open water and for similar urgent tasks.

Nor will any Navy fighter pilot forget how a single helicopter based on the aircraft carrier Franklin D. Roosevelt proved its value by hoisting to safety six pilots whose fixed-wing planes crash-landed in the ocean at various stages of the Atlantic Fleet's spring maneuvers.

MILITARY POTENTIALS

Army Ground Forces is studying the use of direct-lift aircraft not only for liaison and artillery fire control but eventually for lifting armored equipment such as tanks, half tracks and field pieces over obstacles. Consideration is being given to transportation of large groups of personnel.

The Marine Corps, also on the alert to take tactical advantage of the helicopter's unusual flight characteristics, has pilots in training and is examining possibilities in the light of its tactical requirements.

OTHER FEDERAL DEPARTMENTS

On the basis of practical demonstrations, the Civil Aeronautics Board has granted a certificate for the operation of helicopter air mail pick-up routes to serve the Los Angeles area. When these routes go into operation October 1, savings in air mail transit time of from 4½ to 19 hours will be possible. Said Postmaster General Robert E. Hannegan, "The Post Office Department has always taken advantage of every new means to speed up the delivery of mail and it is significant that through the use of the helicopter, the postal service is keeping pace with transportation progress. By so doing, we not only benefit ourselves but in some measure contribute to the welfare of our nation, its commerce and its scientific development." Other routes have been surveyed for the Chicago and New York areas.

The Forest Service, Department of Agriculture, using Air Forces helicopters, has made exhaustive tests of the use of rotary-wing aircraft in fighting costly forest fires. Fires have been surveyed and personnel and equipment flown to strategic points with dispatch possible in no other vehicle. Existing models, however, are considered inadequate in load capacity to give the greatest efficiency in this emergency service. Insect pest control has been demonstrated successfully by the Department. Timber survey and powerline patrol have also been tried with encouraging results.

Border patrol by the Immigration Service and Customs Services and investigations by Internal Revenue are within the normal scope of this aircraft which can operate almost anywhere and in practically any sort of weather, certainly under conditions which ground every other type of aircraft.

COMMERCIAL USES

In its present development, the helicopter is being used commercially for crop dusting and spraying, for advertising flights, for high tension line patrol, geological exploration, taxi service and executive travel. Because of high initial costs, it may be considered that these have not definitely established their economic soundness. They have, however, definitely established the ability of the helicopter to operate safely and continually where other means of transportation cannot function. On the basis of its military and commercial progress to date, the helicopter has established its usefulness and has opened a field of investigation that will undoubtedly discover additional applications still undeveloped.

The helicopter is without doubt the vehicle that will bridge the gap for the air traveller between the metropolitan airport and his final destination. This service cannot be made available until larger models are developed and put into production at a rate which will permit their economical purchase and operation.

This, in brief, is the helicopter status as an aircraft.

THE INDUSTRY

Encouraged by the success of the first military models, various aircraft manufacturing companies started helicopter plans, and at the close of the war, a new industry was almost ready to take its first uncertain steps. Today, two manufacturers at their own expense have carried development to the stage where each has a model certificated for commercial use. Others have prototypes in various stages of completion.

A few operators have made charter service available commercially.

Both manufacturers and operators have been limited by the funds available. Expansion of their activities must be postponed until government procurement of helicopters is large enough to effect economical production costs.

The largest helicopter certificated for use today and in limited production for the military service weighs about 5,000 pounds gross and carries a useful load of 1,250 pounds. It is entirely feasible to design, build and bring to a state of refinement warranting production helicopters weighing 20,000 to 25,000 pounds gross. Such helicopters will not only fill definite requirements for the Armed Services, but will eventually find many commercial applications, thereby creating a sound new industry which will contribute importantly to this country's economic welfare and progress. Such a development is costly and cannot be undertaken by a sick industry. Government sponsorship is required to underwrite the cost of such development in a competitive industry and bring successful prototypes to the pilot line production stage.

THE FUTURE

As a matter of military preparedness, in view of the helicopter's demonstrated effectiveness and the indication that under further development its usefulness to the various branches of the armed services will be increased, it is submitted that a strong peacetime industry must be established.

The art of helicopter design today is in that primitive stage of development reached by fixed-wing aircraft at the time of the first World War. As fixed-wing design was encouraged, so helicopter design must be encouraged into further progress.

It is believed that production of helicopters today in the United States may be ahead of similar production in other nations. However, we believe this margin is not so great with respect to advanced helicopter design. Other nations with intensive engineering might readily overtake us.

The industry is new. Competent engineers are few. Should they be scattered elsewhere through the industry's inability to maintain its organization, delay in regrouping them in an emergency might be damaging beyond recall. There are a few new helicopter designs in progress, supported by the Government and intended to widen the scope of applications to military problems. However, much more intensive exploration of utility is imperative. In order to perform the greatest variety of services for the Army, the Navy, the Coast Guard and the Marine Corps in time of war, a broad peacetime development of helicopters is necessary. Engineering groups are now available for this task.

The industry's plant must be developed on a sound financial basis to the point where quantity military production, if necessity arises, can be undertaken without exorbitantly costly confusion.

RECOMMENDATIONS

To this end, we respectfully recommend:

1. A military program furthering the design and development of the helicopter and sufficient production orders on desirable types to establish pilot line readiness in event of emergency.
2. That sufficient funds be provided for U. S. Coast Guard to equip each of its life saving stations and its coastal air bases with a sufficient quantity of modern type helicopters to properly discharge its traditional responsibility for rescue operations.
3. Appropriate Congressional action to permit certain government agencies, particularly the Department of Agriculture and its Forest Section, to purchase helicopters for crop spraying, forest fire control, etc.
4. That the Post Office Department be encouraged to establish helicopter air mail and air cargo routes in each of the principal metropolitan centers.
5. That Army, Navy and Coast Guard establish, on a broad scale, military helicopter training schools for pilots and mechanics similar to the training schools now established for conventional planes, to provide a reservoir of helicopter pilots and mechanics with adequate training.

"PRODUCTION STATUS, SERVICEABILITY and DEVELOPMENT of TURBINE ENGINES

by

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"PRODUCTION STATUS, SERVICEABILITY AND DEVELOPMENT OF TURBINE ENGINES

SUMMARY

It is recommended that the Air Policy Board give consideration to the following points applying particularly to aircraft power plants:

1. Legislation to permit longer range planning and better continuity in development, production and procurement of engines.

2. Congressional approval of at least the basic and early portions of research, evaluation and special high capacity test facilities for new type power plants the plans for which are now in the hands of the Joint Research Development Board.

3. Legislation to permit the government to provide special test and manufacturing facilities and equipment in power plant manufacturers' plants where needed to properly develop and fabricate new type power plants.

4. Review of development fund application to determine if sufficient emphasis has been placed on power plants in view of broad field and completely new types now to be covered.

5. Review of allowable profits to determine if it would be advantageous under present circumstances to allow manufacturers funds for latitude in exploring certain phases of research and development on their own initiative.

6. Consider support of commercial applications of new power plants to expedite perfection and evaluation of new designs and sizes.

7. Review present procedures in purchasing from the standpoint of simplification of specifications, inspection directives, patent and licensing arrangements, expediting of contracts and procedures for greater flexibility to change in contracts as new information becomes available.

8. Consider means for better peacetime exchange of information to expedite progress in power plant development until new power plants are available in optimum designs and needed sizes.

9. In order to practice the art of production and determine the basic problems of production control it is essential that an adequate number of planes and engines be fabricated in plants which typify war time production. This is equally important in the case of subcontractors and material suppliers.

POWER PLANT TYPES

POWER PLANTS for aircraft and guided missiles may in general be classified as to speed and range possibilities in the following order:

Increasing max. speed ↓	1. Pulse-jet (short range)	
	2. Reciprocating Engines	*Decreasing max. range* ↓
	3. Turbo-prop engine	
	4. Ducted fan jet	
	5. Turbo-jet	
	6. Ram-jet	
	7. Rocket	

The first five types are useful largely in the subsonic region although the turbo-jet, and possibly the ducted fan, has possibilities in the supersonic area. Except for special applications such as assisted takeoff or short time high performance, the ram-jet and rocket engines are applicable chiefly to the supersonic region. Since the pulse-jet is suitable only for low altitude, short range guided missile applications, the ram-jet and rockets are largely specialized supersonic power plants and since reciprocating engine characteristics are well known, this paper will be confined to the remaining important subsonic types, namely, the turbo-jet, ducted fan, and turbo-prop engines. These are all of the basic turbine type.

FOUR BASIC TYPES

It will be noted that, for inhabited aircraft for subsonic flight, power plant manufacturers must provide engines of four possible basic types, that these must be available with the characteristics needed for military and commercial aircraft in the sizes required for specific missions and that the proper selection of size and type in the early development period must be made after careful evaluation of possibilities of each variety. In addition there are a greater number of possibilities in each of the basic turbine types as regards variations in components and arrangement than ever possible with the reciprocating engine. For example, compressors may be single or double inlet centrifugal design, axial flow, multi-stage or combinations of the two, and a much wider range of compression ratio is possible than could be considered on reciprocating engines for a given fuel. Many other possible combinations are available in combustion, turbine, drives and controls. The net result is that the power plant job involves a much wider range of technical knowledge, more specialists and larger engineering staffs than ever before. It also involves much greater development hazard in selecting suitable types and sizes in view of the relative lack of knowledge of limitations and applicability of each type. This in turn should mean allocation of development funds for power plants in accordance with the size and hazard of the problems involved. It is my personal opinion that inadequate emphasis or provision has been made in the post-war era for the best interests of the country for expanded power plant development, test and flight facilities and even special manufacturing facilities for the variety of power plants which must be explored and made available to meet military requirements. For a considerable time airplane manufacturers have been definitely limited as to the performance they can achieve by the limited number of types and sizes of power plants from which they may select. With the longer development time involved in power plants there is only one way to correct this deficiency and that is by a greater emphasis in allocation of development funds to power plant use over the next few years.

PRODUCTION AND DEVELOPMENT STATUS OF TURBO-JETS

Since the turbo-jet is the simplest, lowest cost, easiest to install, smoothest and lightest type of power plant for aircraft, it is inevitable that it will be selected for use on any military or commercial airplane where the performance and economical operation required can be achieved by this type of power. However, its application is severely limited by poor takeoff and climb characteristics and high fuel consumption except at very high speeds and altitudes. There has now been sufficient production and flight operation on one type of turbo-jet engine to justify the advantages claimed for turbo-jets and in addition to show that it is susceptible to a rapid rate of endurance and performance improvement. Figure 1 (not reproduced because of confidential nature) shows the monthly rate of the two turbo-jet engines currently in considerable production. A third smaller turbo-jet is in the preproduction stage in this country and two additional types should be ready in the next year. Unfortunately four out of five of these types are roughly in the same size or power class. Unless some of these types can be developed at an unusual rate to higher outputs it would appear to the writer that, with the need for a variety of sizes in turbo-jet engines to properly cover airplane requirements, more emphasis should be placed on development of a range of sizes than on having competitive engines of somewhat similar size. Other sizes are under development but are limited by available development funds. However, it is possible on a given type of turbo-jet to more rapidly develop improved performance than we are accustomed to on reciprocating engines as shown by the attached Figures 2 and 3 (not reproduced because of confidential nature).

Durability Improvement

Figure 2 shows the rate of durability improvement on one type turbo-jet engine which has been in production over two years. It will be noted that the model or endurance test requirements have been steadily increased until they are now on the same 150-hour basis as reciprocating aircraft engines. Likewise on service overhaul the period for engine removal has steadily increased and, for a given model engine, appears to average twice the endurance test requirement as regards time allowed. In considering durability, it should be noted that American experience is with single engined fighters and that overhaul time is increased slowly and cautiously on this type airplane as compared to multi-engine machines or bomber or transport aircraft applications. For example, reciprocating engines in single engine fighters usually average 300 to 400 hour overhaul periods whereas the same engines in bombers or transports may do 750 to 1,000 hours between overhauls due to the difference in usage and the multi-engine safety factor.

Rapid Rate of Progress

Turbo-jets in their present state of development are susceptible to rather rapid improvement as shown by Figure 3 for one type of turbo-jet. It will be noted that on a model just going into production the take-off thrust per pound of engine weight is 64% higher now than two years ago for a jet engine of the same external dimensions. As shown by the dotted curve it is estimated that this rapid rate of progress can be continued for some time before the law of diminishing returns sets in. It is obvious, with such a rapid rate of endurance and performance improvement demonstrated on a turbo-jet engine of a specific type, that it is extremely difficult for anyone to judge accurately the relative future usage of turbo-jet, ducted fan, turbo-prop or reciprocating engines. It does indicate, however, that development funds expended in the turbine field give under present conditions a high rate of return on the investment. While the latest model turbo-jet is suitable from an engine standpoint for commercial application, it is questionable whether such an application should be made before performance is more stabilized.

Ducted fan jets and turbo-prop engines are more complex, take longer, and cost more to develop than turbo-jets. There is a considerable weight of opinion which feels that ducted fans can be neglected, but others who feel this type has a definite field of usefulness between jets and turbo-props. A considerable number of turbo-prop engines are being developed in this country but are all in the classified category and cannot be discussed here.

COMPARISON WITH FOREIGN ENGINES

It has been generally conceded until recently that British jets were ahead of American as a result of their early start and their emphasis on development rather than production in the latter part of the war. At the present time it is believed safe to say that we have at least caught up with and in some ways are ahead of our British friends. We are well ahead in the production and application of axial flow turbo-jets, in the application of water-alcohol augmentation for take-off and in the low cost producibility of the double entry centrifugal type turbo-jet on which the British have placed the greatest emphasis. We have as much variety in size or thrust rating and a choice between the lighter, more compact but larger diameter centrifugal compressor type and the more costly but smaller diameter and more efficient axial flow than do the British. We are perhaps still slightly behind them on durability between overhauls although if one considers the difference in applications (single engine American vs. twin engine British) in the most widely used fighters, the difference in practices between the countries and the difference in power output of the comparable engines there is little to choose between them.

British Progress

In the case of turbo-prop engines neither country has anything but experimental engines. It is therefore difficult to evaluate the relative situation between the two countries. However, there is no question that the British are well ahead of this country in the variety of turbo-prop engines both from the size and kind of design standpoints. They are rather thoroughly exploring more combinations of design such as axial, mixed flow and centrifugal compressors, regenerators, free wheeling turbine propeller drives and power sizes and have all of these combinations running in various stages of development and flight test. They are therefore making wider exploration of design and development possibilities which from the longer range viewpoint will pay dividends. On the other hand I have the feeling that in their eagerness to get turbo-prop engines operating they have not set their sights high enough to obtain engines truly competitive with reciprocating engines either as to size or specific fuel consumption. Size selection has apparently been influenced considerably by commercial rather than military requirements and lack of military support may force the dropping of some of these developments. It is believed that American turbine developments have given the competitive reciprocating engine more consideration which has resulted in setting our "sights" higher and which of necessity means slower final attainment of perfected engines but possibly more useful ones when they are completed.

Flight Installations

The British are also planning turbo-prop flight installations on a lavish scale compared to this country. With such new types of products it is extremely important that engine manufacturers have the opportunity of flying new designs under all altitude and performance conditions at the earliest possible time in the development in order to incorporate such changes in controls, burner characteristics, etc., as are found necessary in flight. It is the writer's opinion that more emphasis and funds should be applied to this phase in this country.

With such new problems and techniques as are inherent in turbines as compared to reciprocating engines there is a major need for major development facilities of a new type at power plant manufacturers' plants, government evaluation centers and in our research establishment. While plans have been submitted to cover these phases no action has been taken in a major way in this country to provide these facilities. There are also special fabrication problems involving new equipment for tooling, machining and other processing which require special consideration and for which this country has no plan for providing. The British appear to be handling this problem by providing special equipment as needed or by a profit allowance or write-off arrangement which makes the hazard reasonable to power plant manufacturers.

The British government also appears to be sponsoring commercial applications of new power plants with the thought that more rapid development will occur. They furthermore appear to allow more freedom on the new type power plants from regulations, directives and specifications which have been developed in this country over a long period on reciprocating engines with the result that their power plant developers are less hampered in making progress. They are also much freer in releasing new designs for export than in this country. It is recommended that all the above factors be taken into consideration in determining a new air policy.

FUTURE TRENDS IN APPLICATION OF GAS TURBINE POWER

A very good summary of "Future Trends in Aircraft Engine Design" was presented by A. T. Gregory and A. L. Pomeroy at an April 9, 1947, meeting of the S.A.E. and copies can be obtained from Ranger Aircraft Engines, Farmingdale, Long Island, N. Y. This covers a survey of United States technicians based on estimates of the number or percentage of aircraft types **in use** in two, five and ten years of both commercial and military types. Of much more interest to future air policy is the percentage of aircraft types **being procured** or **manufactured** at those periods. It is my personal opinion that in five years military aircraft **being purchased** will be 100% powered by turbines, that all short to medium range aircraft will be powered by turbo-jets and that some medium and all long range aircraft will be powered by turbo-prop engines with the possible exception of some special applications with ducted fans. On commercial and executive transports I believe the same condition will exist on all aircraft involving 1,000 h.p. or larger power plants **providing Government support of new commercial types and turbine installations in present commercial models is made available in the next two years** and assuming at least the present development fund application to power plants. If new type transport and commercial aircraft are left to the sponsorship of individual aircraft companies the application of turbine type power will of course be appreciably delayed.

With the majority of new fighters now being jet powered fuel logistics will be a powerful factor in forcing the complete swing to turbine type power. It has already been demonstrated that turbines can operate on a wide range of fuel and that the fuel can be largely determined by its producibility rather than its quality in terms of octane number as required by reciprocating engines. With an increasing requirement for turbine production and size development it is going to be increasingly difficult to produce reciprocating engines at reasonable cost. The point has already been reached where no power plant manufacturer will expend engineering time or funds on development of a **new type** of reciprocating power plant and it appears certain that only on very long range aircraft with large size engines is there justification for spending time and effort on major model improvement. The increasing use of guided missiles or one-way aircraft with expendable power plants is also a major factor in adding emphasis to turbine type power plant development since it is now established that this type can be cheapened reliably for short time use to a much greater extent than reciprocating engines and turbo-jets can be used into the supersonic region.

DEVELOPMENT PROBLEMS ON NEW TYPES

Power plants for aircraft are one of the most involved engineering problems in existence because of the high power requirements per pound of material, the severe thermal and mechanical stresses involved, the ability to operate satisfactorily over extreme altitude and temperature conditions in a short period of time, the problems of feeding and scavenging oil and feeding fuel under adverse position and pressure change conditions, the necessity for simple pilot control and the reliability requirements. In addition production is small except in wartime and the pressure for improved performance is always high so that in general an aircraft engine model becomes obsolescent at about the time a normal commercial firm would consider the product ready to start in production. These considerations involve manifold development problems. In general the engineer must turn to research and intensive development program for suitable materials, new design factors, constants and techniques, and flight exploration for determination of practical altitude and speed effects. For rapid progress in this field a broad base of well equipped research, adequate facilities for full scale component development and orders for application in reasonable production for reduction to practice and establishment of manufactiuring techniques and facilities are all required. It is obvious that with such a technical product the most complete test facilities are essential in the research, the development and the military evaluation areas. A coordinated and carefully considered country-wide plan for the research, large size development and evaluation facilities is being presented through the Joint Research and Development Board and action on the initial steps of this program is urgently needed for proper power plant development. The military services are badly handicapped by present regulations in assisting the engine manufacturer in obtaining needed component and engine testing facilities and that special equipment required in production for working out lower cost fabrication on new type aircraft power. The patent and license requirements of current contracts need consideration from both prime and sub-contractors' viewpoints as they are the basis for many delays in contractual coverage of needed projects with resultant slowdown and additional costs added to development.

Need for Flexibility

There is with the new type power plants need for greater flexibility to change in development programs and contracts as new information becomes available. Likewise there is the need for less rigid interpretation of specifications, directives and other means of control for a considerable period of time to accelerate application of new developments.

Consideration should also be given to possible continuance of war-time interchange of information during the period of reduction to practice of these new type power plants. This would mean at least a temporary pooling of information for rapid progress with a later return to more competitive practice. It is also felt desirable that a higher profit margin on engineering and production contracts should be allowed for the next few years to allow some freedom of exploration of new possibilities of power plants by the engine companies to the point where firm proposals and contracts are acceptable. With the sudden shift to a wide variety of power plant types and sizes it should be recognized that the hazard of aircraft engine development is greater than ever before.

Experience in the last war proved that the elements necessary to manufacture any article were as follows:

a. Design and development of product.
b. Buildings
c. Machinery.
d. Special tools and fixtures.
e. Trained people.
f. Proper financing.

It is well known that no airplane or aircraft power plant not well developed prior to the war reached the production stage and combat usage during the war from this country. Design and development is the longest time item in the above list. It is less well known and appreciated that the other chief bottleneck in geting production moving was the machinery, and particularly that special machinery needed for critical or major operations which required designing the machines. This is the reason for emphasis on continuous production and the urging of government provision of special machines and equipment in both prime and subcontractors' plants in peacetime.

"FINANCIAL OUTLOOK
of the
AIRCRAFT INDUSTRY"

by

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"FINANCIAL OUTLOOK OF THE AIRCRAFT INDUSTRY"

SUMMARY

1. **Large Post-War Deficits**—1945 operating income of $325 million for 15 aircraft companies replaced by $82 million 1946 operating deficit; further 1947 interim losses. Tax carrybacks greatly reduced losses in 1946, will offset to lesser extent in 1947; no tax carryback thereafter.

2. **Working Capital Depletion**—Working capital of the 15 companies declined $80 million, nearly 13% during 1946. Operating losses, large property acquisitions major contributing factors. Proportions of inventories, other non-cash items increased. Tax problems, 1947 drains on working funds bring companies nearer severe financial difficulties.

3. **Increasing Aircraft Costs**—Labor, material, overhead costs more than double pre-war levels. Aircraft costs increased more importantly by advances in technology, complicated character of post-war airplanes. Experimental, development, tooling costs average ten times pre-war. Higher costs, causing depletion of war-time capital accumulations, give rise to increased need for new capital and profits.

4. **Need for Profitable Volume**—Industry need not for volume orders only, but orders on price basis to yield profit. Although competition certainly advised, uncontrolled competitive contract awards, promising succession of heavy losses, worse financialy for industry than no contracts.

5. **Difficulties in Raising New Capital**—Stronger companies have short-term bank credits, not available to certain other large and small units. Companies' stocks trading on exchanges at large discounts from per share working capital, net worth. Operating losses, working capital depletion, higher costs, other disappointments have lowered public investment opinion of industry. No new postwar equity or long-term financings have been offered; none appear likely in face of continuing deficits.

LARGE POST-WAR DEFICITS

THE AIRCRAFT INDUSTRY is struggling through its second post-war year of great deficits. As shown in Schedule I, the 15 major companies incurred an aggregate loss of nearly \$82 million before tax carryback credits, and after \$70 million of such credits, the net loss still amounted to almost \$12 million. The marked contrast between the 1946 losses and the 1945 profits is also shown in Schedule I. The same companies in 1945, despite the sharp drop in volume during the latter half of the year following war termination, reported aggregate income of \$325 million before taxes and nearly \$100 million after taxes.

A study published by the National City Bank of New York in its April, 1947, "Monthly Letter" illustrates even more vividly the sharp reversal in the aircraft industry's earnings. Whereas the net income after taxes of 2,958 corporations included in the survey showed an average increase of 28% in 1946 over 1945, that for the aircraft manufacturing group dropped 95%. (It was only the inclusion of a number of diversified aircraft-auto parts manufacturers that prevented this total, like that in Schedule I, from dropping 100% into an overall deficit.) The aircraft group made the worst showing of any of the 70 industry groups, with but one exception—our close neighbors, the airlines, who dropped into an aggregate loss position. Not only was the profit margin of ½ of 1% on sales the lowest for any of the groups, in contrast to the 6% margin for all manufacturing companies, but the rate of return on net worth (a point on which aircraft companies have frequently been criticized in the past) amounted to only 9/10 of 1%, again lower than for any other group except the airlines, and widely at variance with the 12% earnings on net worth for all manufacturing companies.

The primary cause of this dismal earnings record in 1946 was the destruction of the market for aircraft. The 15 aircraft companies had sales in 1945, not the peak year of the war demand, totalling \$5.7 billion; in 1946 the sales of these companies amounted to less than ¾ of \$1 billion, a shrinkage of more than 87%. Douglas' sales alone in 1945 were larger than the industry total in 1946.

Continued 1947 Deficits

Unsatisfactory as the 1946 earnings were, the industry nevertheless had the benefit of two factors which have lessened or are altogether inoperative during the present year. The financial reports for 1946 covered fiscal years beginning as early in some cases as August 1, 1945; in these and other instances the carryovers of war-time revenues and termination activities were of considerable importance in sustaining income during 1946 fiscal years. Most important, the companies had the benefit of tax carryback credits to an extent that is not present during 1947, and that will be virtually non-existent by the end of this year.

As shown by Schedule II, the ten companies for which interim 1947 reports are available have thus far reflected a composite operating loss of \$19.5 million. Only two of the ten companies were able to show operating earnings. Excluding those two companies, the losses for the other companies before tax credits totalled more than \$27 million, or at an annual rate of deficit in excess of \$54 million. These same eight companies during 1946 had a total operating loss of slightly over \$63 million; thus, the rate of loss has not lessened importantly during 1947, despite the retrenchments and economies that have been effected, and as indicated in the next section, working capital continues to be depleted rapidly.

SCHEDULE I

AIRCRAFT COMPANIES' OPERATING RESULTS—1945-1946

(000 omitted)

Company	1945 Income Before Taxes	1945 Income After Taxes	1946 Income Before Taxes	1946 Income After Taxes
Beech Aircraft Corp.[1]	$ 13,706	$ 3,722	$ 853 def.	$ 229 def.
Bell Aircraft Corp.	18,965	5,065	2,308 def.	658 def.
Boeing Airplane Co.	23,071	6,489	4,913 def.	1,577 def.
Consolidated Vultee Aircraft Corp.[2]	24,637	6,749	9,116 def.	2,776 def.
Curtiss-Wright Corp.	89,600	24,430	33,716 def.	8,716 def.
Douglas Aircraft Co.[2]	24,396	8,956	2,019 def.	2,181
Fairchild Engine & Airplane Corp.	1,354	716	[5]	[5]
Grumman Aircraft Engineering Corp.	20,814	5,714	1,499	388
Lockheed Aircraft Corp.	6,282	3,490	21,860 def.	10,740 def.
Glenn L. Martin Co.	38,952	8,379	5,194	3,363
North American Aviation[1]	28,020	7,820	6,501 •	4,001
Northrop Aircraft[3]	2,363	748	439 def.	25 def.
Republic Aviation Corp.	5,890	2,254	11,006 def.	4,406 def.
Ryan Aeronautical Co.[4]	1,070	350	500	300
United Aircraft Corp.	26,074	12,855	4,563 def.	6,061
Total	$325,194	$97,737	$81,591 def.	$11,684 def.

[1]Years ended Sept. 30. [2]Years ended Nov. 30. [3]Years ended July 31. [4]Years ended October 31. [5]The 1946 annual report has not yet been released, but AIA estimates have been included in the totals. •North American personal plane, the "Navion," discontinued in 1947 at reported loss of $8 million. def.—Deficit.

WORKING CAPITAL DEPLETION

Decline in 1946

There is no question but that the net worth and working capital of aircraft manufacturers were substantially bolstered during the war. Schedule III shows that the leading 15 aircraft manufacturers emerged at the end of 1945 with working capital in excess of $620 million. The same data also show, however, that the inroads against working capital have been very great since the end of the war, by the drop of $80 million or nearly 13% during 1946 alone. This decline was due both to the large deficits incurred and to the major additions to plant, equipment, and other non-current assets during the first post-war year. As detailed in Schedule IV, the amount of those properties for the same companies increased in total more than $50 million or 63% last year. In a number of instances, moreover, other large property acquisitions have occurred since the 1946 fiscal year-end, one of which is indicated by footnote 7 to Schedule IV. These property additions have been an essential part of the companies' conversions to post-war production, often the unavoidable result of the inextricable comingling of company and Government facilities during the war.

Although the aggregate data indicate that cash and Government securities remained at approximately the same ratio at the end of the 1946 fiscal year as a year earlier, at near 40% of total current assets, the total available cash dropped by $219 million or more than 38%. In comparison with the 40% overall cash ratio, moreover, there were a number of companies with cash ratios of 20%, 15%, and lower. A major factor, in addition to the $12 million of losses and $50 million of property acquisitions, causing cash drains on virtually every aircraft manufacturer, has been the marked increase in inventory investment. The aggregate data show that inventories increased from near 13% of total current assets in 1945 to 36% at the end of last year. Excluding the two large manufacturers of engines and propellers, the increase in inventories has been even more pronounced, from 14% to more than 42% of total current assets. Further analysis would show a similar rise in non-Government accounts receivable. In both instances, cash realization may be slow, and at times since the war has fallen well behind schedule when the airline debtors became involved in their own financial difficulties.

Tax Problems

Another serious working capital problem is that of taxes for the war years. We know of no case where an aircraft manufacturer has finally settled his income and excess profits taxes for the full war period. Small differences in ratios of taxes applied to war volumes represent large sums with great leverage when charged against reduced peacetime operations. Reserves in total may be adequate for these tax assessment contingencies, but it is questionable whether all necessary charges have been made against working capital, and in any event the payment of additional tax assessments will represent disbursement of badly needed funds.

The immense changes in the volume and character of aircraft manufacturing from peace to war and then back to peace have created special tax problems that are not found elsewhere. In addition to large volume fluctuations, there are other special and difficult factors, including the proper timing of tax deductions for development costs and experimental charges, that seriously affect both the basis years and the tax years. These differences in the basis multiply themselves for each tax year against which the basis is applied.

SCHEDULE II
INTERIM OPERATING RESULTS—FIRST SIX MONTHS 1947
(000 omitted)

Company	Sales	Income Before Taxes	Income After Tax Adjustment
Beech Aircraft Corp.*	$ 22,386	$4,366 def.	$1,562 def.
Bell Aircart Corp.	8,882	736 def.	211 def.
Boeing Airplane Co.	10,537	6 def.	64
Consolidated Vultee Aircraft Corp.	14,091	2,478 def.	770 def.
Curtiss-Wright Corp.	38,687	5,908 def.	908 def.
Douglas Aircraft Co.	54,534	6,712 def.	752 def.
Fairchild Engine & Airplane Corp.	N.A.	N.A.	N.A.
Grumman Aircraft Engineering Corp.	N.A.	2,121	1,311
Lockheed Aircraft Corp.	N.A.	N.A.	N.A.
Glenn L. Martin Co.	N.A.	N.A.	N.A.
North American Aviation*	11,849	3,957	304
Northrop Aircraft	N.A.	N.A.	N.A.
Republic Aviation Corp.	12,230	2,946 def.	476 def.
Ryan Aeronautical Co.	N.A.	N.A.	N.A.
United Aircraft Corp.	97,330	5,492	3,417
Total	$270,526	$19,496 def.	$ 417

*For 9 months ended June. N.A.—Not available. def.—Deficit.

SCHEDULE III

CHANGES IN CURRENT ASSETS, WORKING CAPITAL, AND SELECTED ITEMS—1945-1946

(000 omitted)

	Working Capital		Current Assets		Cash Items		Inventories	
	1945	1946	1945	1946	1945	1946	1945	1946
Beech Aircraft Corp.[1]	$ 10,356	$ 8,923	$ 34,479	$ 17,868	$ 15,094	$ 3,496	$13,832	$ 11,580
Bell Aircraft Corp.	18,692	11,333	53,897	24,194	26,799	13,589	1,784	5,992
Boeing Airplane Co.	45,620	43,607	84,767	70,261	41,073	41,465	3,557	19,424
Consolidated Vultee Aircraft Corp.[2]	56,062	43,245	118,927	61,908	13,046	15,928	5,158	19,129
Curtiss-Wright Corp.	138,203	110,349	339,645	193,272	177,467	111,923	28,595	29,281
Douglas Aircraft Co.[2]	64,283	58,489	132,730	82,900	46,932	28,694	8,075	36,554
Fairchild Engine & Airplane Corp.	11,740	[5]	15,700	[5]	3,826	[5]	1,703	[5]
Grumman Aircraft Engineering Corp.	19,253	18,949	87,425	34,008	30,240	17,306	12,072	11,059
Lockheed Aircraft Corp.	42,665	35,653	152,135	90,036	18,597	16,749	37,746	53,056
Glenn L. Martin Co.	41,175	42,485	121,557	86,311	80,429	22,680	10,051	50,230
North American Aviation[1]	42,477	36,577	110,380	50,590	39,264	26,428	34,174	19,539
Northrop Aircraft[3]	4,023	3,693	16,458	6,287	3,876	1,341	378	1,923
Republic Aviation Corp.	10,035	4,708	30,201	18,956	6,417	1,547	2,376	7,727
Ryan Aeronautical Co.[4]	3,581	3,423	13,592	5,665	2,167	795	1,758	1,741
United Aircraft Corp.	112,197	106,976	172,989	145,346	69,029	50,107	38,976	56,878
Total	$620,362	$540,150	$1,484,882	$903,302	$574,256	$355,874	$200,235	$325,816

[1]As of September 30. [2]As of November 30. [3]As of July 31. [4]As of October 31. [5]1946 data not yet available; 1945 balance has been included in 1946 total.

SCHEDULE IV
INCREASE IN PROPERTY, OTHER NON-CURRENT ASSETS—1945-1946
(000 omitted)

	1945	1946	Increase
Beech Aircraft Corp.[1]	$ 750	$ 1,412	$ 662
Bell Aircraft Corp.	696	7,417	6,721
Boeing Airplane Co.	5,619	4,004	1,615[5]
Consolidated Vultee Aircraft Corp.[2]	6,502	14,124	7,622
Curtiss-Wright Corp.	14,187	27,563	13,376
Douglass Aircraft Co.[2]	8,219	21,054	12,835
Fairchild Engine & Airplane Corp.	1,150	[6]	--------
Grumman Aircraft Engineering Corp.	6,283	6,372	89
Lockheed Aircraft Corp.	10,675	15,642	4,967
Glenn L. Martin Co.	16,391	15,038	1,353[5]
North American Aviation[1]	1,553	4,584	3,031
Northrop Aircraft[3]	2,009	3,059	1,050
Republic Aviation Corp.	1,727	2,595	868
Ryan Aeronautical Co.[4]	498	706	208
United Aircraft Corp.	5,781	8,877[7]	3,096
Total	$82,040	$133,597	$51,557

[1]As of September 30. [2]As of November 30. [3]As of July 31. [4]As of October 31. [5]Decrease. [6]1946 data not yet available; 1945 balance has been included in 1946 total. [7]Total had increased to $29,448,000 at June 30, 1947.

Present Situation

The working capital figures quoted are to the end of 1946 fiscal years only, which ended from nine to fourteen months ago. It is common knowledge that, with the continuing operating losses, cancellations of plane contracts, and other disappointments that have subsequently occurred, the actual present working capital of not a few of the aircraft companies has deteriorated to a far greater extent. The necessity for a satisfactory volume of profitable production, in order to stem the post-war drain of the industry's working funds, is not a matter for deferred contemplation by some manufacturers, but on the contrary is an immediate problem, despite the apparent adequacy of the remaining overall balances in the 1946 financial statements. If these great losses of working capital continue, many or all of the companies will find themselves in most severe financial difficulties.

INCREASING AIRCRAFT COSTS

Labor, Materials, Overhead More Than Double

While practically all industry is confronted with an upward cost trend, this is believed to be more intense in aircraft than in most cases. Douglas' experience is undoubtedly typical: as compared with the 1936-1939 average, manufacturing hourly labor rates have increased 106%, tooling labor 111%, and engineering 149%. Materials including engines and instruments have also more than doubled despite a decline in aluminum prices. Overhead costs have increased even more than direct costs, a trend which we understand is common throughout the industry. It is difficult to account entirely for this, but it is partially due to vacations and other social privileges recently granted to employes, increased local taxation, and larger depreciation. Rising overhead has been due to a far greater extent, however, to the added supervision and other managerial requirements of an operation that has grown in complexity, and a lessened ability of the average employe to direct his own efforts or set his own standards. As depreciation and taxation on the large war-time acquired facilities flow into periods of further reduced activity, the ratio of these fixed expenses to total costs will again increase. The depreciation problem is further complicated by higher replacement costs, a matter that has been widely discussed in the press recently.

Further, and peculiar to the aircraft industry, much of the cost increase is due to the fact that an airplane today bears only surface resemblance to pre-war models. More electrical, hydraulic, and radio equipment, cabin pressurization, air conditioning and sound-proofing, greater instrumentation and other installations have multiplied costs throughout. The performance and safety features of modern aircraft have also been tremendously advanced, including increased speed and larger pay-load, longer range and greater operating economy, extensive fireproofing, more elaborate flight controls and navigation aids, and other refinements, all of which have their added costs. In both development and in manufacture, more comprehensive and intensive experimental and test work are performed, and even after a model has been introduced, continued improvements and service modifications are carried on.

Results of Higher Costs

Reflecting these mounting costs, it is estimated that to design and produce the first DC-9, a two-engine plane we have under consideration to replace the DC-3, and a type of airplane we know well, would cost fifteen times as much as the DC-1, the original prototype of the Douglas transport series. Allowing for differences in size, the first DC-9 would cost ten times the DC-1 cost. As compared with the DC-2, the first production model of our commercial series, engineering and tooling for the first 100 DC-9 planes are estimated at twenty times more, and some fourteen times similar costs for the first DC-3s. Again adjusting for weight differences, current engineering and tooling costs for the DC-9 are more than ten times the comparable DC-2 or DC-3 figures. Increased complexity of the product and lower labor productivity appear to be largely offset by greater tooling and improved production techniques, with the result that manufacturing costs per pound of airframe have more than doubled along with the increases in labor, overhead, and materials.

As a further and very real indication of the financial effects of increased production costs, our present new four-engine DC-6 was priced to break even with the production of 200 airplanes. The price was not set until after the war, and allowance was made for further increases in labor and material costs. Although the original price has been increased from \$595,000 to around \$670,000, not all of which has been due to our own costs, we have now concluded that even with these price revisions, we have no hopes of breaking even short of 300 planes. Inasmuch as we have sold only three-fourths of the 200 airplanes originally planned, the last of which are scheduled for delivery next spring, we estimate our loss at that time on this model will total \$20 million. It seems evident that the gains in working capital made by the industry during the war have become critically necessary, and the recent losses particularly deplorable, in view of the higher costs of experimental and production airplanes. Financially, these unfavorable developments make for a greatly increased need for more capital or profits, or both, if satisfactory performance of the aircraft industry is to be continued. As indicated in a following section, however, the prospect for obtaining such needed capital are far from promising.

NEED FOR PROFITABLE VOLUME

There has been a great deal said about the necessity of volume orders if aircraft manufacturers are to be kept in existence. We have seen no comment to the effect that these orders must be placed on a basis that will yield the manufacturer a profit. This is surely a most important point.

If the course should be chosen such that there are successive competitive contract awards, with in each case a desperate manufacturer taking unwise risks, there will in all probability be incurred a succession of heavy losses which, financially speaking, will be worse for the industry than if there were no contract awards at all. We do believe, of course, in properly controlled competitive bidding, and we do believe in the Government buying airplanes and other things on the most economical basis. However, competition in this situation must be used with real discretion.

DIFFICULTIES IN RAISING NEW CAPITAL

Limited Short Term Credits

Because of the large postwar deficits and mounting costs, steadily depleting the industry's remaining working capital and net worth, the industry's need for additional funds is growing, at the same time its ability to raise new capital is measurably and constantly deteriorating. In the short-term market there are a few outstanding units which have been able to arrange for commercial bank credits up to two or three years on prime terms comparing favorably with those extended to other quality industrial companies. We think it is clear that this short-term market has not been open, however, and is not open to certain other large and small aircraft companies who are in a weaker position. Even these present commercial credits are generally dependent upon the maintenance of working capital near current levels; that is, continued losses depleting working capital will have the effect of voiding most if not all of these credit arrangements prior to maturity. Moreover, it is debatable on what terms and to what extent continued short-term credits will be available to even the stronger companies, in the event of further continuation of current operating deficits.

As an indication of this trend, the stocks of even the stronger aircraft companies are selling at only fractions of their working capital and their net worth. Douglas stock, which is approximately similar to that of other aircraft manufacturers, is selling at near \$60 per share, whereas its working capital and net worth are equivalent to \$97 and \$114 per share, respectively. In contrast to these discounts of almost 40% from working capital and 50% from net worth, a year ago the discount on working capital was only 20% and that on net worth only 12%. This widening discount between the market value and the book values with which the industry's stocks are regarded is a serious detriment to new stock financings.

As far as we know there has been no new capital financing of any aircraft manufacturer attempted since prior to the war.

Investment and Market Opinion

The following is quoted from the most recent investment opinion of Standard & Poors Corporation in its aircraft industry survey dated August 22, 1947: "Despite the elimination of war adjustment outlays, generally unsatisfactory operations are indicated for commercial transport builders because of retarded output and high development expenses on new models. The depleted finances of the airline industry have reduced the potential demand for new commercial models and with development expenses high, few manufacturers are likely to make money in this field. Military aircraft enterprises are in a relatively better position, but few will report profits because of the rising overhead costs." In an even more comprehensive study that the Harvard University Graduate School of Business Administration released in the latter part of 1943, it was stated with considerable foresight: "Few if any of the airframe companies are in a position to justify borrowing large amounts for peacetime operations. When the assurance of steady war contracts is gone, the margin of safety afforded creditors by stockholders' capital appears insufficient to permit the raising of substantial funds through either funded debt or normal commercial bank credit. Whether equity funds can be raised will depend on both the prospects for profitability of operations and the general availability of new capital for equity financing." Subsequent developments have indicated rather clearly that the Harvard review was truly prophetic, that there has been no profitability of operations and no general availability of new capital for equity financing.

Again the acid test of investment opinion is the market itself, and it is significant therefore that while Standard & Poor's index of all industrial stocks averaged 9.5% higher in August 1947 than during August 1945, aircraft manufacturing stocks declined 31% during that two-year post-war period. This stock market situation epitomizes the feeling of the public toward the aircraft manufacturing companies and suggests that the public realizes that the compaines are being severely shaken down.

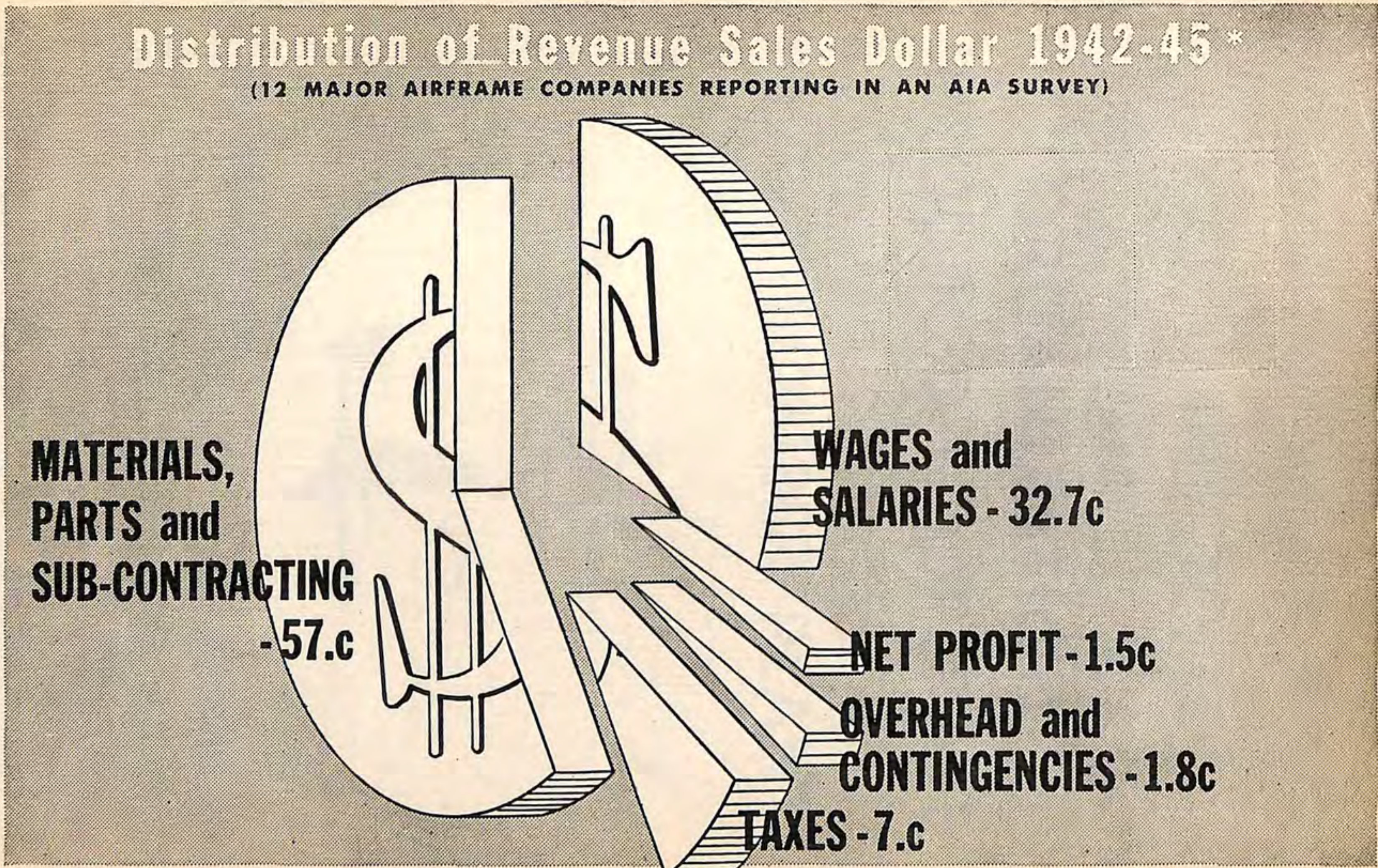
Obstacles to Obtaining New Capital

If new stock were to be sold by the average aircraft company, it would have to be sold somewhat under the present market, which means that any new stockholder would acquire his stock at about half of the present worth of the assets. There is consequently a dilution of the present stockholders' equity. The stockholder can truly say that he could realize more through liquidation of the company than he can realize through continued holding and possible dilution of his equity. There has been no serious talk of any aircraft liquidation to our knowledge, but if aircraft companies turn to products other than aircraft the results in the breaking up of aviation "knowhow" are at least partly as serious as liquidatiton. The natural course for those who find commercial funds unavailable is to turn to Government agencies; in our industry, this has already been done in a number of instances. If Government financing expands along with continued operating losses, however, we may find this country with a large part of its aircraft industry Government-owned, but without such a social policy having been intended, having risen only step by step. The implications of this situation, with the resulting impairment of product, would, in our opinion, be incalculably harmful. It has been our observation that no common stock can be sold when the stock presently outstanding is selling in a recognized market at a level materially below its net worth. It is also most difficult under these conditions to market issues senior to common stock without giving conversion rights, yet conversion rights cannot bear any resemblance to reasonable expectations when the market discounts net worth so heavily. We believe it can be fairly stated that there is no important new capital available to the aircraft industry so long as its operations are profitless.

CONCLUSION

To conclude, it is evident that the post-war financial characteristics of the aircraft industry in the aggregate have been and are losses of record proportions, mounting costs, and a steady shrinking of working capital resources. These unfavorable trends have given rise to new capital needs, but at the same time they have discouraged and prevented new financing except for a few short-term credits.

From the financial viewpoint, the basic requirement of the industry is a larger, more sustained volume of production at competitive prices which permit reasonable margins of profit. Without this single but important element of profitable volume, it is difficult to visualize any alternative other than that the industry will continue along its path of financial retrenchment, attempts at diversification, and makeshift devices in an effort, possibly a futile one in many cases, to stave off insolvency or bankruptcy. This is not a prospect suggesting strength in the air.



AS REPORTED BY AIRCRAFT INDUSTRIES ASSOCIATION

"COST INVOLVED and ORGANIZATION REQUIRED to OPERATE a HEAVY BOMBER PLANT"

by

WILLIAM M. ALLEN

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"COSTS INVOLVED AND ORGANIZATION REQUIRED TO OPERATE A HEAVY BOMBER PLANT"

SUMMARY

The modern heavy bomber is a highly complex machine. New models require 4 to 6 years to develop and cost upwards of $10,000,000. To assure continued supremacy in the air extensive research laboratories staffed by qualified men must continue to advance the frontiers of aeronautical science.

A heavy bomber plant must maintain a minimum payroll of 13,000 employees, which means an annual dollar volume (based on current labor and material costs) of approximately $80,000,000, in order to carry on with necessary experimental models, produce small quantities of service test airplanes and maintain a delivery schedule on production models of 5 per month. This is the minimum volume which will permit construction at reasonable costs and provide enough projects in various stages of development and production to sustain a well balanced organizational nucleus capable of reasonable expansion in an emergency. This level of production is based on the size and complexity of bombers currently in production. As larger bombers now in development stages go into production these figures will be subject to upward revision.

Production levels higher than the minimums proposed will result in lower unit costs and provide for greater expansibility. The final determination of the level at which heavy bomber plants should operate must come from a combined consideration of various data and information including the current and anticipated needs of the Armed Forces.

Boeing Aircraft Company, a wholly owned subsidiary of Boeing Airplane Company, has been engaged in the design and construction of airplanes since before World War I and has pioneered in the development of heavy bombers since the early 1930's. I am pleased to have the opportunity to appear before the President's Air Policy Commission and express my views on the above subject.

60,000 PARTS

A HEAVY BOMBER is one of the most complex machines ever made by man. A Model B-50 bomber (advanced B-29 Superfortress) currently under production in the Boeing-Seattle plant has a maximum gross weight of over 164,000 lbs. and contains more than 60,000 different parts, many of which are manufactured to close tolerances. It is operated and controlled by hundreds of precision instruments, each of which must be capable of functioning perfectly in temperatures ranging from 65° below zero, Fahrenheit, up to 160° above zero, and at altitudes ranging from sea level to 40,000 ft. above sea level. It is powered with four 28-cylinder engines developing 3,500 horsepower each and is equipped with 16′ 9″ reversible pitch propellers. It has a supercharged cabin. It is equipped with radio, radar, and automatic gun fire control. It has a maximum fuel capacity of 10,000 gallons and a maximum bomb load of 20,000 lbs. This is the machine that must be designed for quantity production.

THE DEVELOPMENT OF A NEW HEAVY BOMBER

To appreciate the costs involved and the organization required to operate a heavy bomber plant it is necessary to understand the time and effort required for research, development and testing to place a new heavy bomber in production. The B-29 Superfortress specification was set up in 1939 after two years of preliminary study. In 1940 actual design and construction was started on an experimental model. The first flight was made in 1942 and even under the pressure of war time needs the B-29 was not available for combat service until 1944, five years after agreement on specification.

So much for the time. Now what about the effort? On the experimental XB-29's a total of 1,433,000 direct engineering man hours were expended. By the end of 1944 (the year in which the first B-29 went into combat) another 4,850,000 engineering man hours had been expended. All during the war additional engineering man hours were expended in further developments and improvements. We are currently constructing an advanced Model B-50C prototype which will further improve the performance of the current production model and this will also require many additional engineering man hours. This expenditure of engineering manpower is in part due to continuing efforts, encouraged by the Army Air Forces, to reach for the ultimate in the performance of military airplanes.

To facilitate the research, development and testing required to attain the desired performance, laboratories have been maintained in the fields of electronics, acoustics, air conditioning, aerodynamics, plastics, electricity, structural test, propulsion, mechanical equipment and flight test. Each of these laboratories is staffed with men having years of experience in their respective fields. Progress in the aeronautical sciences, which was rapid even in peacetime, was greatly stimulated by the war and today we are on the threshold of many new developments, particularly in the transonic and supersonic fields.

As the science advances and the airplane becomes larger and more complex, costs and the required research and development increase out of all proportion to the increase in size. This is well illustrated by a comparison of costs between the first B-17 and the first B-29. The first Model 299 (prototype of the B-17 Fortress) required 150,000 engineering man hours and was constructed at a total cost of

$660,000. The first three XB-29 airplanes required 1,433,000 engineering man hours and were constructed at a total cost of $8,850,000. (One XB-29 would have cost approximately one-half this amount.)

COST OF OPERATION AND ORGANIZATION REQUIRED

The operation of a heavy bomber plant cannot be carried on successfully below a certain minimum level if it is expected to meet the following objectives:

1. Develop the world's best heavy bombers.
2. Produce such heavy bombers in production quantities at a reasonable cost.
3. Maintain a plant containing the necessary facilities and an organization consisting of all the necessary skills capable of reasonable expansion in time of emergency.

We assume that it is the desire of all concerned to meet these objectives. It is the considered judgment of the management of the Boeing Airplane Company that these objectives cannot be attained with respect to a heavy bomber plant unless it can maintain a minimum employment of approximately 13,000 employees. Expressed in terms of dollars (based on current labor and material costs) this represents an annual volume of approximately $80,000,000. These figures are predicated upon the size and complexity of heavy bombers such as the B-50 now in production. Much larger bombers are already in design and mockup stages, and as actual construction of experimental and production models gets underway, these figures will require substantial upward adjustment. The more pertinent data and facts upon which the foregoing figures are predicated are set forth in succeeding paragraphs.

ANNUAL PRODUCTION

Based on current contracts, the $80,000,000 would permit the following annual production expressed in terms of airplanes (exclusive of engines, propellers and other government furnished equipment):

2	Model XB-47 experimental jet bombers (including spares)	$10,500,000
10	Model YC-97 military cargo and transport airplanes (including spares)	20,360,000
60	Model B-50 bombers (including spares)	48,460,000
	Sundry spares and miscellaneous	680,000
72		$80,000,000

This output would require approximately 13,000 employees, divided between factory direct labor employees, indirect labor employees, and engineering employees as follows:

Direct labor	7,000
Indirect labor	4,500
Engineering	1,500
	13,000

Each employee works approximately 1,800 hours per year after allowing for vacation, sick leave and normal absenteeism. The 7,000 direct labor employees would be the equivalent of 12,600,000 man hours per year. Again based on current contract estimates these man hours would be expended as follows:

2 Model XB-47	1,750,000
10 Model YC-97	3,550,000
60 Model B-50	7,000,000
Miscellaneous	300,000
72	12,600,000

SURPLUS UTILIZATION

The figures presented above are not hypothetical but are approximated from actual current contracts. The man hours and dollar values for the ten Model YC-97's are abnormally high for the reason that three different models (YC-97, YC-97A, and YC-97B) are involved. This is not usual for a service test order. Conversely, the man hours and dollar values for the sixty B-50's are low due to the utilization of B-29 war surplus parts and assemblies. These deviations from what might be considered a normal situation substantially offset each other and do not affect the conclusions drawn from the data presented herein.

The above tabulations represent *one* experimental contract for 2 airplanes, *one* service test contract for 10 airplanes and *one* production contract for a quantity of 60 airplanes. This is not an uncommon sequence in the procurement of heavy bombers. First there is an experimental contract involving 2 or 3 airplanes. If the experimental bombers prove successful they are frequently followed by a service test contract for a quantity of 10 to 13 airplanes which provides the Armed Forces with a small quantity to test the model in service operations. The next step is a limited production contract for some larger quantity. In some instances an experimental contract may be followed directly by a limited production contract, particularly if an emergency does not warrant the intermediate step.

EXPERIMENTAL MODELS

The schedule showing volume of business required includes 2 XB-47 experimental jet bombers at a cost of $10,500,000. These experimental bombers will not be completed in one year. This is merely illustrative of the minimum that should be expended annually on experimental models. A heavy bomber plant should be working on two or three experimental models in various stages of development at any one time. Actually the Boeing-Seattle plant in addition to constructing the XB-47's is presently constructing a new Model B-50C prototype and has under development in preliminary stages a new Model XB-52 heavy bomber. The Company is also doing extensive experimental work for the Armed Forces in such fields as guided missiles, turbo jet engines, ram-jets and high altitude flight testing. During the year 1947 the Boeing-Seattle plant will expend well in excess of $13,000,000 on strictly experimental contracts. The proposed average annual expenditure of $10,500,000 on experimental models is an absolute minimum figure for a heavy bomber plant if it is to have a reasonable chance to continue to develop the world's best aircraft.

The second item in the tabulation of annual dollar volume required is 10 Model YC-97 airplanes. These airplanes are a cargo and transport version of the B-29-B-50 heavy bomber type. Again we point out that these planes would not all be produced in one year. This simply indicates the minimum yearly equivalent which is required in this second phase of procurement of heavy bombers. For each experimental bomber that proves meritorious a service test contract or a production contract for a limited number of airplanes should follow. This permits the incorporation of improvements indicated during flight tests and provides the Armed Forces with a sufficient quantity to test the model in service. It would be shortsighted indeed to spend money developing a new experimental bomber and then fail to follow through with a contract for additional quantities if the experimental model was successful in meeting advanced requirements of national defense.

MINIMUM RATE

That brings us to the third item included in the tabulation of minimum volume required, which is a quantity of 60 Model B-50 bombers. A quantity of 60 per year means a delivery rate of 5 per month. When it is remembered that we were delivering B-29 bombers at a rate of 160 per month during the war, and were prepared to accelerate deliveries up to 200 per month, the suggested minimum rate of 5 per month seems low indeed. This is the very minimum rate at which Boeing-Seattle can turn out heavy bombers at anything like a reasonable cost and maintain a balanced organization of the required skills available for reasonable expansion in time of emergency.

On production contracts, quantity has a very important bearing on all major elements of cost. These major elements are:

Engineering direct labor
Engineering overhead
Factory direct labor
Manufacturing overhead
Materials

The effect of quantity on each of these major elements is discussed in separate paragraphs below:

Engineering Direct Labor

With respect to that portion of engineering direct labor which represents design and development, it takes substantially as many man hours for one airplane as for a hundred. That portion of engineering which represents production drawings and liaison work with the manufacturing department does vary with quantity produced, although not in direct ratio to the increase in quantity. Referring again to the B-50 bomber contract to illustrate the effect on unit costs of engineering direct labor, the engineering man hours required on the first 60 B-50's is estimated at 1,224,000 or an average of 20,400 hours per plane. For the next lot of 73 B-50's, engineering man hours are estimated at 227,000, or an average of 3,100 hours per airplane. This is less than one-sixth of the average for the first 60.

Engineering Overhead

Engineering overhead varies almost directly with engineering direct labor, and quantity would have substantially the same effect on unit costs for engineering overhead as it has on engineering direct labor.

Factory Direct Labor

Factory direct labor divides itself into three main categories. The 7,000,000 man hours required to build the 60 B-50 bombers is divided into these three categories as follows:

Developmental labor	325,000
Tool labor	935,000
Production labor	5,740,000
	7,000,000

Developmental labor represents primarily the shop labor required for the construction of mockups and tests. The total hours required remains substantially the same regardless of quantity, with the result that unit costs decrease rapidly as quantity increases. The 325,000 hours set forth above covers 60 airplanes, an average of approximately 5,400 hours per airplane. The estimated developmental man hours for the succeeding 73 airplanes is 73,300, or an average of approximately 1,000 hours per airplane.

FACTOR OF QUANTITY

The effect of quantity on tooling labor costs is somewhat different, although the cost of tooling labor does decrease per unit as quantity increases. The quantity of airplanes to be constructed determines the type of tools and jigs as well as the extent to which it is economically practical to tool. In building one or two experimental airplanes the tools and jigs are of a very temporary nature and many parts are constructed without benefit of special tools. If the quantity to be produced is from 10 to 15, certain additional tooling would be required, but most of the so-called experimental tooling would be utilized. As the quantity is increased beyond this point the experimental tooling becomes entirely inadequate and more permanent tools are required. As the quantity reaches 50 to 75 more extensive tooling is required, and while still not wholly adaptable to war time production volumes, the greater proportion of the tooling would be suitable for use in accelerating production schedules. The estimate of 935,000 tooling man hours for the 60 B-50's compares with an estimate of 432,000 tooling man hours for the additional quantity of 73.

The effect of quantity on productive labor man hours follows a fairly uniform pattern. The rate of improvement resulting from experience and repetitive operations varies somewhat as between models but generally speaking follows what is frequently referred to as an 80% improvement curve when plotted on log-log paper. The estimated productive labor man hours on the 60 B-50's totals 5,740,000 or an average of 95,800 hours per unit. This same figure when plotted on our normal improvement curve would give the following average man hours for varying quantities:

Quantity	Average Man Hours Per Unit	Reduction in Unit Averages
10	158,700	
20	131,800	26,900
30	117,500	14,300
40	108,000	9,500
50	101,200	6,800
60	95,800	5,400
70	91,500	4,300
80	87,800	3,700
90	84,800	3,000
100	82,100	2,700

(See Appendix A for graphical presentation)

RATE OF REDUCTION

It will be noted that the average man hours per unit decreases very rapidly at first, but as the quantities go up to 60 and above the rate of reduction is less pronounced. We believe the above tabulation in itself indicates the desirability from a cost standpoint of keeping production quantities above 60.

MANUFACTURING OVERHEAD

Overhead costs, which in the aircraft industry are normally expressed as a percentage of direct labor dollar costs, vary as the volume of direct labor varies. The percentage of course increases as the volume of direct labor decreases because certain fixed charges such as depreciation, taxes and insurance remain fixed and most of the other overhead expenses do not decrease in proportion as direct labor decreases. A good example of this is production planning and control, which is one of the larger items of overhead expense. It takes substantially as much work to plan the production of parts for 30 airplanes as for 60 and since the direct labor required is less the overhead ratio is necessarily higher.

A study of all overhead functions indicates that with a total employment of 13,000, which provides for 7,000 direct labor employees, our overhead rate should be approximately 130% of direct labor. With a lesser or greater number of employees the ratio of overhead expenses to direct labor dollars would increase or decrease approximately as indicated by the following tabulation:

Total Employees	Direct Labor Employees	Overhead Percentage	Percent Reduction
4,600	2,000	213.0%	
6,400	3,000	174.0%	39.0%
8,200	4,000	153.5%	20.5%
9,900	5,000	143.0%	10.5%
11,500	6,000	135.5%	7.5%
13,000	7,000	130.0%	5.5%
14,400	8,000	125.0%	5.0%
15,900	9,000	120.5%	4.5%
17,400	10,000	116.5%	4.0%

(See Appendix B for graphical presentation)

Again we believe the economic soundness of operating at levels above the suggested minimum of 7,000 direct labor employees is apparent. We call attention to the fact that as quantities decrease there is a twofold effect on unit costs as to the labor and overhead elements. The number of man hours per unit increases and the rate of overhead which must be applied to the increased man hours also increases.

MATERIALS

Material costs are not affected as appreciably by quantity as are the other costs, although many of the special purchased equipment items are influenced to approximately the same extent as our own costs, and for substantially the same reasons.

INCREASED QUANTITY, WITH REPEAT ORDERS

If the procurement agencies place a repeat order for substantially identical airplanes in time to permit continuous production in assembly operations many of the cost advantages of a larger quantity order are preserved. This means that an increased number of airplanes could be produced at the same level of operations. For example, on a repeat order following an original order for 60 airplanes we could produce in the neighborhood of 80 to 85 airplanes with the same employment and for the same cost.

NUMBER OF CONTRACTS REQUIRED FOR STABILITY OF EMPLOYMENT

It is necessary for the Boeing-Seattle plant to be working on 6 to 8 contracts in various stages of completion in order to have reasonable continuity of work for all departments. For example, the actual building of the airplane structure is divided into four main subdivisions of tool fabrication, parts fabrication, sub-assembly and final assembly. When constructing relatively small quantities such as we are now talking of, the parts fabrication is substantially completed by the time sub-assembly gets well under way. Similarly sub-assembly must be well along before final assembly can make any real progress. Unless a new model or an additional quantity of an old model is released every four to six months, violent fluctuations in employment in any one department are bound to occur even though the total fluctuations within the plant might not be great. The minimum employment must be a fairly stabilized one, even within departments, in order that a nucleus of all skills will be available for quick expansion in an emergency. This also helps to keep costs within reason, since the hiring and training of new employees is very costly. This stability of employment requires a minimum of 6 to 8 contracts and this minimum number of contracts again points to a minimum annual volume of $80,000,000.

RESEARCH AND DEVELOPMENT EXPENSES NOT COVERED BY CONTRACT

Previous statements have been made on the cost of research and development particularly as it relates to contracts for experimental airplanes. The Boeing Company in its endeavor to maintain high standards of performance and also to be in a position to undertake the experimental work requested by the Armed Forces spends substantial sums for basic research and development which are not specifically covered by contract. Each year the engineering department submits a proposed budget together with a list of the proposed research projects to the Board of Directors for approval. For the year 1947 the Board of Directors approved a budget of $1,000,000 to be expended by the engineering department on such work. This not only emphasizes the importance which the Boeing management places on research but also points to the necessity for a substantial volume of business to make this possible.

EFFECTS OF COMMERCIAL BUSINESS

With respect to the minimum requirements for employment and volume of business, it is pointed out that commercial contracts for large transport planes, if properly coordinated and timed with military contracts, will help to provide the organization nucleus required, to maintain overhead costs at reasonable levels, and to carry some part of the research and development load. On the other hand, commercial contracts will not be a substitute for the research and development that relates solely to military weapons, not for the most of the cost advantages that accrue with quantity procurement of heavy bombers. In the overall picture commercial business has never been stable enough to hold together our aircraft industry.

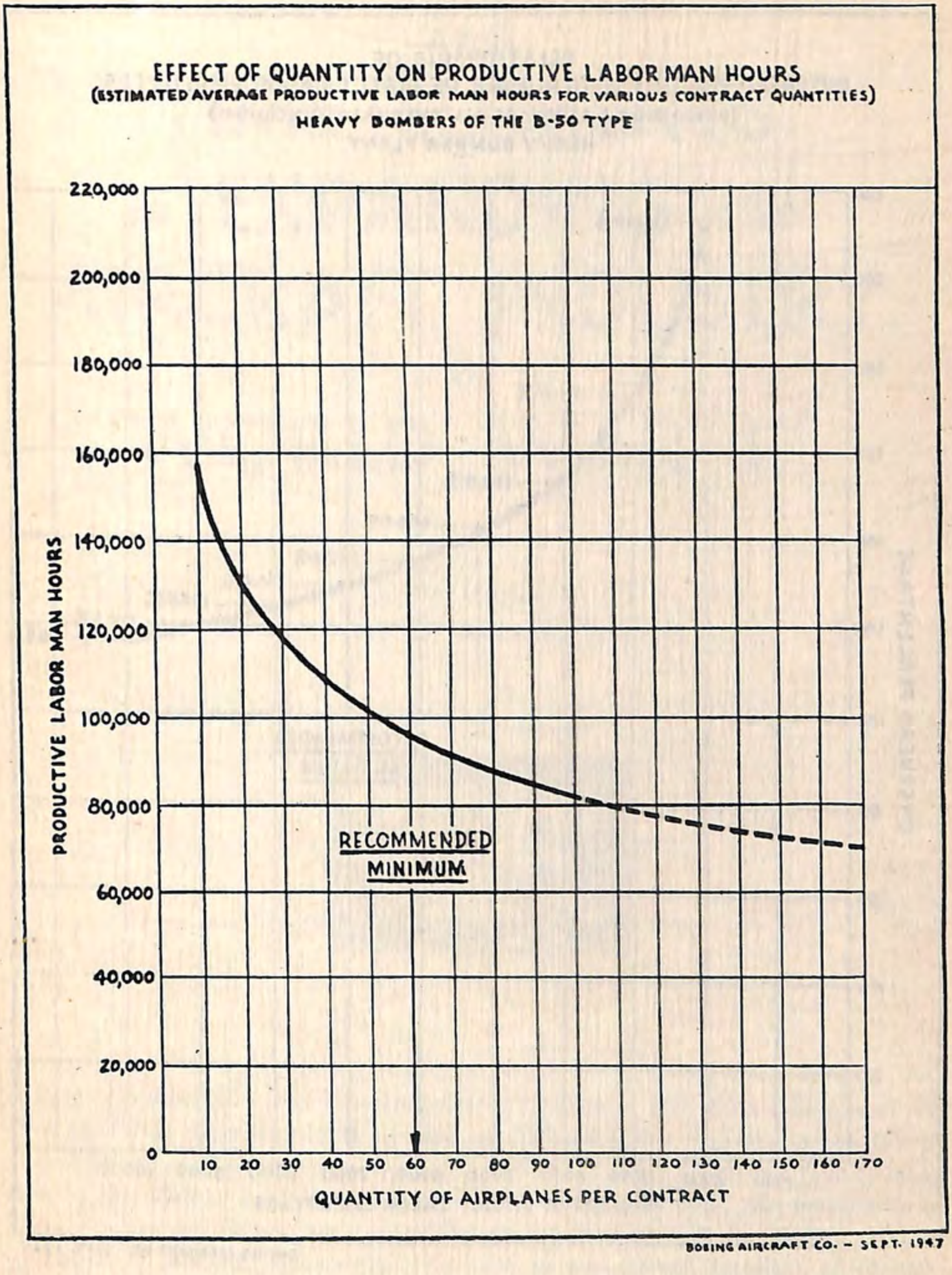
COMPARATIVE COSTS—PREWAR VS. 1947

In 1940 our average labor rate was $0.814 per hour and our overhead represented 72.4% thereof, so that for each direct man hour our total cost was $1.403. Today our average labor rate is approximately $1.40 and our overhead is approximately 125% so that for each direct man hour our cost is now $3.15 or approximately 2¼ times as much as in 1940. Labor and overhead represent approximately two thirds of the total cost on military contracts. Materials and subcontracted parts have also increased materially in price. It is obvious therefore that a volume of $80,000,000 in 1947 is comparable to something less than half that amount in prewar years. This increase in price levels when considered in conjunction with the increase in size and complexity that has taken place during this interval makes the required $80,000,000 volume more readily understandable.

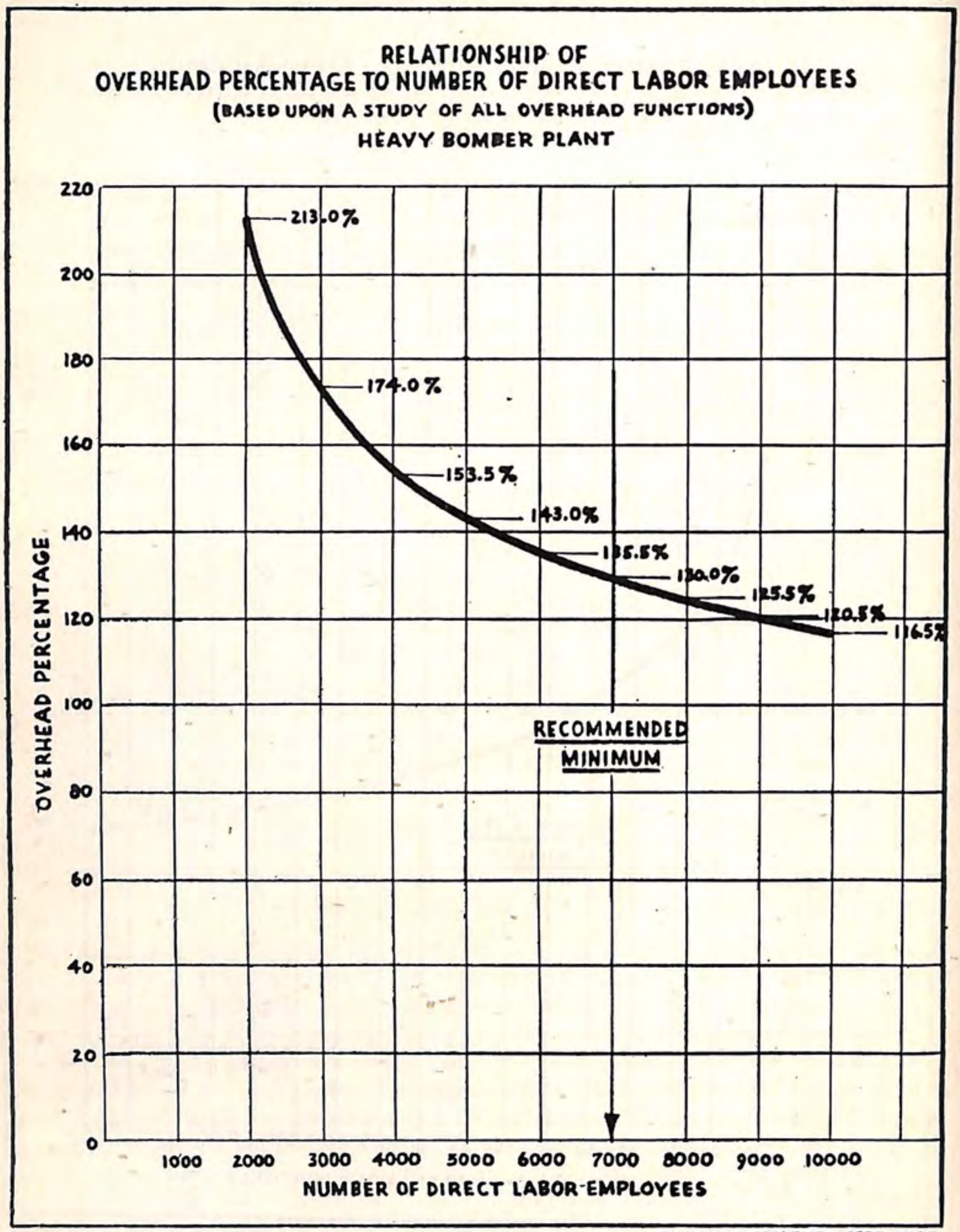
CONCLUSION

It has been the primary purpose of this statement to show the very minimum levels at which a heavy bomber plant can operate and (a) carry on with the necessary research and development to provide the Air Forces with replacement bombers of superior design and performance, (b) avoid unreasonably high costs, and (c) maintain a stabilized organizational nucleus available for reasonably rapid expansion in an emergency. No consideration has been given to such factors as the number of heavy bombers needed by the Armed Forces or the actual rate at which the heavy bomber plants will be expected to expand in an emergency. From the data presented herein it is obvious that still lower unit costs would result if quantities were increased above minimums indicated. Also a larger organization would be more expansible assuming it was a stabilized and well-rounded organization. The final determination of the levels at which our heavy bomber plants should be producing must result from a combined consideration of data of the type contained herein with other information such as current and anticipated needs of the Armed Forces.

APPENDIX "A"


EFFECT OF QUANTITY ON PRODUCTIVE LABOR MAN HOURS
(ESTIMATED AVERAGE PRODUCTIVE LABOR MAN HOURS FOR VARIOUS CONTRACT QUANTITIES)
HEAVY BOMBERS OF THE B-50 TYPE
PRODUCTIVE LABOR MAN HOURS
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
RECOMMENDED
MINIMUM
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
QUANTITY OF AIRPLANES PER CONTRACT
BOEING AIRCRAFT CO. – SEPT. 1947

APPENDIX "B"



BOEING AIRCRAFT CO. SEPT. 1947

"MAJOR PROBLEMS and TIME ELEMENTS in EXPANDING the AIRCRAFT INDUSTRY in WORLD WAR II"

by

GUY W. VAUGHAN

President, Curtiss-Wright Corporation, New York, N. Y.

★ *A racing car driver in the days of Barney Oldfield, and later, designer and builder of automobiles, Mr. Vaughan entered aviation in 1917 as an executive of the Wright-Martin Company, then producing Hispano-Suiza engines. After World War I he returned to the automotive field until 1924, when he became factory manager of the Wright Aeronautical Corp., and the following year, vice president and general manager. When the Curtiss-Wright merger occurred in 1929, he became president of Wright Aeronautical. In 1935 he was elected president of Curtiss-Wright, and has since directed its activities.*

"MAJOR PROBLEMS AND TIME ELEMENTS IN EXPANDING THE AIRCRAFT INDUSTRY IN WORLD WAR II"

SUMMARY

1. The problems besetting Curtiss-Wright in its efforts to expand for World War II are cited as representative of those encountered by the entire aircraft manufacturing industry.

2. This experience indicates two major and fundamental shortcomings in the national aviation policy—the lack of a clear concept of the aviation industry's functions in peace and war; the lack of a workable plan to achieve the most effective use of the specialized talents and physical facilities of the industry.

3. These shortcomings suggest the aviation industry should be organized and maintained as the primary source for the design and development of aircraft and their components. Thus it should:

a. In time of peace, maintain continuity of production in quantity sufficient to enable it to design and develop the most effective and economic tools for primary mass production at the earliest possible date.

b. In time of war, while producing to its fullest capacity, serve as the source of supply not only for the basic designs of aircraft which will be needed immediately; but also as source for the design of specialized patterns, tools and fixtures with which qualified manufacturers outside the aviation industry could most rapidly get such aircraft in full mass production.

4. With this concept of the aircraft industry's functions, a plan could be projected for harnessing additional industries for the rapid and efficient mass production of aircraft. Not only would this provide for the mass of airpower needed immediately, but also allow the specialized talents and facilities of the aircraft industry to be concentrated on the development and initial production of the aircraft necessary to maintain that airpower.

5. Lacking this proper concept and a plan based upon it, the best that could be expected would be a repetition of the chaotic conditions encountered in producing aircraft for World War II. Never again will there be three years to overcome the obstacles encountered in mass producing by trial and error.

6. Materials, methods and manpower are the three essentials of any plan for defense expansion. Special significance is attached to manpower if Russia is to be our enemy because subversive elements could cause unprecedented delay in industrial centers.

TWO-WAR EXPERIENCE

CURTISS-WRIGHT CORPORATION, formed by the grouping of several aircraft companies, is one of the few manufacturers in the aircraft industry whose experience dates back through both wars.

Having maintained a continuity of production through its various units which survived the drastic conditions besetting the industry after the first World War, it was called upon to undertake certain experiments with regard to policies and programs for World War II.

Thus, its experiences in the preparation for and during the last war are, in fact, a composite of those encountered by the entire industry but compounded in our case by the magnitude of the assignment which made Curtiss-Wright the nation's largest producer of aircraft and their components.

ROOSEVELT PROGRAM

Prior to the entry of the United States into World War II, Curtiss-Wright was first called upon to expand its production of aircraft, engines and propellers for allied nations. When President Roosevelt called for his expanded program in 1940, we were asked to provide for the mass production for the United States of the following:

6 types of airframes
4 types of engines
5 types of propellers

As a result of the condition in which the industry had been maintained between wars, neither Curtiss-Wright nor any aircraft company had facilities adequate for this production and it was necessary to enlist outside companies.

From the outset we experienced considerable difficulty in finding suitable companies with adequate facilities who were interested in subcontracting or taking licenses.

EXPANSION PROGRAM

In order to live up to the task assigned us, we were, therefore, required to lay out an expansion program starting from our four plants and ultimately resulting in the operation of 17 plants in 10 localities. Our employment grew from 14,000 in 1940 to 181,000 at the peak of the war. The square footage in our manufacturing plants spread from 1,971,000 at the beginning of 1940 to a total of 24,963,000 square feet in 1944.

This required that Curtiss-Wright:

1. Expand four plants.
2. Build eight plants.
3. Lease five additional plants.
4. Construct and operate two modification centers; one at Buffalo, N. Y., and the other at Columbus, Ohio.
5. Train over half a million employes in order to maintain a sufficient number to do the job required of us, in the face of a constant labor turnover.
6. Provide college courses for approximately 1,000 women who were necessary to replace engineers who were drafted.

7. Train an organization of 2,000 people for the purpose of maintaining liaison with licensees and, in turn, training their personnel as well as that of subcontractors to meet the higher standards of the aircraft industry.
8. Subcontract to approximately 2,000 companies.
9. License 9 companies.
10. Provide approximately 1,000 trained technical representatives in foreign and domestic operating areas to instruct in maintenance of products.

WAR PRODUCTION

Under this program, Curtiss-Wright produced a total of 142,840 engines, 146,468 propellers and 26,269 airplanes in its own plants.

In addition, under licensees it produced 136,919 engines and 1,134 airplanes.

In dollar volume, Curtiss-Wright during these five years delivered to the armed forces, airplanes, engines and propellers valued at over five billion dollars — the largest contribution to the war effort by any single aircraft company.

Our experiences in World War II, largely confirming the earlier lessons of World War I, emphasizes two major and fundamental shortcomings in our national policy:

1. The lack of a clear concept of the proper function of the aviation industry in peace and in war.
2. The lack of a workable plan to achieve the most effective use of the talents and physical facilities of this one industry upon which the country is most dependent for its defense in war and its security in peace.

These two factors are fundamental to the ultimate purposes for which this Commission was created.

Until a proper concept of the industry is understood, there can, obviously, be no workable plan.

PRIMARY SOURCE

The aviation industry should be organized and maintained as the primary source for the design and development of aircraft and their components. Thus, it should:

In time of peace, maintain continuity of production in quantity sufficient to enable it to design and develop the most effective and economic tools for primary mass production at the earliest possible date.

In time of war — while producing to its fullest capacity — serve as the source of supply not only for the basic designs of aircraft which will immediately be needed; but also as a source for the design of specialized patterns, tools and fixtures with which qualified manufacturers outside the aviation industry could most rapidly get such aircraft in full mass production.

INITIAL PRODUCTION

With this concept of the aircraft industry's functions, a plan could be projected for harnessing additional industries for the rapid and efficient mass production of aircraft. Not only would this provide for the mass of air power needed immediately, but also allow the specialized talents and facilities of the aircraft industry to be concentrated on the development and initial production of the aircraft necessary to maintain that air power.

Lacking these two things — this proper concept and a plan based on it — the best we could expect would be a repetition of the chaotic conditions that we encountered in producing aircraft for World War II.

I say this is the best we can expect. I think it extremely unlikely we would ever again have three years to overcome the obstacles encountered in mass production by trial and error.

The resulting problems which detracted from the essential job of production and added immeasurably to the cost of World War II were countless. A few are so illustrative of the conditions that prevailed throughout the industry in the absence of a plan and a proper concept, I should like to outline them briefly.

"TYPING" PLANTS

In many instances, the requirement for the placing in production of more than one type of airplane in a plant created great confusion on the part of the entire personnel. By spreading the responsibility over several types, serious inefficiency was inevitable and resulted in excessive costs and serious delays in production schedules.

In general, experience proved it most effective to "type" a plant with one design, thus affording the opportunity for all concerned to concentrate on this one type and produce with the greatest efficiency and results.

Designs in process should obviously be continued in the established plant of the prime contractor until completed and tested for service. Initial design and production changes should be worked out in the prime contractor's plant prior to releasing it to other plants for manufacture.

ENGINEERING FOR MASS PRODUCTION

Because of the depleted state in which the aircraft manufacturing industry was maintained in the period between the wars, staffs were undermanned and lacked experience to engineer for mass production.

Salary stabilization, due to its inflexibility, seriously interfered with the efforts of the aircraft manufacturing industry to attract qualified personnel from peacetime industries. Although some persons hesitated to give up employment in normal peacetime industries for what they believed were temporary war jobs in the aircraft industry, the greatest single factor of influence was the wage and salary differential in the aircraft industry when wages and salaries were frozen.

The pay scale in the aircraft manufacturing industry had always been lower than those in several other major industries. When freezing came, the aircraft industry was trapped at a level that left it with relatively poor-paying war jobs. Naturally, war-job seekers jumped into industries with salary levels frozen far above the aircraft industry rates.

DESIGN AND PROCUREMENT OF EQUIPMENT

The problems encountered by manufacturers in attempting to procure production equipment and materials indicated a reluctance on the part of the government to delegate authority to individuals empowered to issue orders for materials and tools for those contractors who had immediate production schedules to meet.

The manufacturer was constantly improvising specialized tools because the sources and availability of specialized tools and equipment had never been catalogued. Also, delays of as much as 14 to 30 months occurred in the procurement of certain important items needed for production.

The shortage of tool designers, tool makers, and tool production capacity was one of the most serious related problems and compounded the basic difficulty.

PLANT CONSTRUCTION AND INSTALLATION OF EQUIPMENT

Lack of early provision by the government for adequate priority control left the plant construction contractor unprotected and resulted in his experiencing many delays in obtaining labor and delivery of building installations items.

EXPANDING MANAGEMENT AND SUPERVISION

The nucleus of trained personnel at the outbreak of the war was only that which could be economically justified and supported by the peacetime level of the aircraft industry. It proved to be wholly inadequate, and the level is relatively worse today.

Although promoting "from within" is a healthy and successful policy of industry in normal times, the unusual demand for expansion and multiplication of management and supervisory groups required additional key personnel of extensive experience which had to be secured from the outside. Naturally, because of the previously mentioned salary stabilization policy, the industry was handicapped in its efforts to get this outside help.

Branch or new plants located at points distant from the prime contractor's main plant, placed an unusual load on the prime contractor's management, executive and supervisory personnel. Maximum utilization of personnel can only be obtained by limiting activities of personnel to one geographical location.

EMPLOYMENT PROBLEMS

The most serious employment problem encountered by the aircraft industry reflects the serious lack of an adequate system of vocational training in the United States. The ratio of mechanically trained to non-mechanically trained youths of today is so far out of line with the requirement of industry for war and personnel for the armed forces that it constitutes a real hazard.

The lack of a well-integrated system providing for apprenticeship courses, properly sponsored, contributed further to the personnel problems of the industry, particularly with regard to the shortage of skilled labor such as toolmakers and die sinkers.

MATERIALS

The lack of proper stockpiles of critical materials and the corresponding lack of adequate equipment for their processing, in many instances, became the limiting factor in the acceleration of production.

The priority system for material procurement was inadequate and ineffective, resulting in large unbalanced inventories. The Controlled Material Plan attempted to correct this but the administration of the plan never grew up to the job at hand. Possibly, if war had continued, the C.M.P. might have been the solution.

TRANSPORTATION OF SUPPLIES

Due to the lack of a supporting system of rapid transportation, serious production line delays were often caused by the slow movement of materials. The manufacturer had to rely on ground and water transportation at times "when minutes meant hours." Provision of a supplementary system of air cargo for essential materials was needed and could have appreciably reduced material and parts delivery delay problems.

SUPPLIERS, SUBCONTRACTORS, LICENSEES

The absence of a practical plan for the allocation of suppliers, subcontractors and licensees resulted in a scramble among prime contractors to tie up available facilities, at a considerable cost of time and money. Licensees and subcontractors, properly chosen and allocated prior to the expansion program, could have relieved the prime contractor of many of the problems that arose from the necessity for expanding his own facilities.

Under the system that existed, the demands of expansion on the prime contractor's executive and supervisory personnel seriously weakened his organization. Adequate licensees would have supplied the opportunity to have them absorb a large portion of the work requiring specialized skills.

The lack of a uniform type of subcontracting contract, approved by government and industry, caused too much bickering between prime manufacturer and prospective subcontractors, and resulted in lengthy delays in getting subcontracts signed and executed.

INEFFICIENCY AND CONFUSION

The delay in government agencies making decisions and, once made, to issue effective authority to take action on these decisions, proved to be a serious source of delay. Inestimable time and money was lost by the practice of calling unnecessary conferences to reach decisions that should have been rendered by one official.

As an instance, it took four months to obtain a decision on the construction of a new plant and three months additional to get the authority to begin construction.

The lack of a standard system of methods and procedures covering the relationships between contractors and government agencies added appreciably to the confusion.

Lack of proper timing on delivery schedules of Government Furnished Equipment and other components to the prime contractor created overages or shortages imposing a tremendous burden on his warehousing, dispatching and production personnel. This frequently resulted in installing a part on the airplane after assembly instead of installing it on the production line.

The requirement that contractors must seek bids for materials and subcontracting work and then do business with the lowest bidder often led to extravagances far greater than those the requirement was designed to eliminate. In practice, this often meant that the contractor was forced to do business with organizations which he knew from the start were not in any way qualified. As a result, he often spent more time and money expediting the items or repairing them than if he had been allowed to pay a slightly higher price in the first place. Cost inspectors at the local level, many of whom were inexperienced or incompetent, should not have been allowed to interfere with the contractor's practical experience on the selection of material sources.

STABILITY OF EMPLOYMENT

The history of "ups" and "downs" in the aircraft manufacturing industry has marked it as a business where tenure of employment is uncertain. As a result, the recruitment of employes, particularly in the skilled crafts, has always been handicapped.

Because of this, the highly specialized engineering, tooling and factory groups that the industry can train and retain continuously represent only the nucleus of a manufacturing organization.

This special status of these groups must be recognized in time of war and these men must not be drafted out of their jobs if the industry is expected to establish and direct a vast and complex national organization for the mass production of aircraft.

CONCLUSIONS

The experience of the aircraft manufacturing industry in World War II demonstrates these two essential shortcomings in our national policy with regard to aviation — the lack of a proper concept of the industry's function in peace and in war; and the lack of a sound long range program based upon such a concept. Had it not been for the fact that the delaying action of our allies gave us more than two years to prepare for World War II, the contribution of American air power could not have been what it was. Considering the conditions under which it operated, the accomplishments of the American aircraft industry were miraculous, but it was a man-made miracle forged with hastily acquired tools and trial and error mass production. Never again will the nation have the time. Even a well established plan for war expansion is not enough. There will be no time to prepare — only time to fight. And that means an air force in being at all times, with sufficient production to maintain that air power.

Any adequate plan for defense expansion must be based upon full consideration of the three essential elements of materials, methods and manpower.

There are times when one of these elements may assume special significance. At the present time for instance, special consideration must be given manpower because of the nature of our potential enemies. If Russia should be an enemy, the subversive elements in this country could cause unprecedented delay in any production program in industrial centers.

With a comprehensive long range plan, and production adequate to sustain it, the aircraft manufacturing industry can assume with confidence its full responsibility as the primary element in the nation's defense in war and security in peace.

"PROBLEMS of a RAPID EXPANSION of AIRFRAME PRODUCTION in a FUTURE WAR"

by

J. H. KINDELBERGER

President, North American Aviation, Inc., Los Angeles, Cal.

★ *Mr. Kindelberger has been actively engaged in the manufacture of airplanes for 29 years. A flight instructor for Army Air Service in World War I, Kindelberger entered the aircraft industry as a draftsman at the Glenn L. Martin plant in Cleveland after the Armistice. When Donald Douglas formed his company in 1925, Kindelberger became its Chief Engineer. In 1934 he left Douglas Aircraft Company to become president and general manager of North American Aviation, Inc.*

J. H. KINDELBERGER

"PROBLEMS OF A RAPID EXPANSION OF AIRFRAME PRODUCTION IN A FUTURE WAR"

INTRODUCTORY SUMMARY

I HAVE BEEN asked to submit a statement discussing "the problems of a rapid expansion of airframe production in a future war." At the outset I wish to express to the Commission my appreciation of this opportunity to present my views on this vital matter.

Because of the scope of the subject, it will be necessary that I make rather broad assertions on many points, and submit verbally at subsequent hearings whatever supporting facts or further development the Commission may desire.

I am aware that there are differences of opinion within the airframe industry on some phases of this problem. I therefore point out that the opinions expressed herein represent myself and the company which I head, and cite as background our qualifications. I have been actively engaged in the airframe manufacturing business for 29 years, the last 13 as president of North American Aviation. The company expanded from 6,000 employes in one plant in the summer of 1940 to some 92,000 in five plants three years later — delivering 13.8 per cent in terms of units and 11.1 per cent in terms of airframe weight of all the military airplanes produced by the nation during the war years. Airplanes developed by this company and produced in large volume throughout World War II included the P-51 Mustang fighter, the AT-6 Texan combat trainer, and the B-25 Mitchell bomber.

It is my belief that, from the standpoint of military aviation, three basic conditions are essential to national security. In the order of importance they are:

1. Maintenance of air forces in being modern enough and strong enough to meet and contain any military threat for a period of six months to one year. No matter what kind or extent of preparedness planning we undertake, the nation cannot realistically depend on the airframe industry to contribute a significant increase over its peacetime volume in the first year following an unlimited production go-ahead.
2. Continuous military aircraft production sufficient to provide adequate replacements for these air forces, and sufficient to maintain a rapidly expandable nucleus of production equipment, flow, and skills. I believe that, for the foreseeable future, a level of aircraft production adequate to supply replacements for the air forces we need will be adequate to maintain this industrial nucleus. When the nation no longer needs large air forces, we will probably no longer have to worry about the expansibility of aircraft production.
3. Provision on a national scale for availability of plant space and machine tools, but most important of all for flow of materials to aircraft plants on a time schedule consistent with the schedules the manufacturers will be expected to meet. In any such material flow planning realistic recognition should be given to processing time from mine to airframe plant, and to the lead time necessary between receipt of material by the manufacturer and delivery of the finished airplane. I believe that, given reasonable foresight on the part of the airframe manufacturers and just a few minor and inexpensive so-called "internal" (or in-plant) preparedness measures, all major steps necessary for expansion of the airframe industry can be accomplished within the schedule made possible by the material flow schedule.

In the following pages the Commission will find a discussion of various elements of the expansion problem under their appropriate headings.

ENGINEERING FOR VOLUME PRODUCTION

By the way of background, it should be pointed out that there is always some engineering to be done as long as an airplane type is in production. As an illustration of this point, the B-25 original design in 1939-40 required only about 200,000 engineering man hours, but when the last of some 9,800 airplanes was completed in 1945, the engineering effort had reached more than 4,830,000 man hours. That is an extreme example, since the B-25 was probably modified for a greater number of specialized functions than any other wartime airplane, but it serves to emphasize the point that in military aviation engineering is a concomitant as well as an antecedent of production.

Naturally a rapid increase in production rate would automatically increase the volume of this "maintenance" engineering, and would also require some further refinements of design. However, and this is the important point, it should not require **complete re-design** for volume production. I have been informed that some companies have indicated in their Phase I reports under the Mobilization Planning Program that they contemplate a complete re-design as the first step in getting ready for high production. I am in fundamental disagreement with development practices which result in the necessity of this step.

At North American we design even an experimental airplane for production, in the sense that we attempt from the outset to achieve optimum production breakdown into component assemblies, maximum use of standard parts, and consideration of fabrication and assembly problems on all items. We have always followed this practice because we consider it more economical, more efficient, and part of our fundamental design responsibility.

If it is assumed that all the other elements necessary to rapid production expansion will magically become available overnight, so that the minor amount of re-designing that should be required may be a limiting factor, then I say that this minor re-designing for high production should be accomplished in peacetime. However, if we are more realistic about the availability of other elements, notably materials, then I feel there should be no concern about initial engineering bottlenecks, provided of course that the design job has been done properly from the beginning. With reference to the latter point, I believe it should be the responsibility of the air services to see that models which will be relied upon in an emergency are properly designed from the standpoint of producibility.

TOOLS AND EQUIPMENT

There are three major categories of tools to be considered: (1) general purpose machine tools like lathes, milling machines, drill presses, etc., which can be used to produce many different parts for any type of airplane; (2) special purpose machine tools, such as spar milling machines, multiple drill machines, etc., which are necessary or desirable to produce a specific part or small group of parts; and (3) special fabrication and assembly tooling, such as drill jigs, contour templates, forming dies, forging and extrusion dies, and assembly jigs. Small tools and handling equipment are not a serious problem.

General purpose machine tools were a bottleneck in World War II. Establishment of a reserve of such machine tools is a desirable and necessary step which is already being taken by the Government. Existence of this reserve will not only make these general purpose machine tools more readily available in an emergency, but will release capacity in the machine tool industry for rapid production of critically needed special purpose tools.

Special purpose machine tools were a serious bottleneck in World War II. They are harder to obtain because they are normally larger than regular machine tools and because they are not standard items for the machine tool industry. Special purpose machine tools could be a more serious problem in a future war because more of them will be needed by virtue of high performance aircraft requiring more complex manufacturing methods. An example may be found in the tapered wing skins necessary on the new P-86 jet fighter. A special machine costing about $60,000 will be needed to mill the relatively small quantity of these skins required for low production. If we had to accelerate to high production on the P-86 airplane we would need many of these machines or a better way of doing the job. Problems such as this will have to be investigated in peacetime, and in some instances it may be advisable to spend a little money on obtaining the necessary equipment, or better still on developing a high production method for meeting low production requirements. In the instance of tapered skins, this might consist of a precision method of rolling sheet to a controlled taper at the mill.

Fabrication and assembly tooling is designed and made by the airframe manufacturer to meet his requirements. Normally such a tool is applicable only to one part or assembly, and frequently a series of tools will be required for one part or assembly.

I believe that duplicate and, wherever necessary, more refined fabrication and assembly tooling can be made for high production rapidly enough to coincide with acceleration requirements provided the peace time tooling is soundly conceived. That is, if the airplane has been properly designed for production, and if the peacetime low production tooling represents a step on the road to high production tooling rather than on a dead-end alley, then it should not be necessary to scrap all low production tooling in order to go to high production. As in the instance of engineering, the air services should encourage progressive tooling policy and practice.

I definitely do not agree with the concept of building a complete set of high production tooling and "putting it on the shelf." About 90 per cent of such tooling would be obsolete or impracticable when it came time to use it, and the cost would be tremendous. Tooling is a little like the airplane itself, in the sense that it cannot be said to be developed until it has been used and had the "bugs" taken out of it. Shelf tooling would be about as reliable in an emergency as paper airplanes. I do believe that it would be desirable to make some general studies of tooling and plant layout requirements as part of preparedness planning; these studies may reveal the need on certain programs for the peacetime construction of control masters of certain tools to facilitate duplication of the tooling for other plants which may be activated. None of these activities will be extremely expensive if held to a necessary minimum.

ACTIVATION OF STANDBY PLANTS

Some standby plants have been established by the Government. I consider this desirable, since some delay was caused in World War II by plant construction.

Activation of standby plants by existing airframe manufacturers should present no serious problems if the plants can be occupied promptly, if machine tools are available, and if the airplane in question has been properly engineered and tooled as discussed above. The only preparedness planning I would recommend would consist of general studies of problems and plans involved in putting a given model into a specific plant, which of course must be based on prior allocation of available standby plants to the various airframe companies. This type of study will be very inexpensive.

EXPANDING MANAGEMENT

On the basis of our wartime experience, I believe that airframe management in a war will have to come largely from the airframe management existing in peacetime. Our company's expansion from one to five plants was handled entirely with prewar personnel at the top levels, supplemented of course by promotions from within at the supervisory levels, and in a very few instances by outside recruiting in specialist categories.

North American found that concentration of its best managerial talent in a general office staff, with branch managers subject to guidance from these staff members in their respective spheres of activity, worked out very satisfactorily. The system permitted focussing our best people's attention on the weakest link in the chain at any given time.

Insofar as preparedness planning is concerned, I know of absolutely no means of insuring enough skilled airframe management in wartime except through adequate peacetime production to develop and hold top-notch personnel.

RECRUITING AND TRAINING WORKERS

In my opinion, the recruiting and training of workers for production expansion is not likely to be a major limiting factor, provided that necessary steps, such as curtailment of material allocations to non-war industries, are promptly taken at the national level to force labor out of civilian production.

However, I believe that some benefit would be derived from developing workable training programs in peacetime, and also from discussions with local school authorities, particularly in standby plant communities, toward the end of perfecting plans for emergency large scale training in basic shop skills. Possibly it will be feasible in many communities wherein peacetime airframe plants are located to utilize these arrangements in peacetime as a source of labor replacements. Our company had very good experience with such training programs during the war, and I heartily endorse any soundly conceived efforts of this nature.

LOSS OF MANPOWER TO SERVICES

Production accelerations can be retarded if we fail to understand that trained workers in vital war industries can do infinitely more good for the war effort in the production job than in the fighting job. In my opinion it is ridiculous to take a man from a production job or a technical job which he understands, and in which he contributes to an end product vital to the armed forces, and put him in some branch of the services as a raw rookie who can contribute nothing until he has been given expensive and time-consuming training in some military specialty. Withdrawals from the West Coast airframe industry during World War II left us in such a critical position at one point that we flatly told the Government it would have to decide whether it wanted soldiers or airplanes from the airframe plants. Temporary relief was given in the form of a draft moratorium, but this problem plagued every manufacturer throughout the war.

If it is necessary that the authority for manpower draft selection be placed in local boards, then I consider it essential that they operate under a clear and concise set of rules which will prevent the draining of manpower from airframe and other vital war plants. It must be borne in mind that our peacetime team will have to be split up to provide supervisory nuclei in a number of plants, thereby distributing higher responsibilities all down the line.

Another important point I want to make is that airframe technical people should not be encouraged to get into the Army or Navy reserves. Their training and experience comprise one of the most vital resources of the airframe industry at any time, and most particularly in wartime. Further, I believe that the airframe industry has an obligation to do everything possible in peacetime to prepare these technical people and specialists of all kinds for increased responsibility and supervisory authority in an emergency expansion. Since the services will also need personnel with technical training on the various types of aircraft, I would suggest that we be given contracts during peacetime to train their people at our factory, much as we trained enlisted men at our factory service schools during the war.

MATERIALS

As background for my comments on the material problem I should like to acquaint the Commission with the nature of airframe materials and some other fundamental considerations necessary to realistic material planning. The general misconception I want to attack is that materials coming out of the mine today can be flying around in the sky tomorrow, or any time within the next 12 months. The airframe industry is a long way downstream from the basic raw material.

When the airframe industry speaks of raw material, it actually means processed material. Let us consider aluminum, since it is our principal material. After bauxite ore is mined, it is shipped to the processing plant. There it is refined, combined with other metals to make the required alloys, and poured into molds to make large bars or "billets." These billets are finally drawn or extruded into wires, tubes, bars, rods, and extrusions; rolled into sheets; hammered into forgings; and poured to make castings. These processed products, after heat treatment and various other steps, then become the "raw material" of the airframe industry. The average time span from mine to airframe plant is estimated at about six months.

Since the airframe industry obtains thousands of equipment items and parts from suppliers specializing in these items, there will be an additional delay of from four to ten months to allow for fabrication and assembly of these items. On complicated major equipment items like engines the time span will be even longer. Finally, after all materials are in the hands of the airframe manufacturer, it will take from two to six months, depending upon the item involved, before the materials will be fabricated and assembled into a finished airplane. The average in-plant time span under high production conditions is about four months, including the necessary allowance for working inventory. However, during the critical build-up period this in-plant time span will probably be between six and seven months.

With that background we can consider the material problem in its proper perspective. In all mobilization planning studies I have seen to date there is the blanket assumption that materials will be "available." I say they will not be available unless we take this out of the category of a comfortable assumption and devote most of our planning effort, and most of the funds over current procurement requirements, to see that we have the materials or the capacity to produce them.

The average person in or out of government has no conception of the aggregate material requirements for large scale production in a score of industries under war emergency conditions. Orders from all tiers in all these industries snowball so rapidly that soon only the most critical of many critical programs is getting what it needs. Dare we close our minds to the experience so recently behind us?

I believe that something should be done to avoid a repetition, under far more critical conditions, of our World War II experience. My conception of what might be done runs something like this:

1. Our top military planners should determine in general terms how much material of various kinds is required per unit of measure for all the items needed in an emergency, including planes, guns, tanks, shells, ships, etc.
2. Allowing adequate lead time based on the advice of industry, they should then set up a tentative material requirement schedule which would make possible the end product deliveries contemplated in strategic plans.
3. After determining from material sources just how far the actual material potential is below this master requirement schedule, the Government should take whatever steps are necessary to bring the potential supply in line with the projected demand — or at least as nearly in line as a minimum safe measure of national security may require.
4. The military planners will then know that, if their schedule calls for 5,000 planes and 2,000 tanks delivered within a given period after the emergency starts, but their material potential makes possible only one-fifth of this output — they cannot possibly get more than 1,000 planes and 400 tanks. This will avoid the very great danger of basing strategic plans on unrealistic estimates of material strength.

I cannot emphasize too strongly the importance of this fundamental approach to material planning. We must realize that a future war could be lost in a relatively short time if our armed forces receive only one-third or one-half of what they expect after the emergency arrives and the Government says "go."

The only practicable way I know to narrow the gap between materials required and materials available, at least for the airframe industry, would be to stockpile billets of the proper alloys, which would be far enough downstream to facilitate delivery to the manufacturer, but which would not become obsolete. In addition it would be desirable to stockpile certain semi-finished materials in standard shapes and gauges, such as sheets, bars, tubes, and wires. This latter could be a revolving stockpile to be drawn on by the industry in peacetime and thereby avoid large scale obsolescence.

If one particular item is overlooked in this stockpiling it will not be too serious, because the processing capacity will not be immediately swamped. It will be able to take care of exceptions instead of being overloaded with basic requirements.

When an emergency comes, we want to start getting extra materials on our receiving docks in a matter of weeks rather than months. The only way to insure this is a stockpile of some sort plus going capacity.

SUPPLIERS

By suppliers we mean specialist companies which design and fabricate more or less standard materials and parts, such as sheet stock, rivets, fittings, electrical equipment, hydraulic equipment, rubber fuel cells, etc.

In my opinion, the best insurance for expansibility with regard to items purchased from suppliers is adequate peacetime volume. Further, in placement of their peacetime orders airframe manufacturers should exercise a reasonable degree of judgment so as not to give all business to companies incapable of high production. A problem is encountered here at the present time, in that some of the more dependable companies will not even bid on present peacetime business because the volume is too low to make it worthwhile.

The needs of suppliers should of course be considered in determining over-all national material requirements, with due regard for the in-process time necessary for completion of the items and delivery to the airframe plant.

SUBCONTRACTORS

By subcontractors we mean firms which manufacture non-standard items to designs originated by the airframe manufacturers. These might be part of the airplane structure, such as wing sections, tail sections, or fuselage panels. Or they might be equipment such as landing gear struts, hydraulic system assemblies, or instrument panels.

It is the normal policy of the airframe industry to subcontract only when internal capacity is short or when the subcontractor can compete with the manufacturer's plant in terms of price, delivery, and quality. This obviously results in a relatively low volume of subcontracting during peacetime, which would have to be expanded greatly in an emergency.

There should be no serious problems involved in such expansion provided that the basic engineering and tooling are right as outlined herein, and provided that the airframe manufacturer retains the authority to select his own subcontractors. I disapprove of what I call the "rat-hole" method of subcontracting, wherein you lay an assortment of parts on a table, a group of would-be subcontractors mill around the table and pick out what they want, and the "subcontractors" then disappear down their respective holes clutching the parts. Pressures exerted on us in World War II resulted in our waiting for a long time, often in vain, for something to come out of these rat holes.

Finally, we would prefer not to become involved in split programs wherein an airframe company is wholly dependent on one or more non-airframe companies for certain major components. Experience shows that it takes too long for such companies, which may be outstanding in their particular type of activity, to absorb the know-how of airframe fabrication and assembly. Conversely, an airframe plant would be hopelessly handicapped if it attempted to build refrigerators or automobile bodies.

I would recommend that preparedness planning with respect to subcontracting include peacetime consideration by the airframe manufacturers of the components they would subcontract, and also some advance allocation of available subcontractor capacity so that representatives of two or three airframe companies will not crash head-on at the door of one subcontractor's plant when the emergency comes.

LICENSEES

The licensing arrangement, whereby one firm is authorized to manufacture an airplane designed by another, was utilized extensively in World War II, with both airframe companies and non-airframe companies as licensees. On the basis of my knowledge of this experience, I believe that, just as the nation cannot safely depend on the airframe industry for a flood of airplanes in the first year of a war, it cannot depend on non-airframe licensees for an appreciable volume of output in the first three years. In a future war I believe that the performance of non-airframe licensees would be worse than in the last, because manufacturing problems are increasing rapidly as we push airplane speeds upward into the sonic range.

If we ever again become involved in a long war in which the number of airplanes turned out after about three years will be significant, then licensing of non-airframe companies will not be a complete failure. In a short war it will merely tie up materials and divert skills which could be better applied to some other phase of war production, without having any favorable effect on the outcome of the war. In either event better results would be obtained by relying on further expansion of the peacetime airframe industry to attain the extra volume.

Licensing of airframe companies which have free capacity should produce good results in a relatively short time if engineering and tooling of the licensor are adequate, and if materials are available. The B-24 assembly plant operated by this company in Dallas experienced such free capacity when the B-24 program was concluded late in 1944. The company therefore entered into a contract with the Army Air Forces to build C-82 cargo airplanes, then a pressing requirement, and completed the first airplane just six months after the project was authorized.

Peacetime licensing of non-airframe companies would, in my opinion, be impracticable and excessively expensive. On the other hand, peacetime licensing of airframe companies, as a means of holding together the organization of a company temporarily left without satisfactory production models of its own design, would be a desirable step, provided that the licensor was given adequate compensation for his initiative and effort in development of the model in question, and for his voluntary sacrifice of the business placed with the licensee. We must preserve the incentives necessary to keep our competitive development activities healthy.

GOVERNMENT-FURNISHED EQUIPMENT

It has been the practice of the air services for many years to provide the airframe manufacturers with certain highly specialized major items of equipment, such as engines, propellers, landing gear wheels, radio, instruments, and of course armament. These items are developed by specialist companies, and normally are used on more than one airplane type. There have been many advantages in this arrangement. One is maximum standardization in major equipment items, resulting in simplified training and maintenance. Another is controlled allocation to the various manufacturers in accordance with the current requirements of the air services; if three companies were using one type of engine and obtaining their engines direct from the manufacturer, chances are that most engines would go to the company placing its order earliest rather than to the company building the most urgently needed airplane. Finally, the development of these major items of equipment is so costly that it is virtually essential for the Government to underwrite it on a competitive experimental basis very similar to that used for airframes.

The present arrangement on Government-furnished equipment is, in my opinion, very satisfactory—with reference to both the method of handling involving direct Government purchase, and to the nature of items specified as G.F.E. The determining factors concerning which items are to be G.F.E. should be (1) whether the item may be required by more than one airframe manufacturer, and (2) whether it is sufficiently complex and specialized to require costly development foreign to the skills and capacity of the airframe industry. If some future question arises on a new item not now in the picture, as for instance a component of a guided missile, we will be satisfied to have it designated G.F.E. if it meets both these conditions as stated above.

In most respects the industries supplying G.F.E. items face substantially the same emergency expansion problems as the airframe industry. It is just as essential that these problems be anticipated as it is that the airframe problems be anticipated, because we cannot fight a war with airframes sitting on the ground for lack of an engine, or incapable of action for lack of armament. The leaders of these specialized G.F.E. industries can outline their own expansion problems better than we can do it for them. However, I believe none of them will quarrel with an airframe man's statement that adequate peacetime volume will be their safest and best guarantee of expansibility in an emergency.

CONTRACTUAL DELAYS

It is conceivable that delay in reaching agreement on the terms of high production contracts could delay expansion. I therefore believe that forms of emergency contracts should be worked out in advance. These could be more or less standardized for the airframe industry, with only the amounts, types, etc., to be filled in. The manufacturer could then proceed on the basis of a letter of authority pending negotiations of amounts.

Our company favors the fixed-price type of contract wherever it is possible for us to estimate our costs with reasonable accuracy. In any event we believe it is impracticable and excessively costly to mix fixed-price and cost-plus-a-fixed-fee business in a single plant, because the problems of segregation and administration would be very great.

One important point I should like to make concerns renegotiation of prices to eliminate excessive profits. This can be done by individual contracts, or in the aggregate for each year's business as in World War II. We strongly favor the latter method, or blanket price re-determination, because it enables us to move into expansion rapidly with confidence born of the knowledge that losses on one contract may be offset by profits on another in the year's aggregate business. Statutory renegotiation was our vital enabling act for expansion of production in World War II. Under this sound arrangement we were reasonably sure of breaking even. Further, we were protected from the fear of excessive profit and resulting public criticism, which might have seriously delayed us in the contract negotiation phase.

AVOIDANCE OF CONFUSION

The major factor in avoiding confusion will be advance knowledge on the part of Government and industry of who will build what when, and where he will get the space, materials, and machine tools to do it. Another factor will be prompt enactment of enabling legislation upon arrival of the emergency. Failure of Congress to pass all necessary legislation quickly could upset some element of the expansion activity and throw other elements out of balance.

One other possible source of confusion in the airframe program is the necessity for major design changes. This can be avoided only by adequate peacetime research and development, coupled with adequate military planning and service testing, so that the planes in production at the time of emergency are militarily useable without major design changes. In 1941 we suddenly discovered we needed more and larger guns, more armor, and self-sealing fuel tanks on the planes then in production. Those changes cost us precious months which we might not in the future be able to afford.

GENERAL COMMENTS AND CONCLUSIONS

This nation has practically no conception of what it means to produce for and fight a war wherein we start to get ready under whatever form of blitz attack the future may hold in store for us. To be perfectly frank, I place very little faith in what the airframe industry or any industry will be able to do after the emergency comes. While it is true that a future war, like past wars, could be won with the weapons industry is eventually able to produce, it is also true that a future war could be lost before industry has a chance to produce anything of significant proportions. To me, that is the most important point in this whole picture of preparedness planning.

Assuming that we do have the strength to meet and counter an initial attack, I believe that the airframe industry can do a good job of expanding production rapidly in a future war IF we have a peacetime level high enough to build something on and IF we are given a fighting chance to get such basic requirements as plant space, machine tools, and materials. I believe that the providing of replacements for adequate air forces will in itself insure a safe peacetime volume; since plant space and machine tools are already being provided for, the remaining major area of deficiency is material, in the broad airframe sense including raw materials, supplier items, and Government-furnished equipment. As things now stand, I believe that the bulk of any funds made available for preparedness planning should go toward advance solution of this material problem. Part of the answer, in my opinion, may be found in the "momentum of flow" which will accompany adequate peacetime airframe production, and part of it will have to be found in judicious stockpiling.

There can be no preparedness planning except in the light of conditions which will pertain on the day when it is to be activated. For the immediate future the nation will be wealthy in terms of plants and machine tools — the carry-over from World War II. I have not emphasized these elements because I know that they are here and could be obtained by the Government in one way or another if an emergency came. Perhaps 10 or 15 years from now, when the machine tools of the nation may be worn out and otherwise dissipated, when the beautiful war-built plants may be falling down or otherwise unsuited to emergency needs — perhaps then these items may be as critical in preparedness planning as material is today. Greatest attention must always be given to the limiting element, and, when that is provided for, the next limiting element, and so on until you get down to a schedule that meets your strategic requirements. Industrial preparedness planning must therefore be a dynamic evaluation of the nation's production potential, kept up to date with changing conditions.

In this statement I have emphasized the need for a "going" airframe industry. By that I do not mean that the Government should decide that six or 10 or 20 companies are the airframe industry, and see to it that those particular companies get enough orders to stay in business. I know of no better way to stifle the thing we are trying to keep alive. Instead I believe that provision should be made for a long-range airplane procurement program, to the extent of providing the air services with funds for procurement. Then let the airframe companies compete for the business on the basis of design and price as they have in the past. I would say that the emphasis should be heavier on the design side in the development phase, and about equal between design and price in the production phase. If some companies cannot compete, and go out of business under this competitive arrangement, others will rise to take their places. Instead of organizations growing lazy and complacent under what would amount to Government subsidy, we will have aggressive design and production teams fighting to do a better job than their competitors. The government can buy the largest air force in the world in terms of numbers simply by spending a lot of money, but it cannot buy the best air force unless the designing and manufacturing industry is subjected, insofar as practicable, to the competitive forces which helped build our nation to its present stature.

The big "if's" in the whole picture of airframe preparedness planning are matters controlled by the Government — notably what it does now about:

1. An air force in being
2. An industry to supply it
3. Materials to supply the industry in an emergency

plus what it does in an emergency about:

1. Appropriations and enabling legislation of various kinds
2. Material controls favorable to war industry
3. Discouragement of manpower withdrawals from war industry

I believe I have made it clear in this statement that it is impossible to determine in terms of months the acceleration time which might be saved by any single preparedness measure or combination of measures without analyzing in very great detail all the assumed conditions. Then the determination could be worthless if any of the assumptions were unrealistic. The Air Force has made some studies of this problem, but it is far too large in scope for treatment here. Let me say, however, that no airframe preparedness planning will be worth anything if there is not a strong airframe industry to utilize it. In very general terms, I believe that the existence of a strong industry will of itself accomplish about 50 per cent of the time-saving that could be accomplished by the ultimate in elaborate preparedness planning. About 40 of the remaining 50 per cent could be accomplished by arranging for availability of plants, machine tools, and materials. That leaves a time-saving of 10 per cent for any other elements of preparedness planning you care to name — such as building high production tools, developing training programs, and so forth. This is a very rough way of expressing the relative faith I place in the various preparedness planning possibilities.

Even with the recent war so fresh in our memories, I strongly suspect that a large part of the public believe that good airplanes in overwhelming quantities can be had by the Government in a matter of weeks or months merely by the appropriation of large sums of money. The fact that we had a long time to get ready in World War II is easily forgotten. Orders from Britain and France starting in 1938 were the first step. Next came the National Defense Program and the optimistic 50,000-plane demand in May, 1940. That was 19 months before Pearl Harbor. It still took us two more years after Pearl Harbor to produce enough airplanes to fight an offensive air war. Altogether, it took more than five years from the time when we got our first large production orders until we were ready for offensive action!

It might help if the nation could be encouraged to think of the building of an air force in somewhat the same terms as the building of a navy. Although the time spans involved are considerably shorter, the problems are essentially similar. The nation can no more develop an air force overnight than it can design and construct vessels and train Navy personnel on short notice.

In conclusion, I want to emphasize that the "gadgetry" which must go into the military airplane is becoming more complex and costly with each passing year. Although the airframe itself is becoming more difficult to build, we may find that radar, jet engines, or some new gadgets we have not even heard of yet, may be the limiting factors in a future war. The battle for time will not be won by the airframe industry alone. It will require coordinated and synchronized effort by many industries to get airplanes built, and, beyond that, coordinated planning and action for the whole nation to get all the war requirements met.

I wish to thank the Commission again for this opportunity to express my views.

"PROBLEMS INVOLVED in POWERPLANT DEVELOPMENT"

by

H. M. HORNER

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★ *Mr. Horner has been President of United Aircraft since 1943. He joined Pratt & Whitney in 1926, one year after formation of the company, and served in various administrative and executive spots before being named General Manager of the Pratt & Whitney Division in 1940. He later was elected Vice President of United Aircraft Corp., in charge of manufacturing.*

"PROBLEMS INVOLVED IN POWERPLANT DEVELOPMENT"

SUMMARY

1. The importance of the aircraft powerplant to National Defense and commercial aviation.
2. The three phases in the development of a powerplant or propeller.
3. The expansibility of production of powerplants.
4. Recommendations.

VITAL IMPORTANCE

WHILE I RECOGNIZE that every crow believes he is the blackest, I feel completely justified in stressing to this Committee the vital importance of the powerplant, including the propeller, to the Military and Naval Air Arms and to commercial aviation. In the relatively short history of aviation, there has never been a single deviation from this proven fact—the best powerplants produce the best aircraft, military or commercial. No country with inferior powerplants can have superior airplanes. For instance, using just one criterion of performance—speed—of the approximate 300 to 400 mph. increase in fighter speed between World War I and World War II, 75 per cent of the gain came from increased power. Aerodynamic improvement accounted for the remaining 25 per cent.

To have superior powerplants ready for production when an emergency is upon us requires that their development should be under way years prior to that emergency. And not just two, or three, or four years. The development must have at least eight and preferably ten years of labor and refinement behind it. In a nutshell, a superior powerplant can meet the crisis of an emergency only after many millions of dollars and thousands of hours of research, testing and development have been spent on it.

THREE PHASES

There are three distinct phases to the design and development of either a powerplant or a propeller. The first is the design and construction of the experimental articles (which, of course, result from general engineering know-how and research) and passing a type test. For a present-day high-powered engine, either reciprocating or turbine, this phase takes roughly three years or more and costs some ten to fifteen millions of dollars.

The second phase is the development of the powerplant and tooling it for initial production. This phase takes some two to three years and again costs some ten to fifteen millions of dollars. But we still haven't a real national asset, a powerplant that is proven, and therefore one that could be produced effectively by a licensee, as Chevrolet, Ford, Studebaker, Nash and Buick did with such success in World War II.

The third phase is the actual day-in and day-out service use of the powerplant backed by further intensive development work at the factory. After—but only after—this redesign is itself in quantity production do we have a really useful article. After this phase, which, excluding the flying expenses, costs an additional ten to fifteen millions of dollars, and takes some two to three years, we do have a real national asset, one that we can count on to give satisfactory results in service and one which is in a position where it can be produced by an associated licensee manufacturer.

It must be borne in mind that these three development phases, with their respective time and cost elements, are necessary for each powerplant size required.

OUTLAYS FOR FACILITIES

These development phases in connection with turbine and jet types require large outlays for facilities in addition to facilities already available. In our case we are constructing research and development facilities for turbo-jet and turbo-prop powerplants costing approximately $15,000,000. In order that the development of these types in this country may compete successfully with that of foreign countries the use of such facilities under the immediate control of the manufacturer is absolutely essential.

The development phases and costs for a propeller are somewhat less but are still very significant, the three phases taking some five years and the total cost being in the neighborhood of ten million dollars.

This country entered World War II with a line of engines, many of which were more or less completely developed ten or more years prior to Pearl Harbor. For instance, our R-1340 Wasp was widely used in advance trainers and it was a going type in the late 1920's.

TOOLING PROBLEM

We are now faced with the necessity of developing a complete line of new engines—turbo-jet and turbo-prop—while carrying on with the continued development of certain of the reciprocating types. The same will apply to machine tools and tooling. Where tools were provided for our country's prewar engines over an extended period, we now face a job which must be done in a much shorter period of time. This job will be more expensive than could possibly have been visualized in prewar because of the increased average size of powerplants and the lower purchasing power of the dollar.

All of this seems to add up to one thing—if this country of ours is to have first-rate military air arms and is to maintain its present position in commercial air transportation; it is faced with the necessity for very large expenditures for the development of powerplants.

On the general subject of our country's ability to expand the production of powerplants in case of another emergency, I feel that I can speak from practical experience. I have worked for the Pratt & Whitney engine division of my company since 1926 and was its general manager during the hectic expansion period prior to and during the last war, and production of Pratt & Whitney engines really was expanded. There were more Pratt & Whitney design engines used in our combat and transport types than all other makes combined.

FOREIGN ORDER EXPANSION

In the year 1944, the value of these engines actually delivered to the military exceeded $2,000,000,000. We must never forget that to reach that rather astronomical rate we started expanding (just about as rapidly as we could) in early 1939 for the French and British. Our prewar expansion was augmented by the President's 50,000 plane program in mid-1940, still some eighteen months before Pearl Harbor. As a result of this war experience and my continuing study of this general problem, I am absolutely convinced that there is a maximum rate of expansion possible for any given set of conditions, that just cannot be exceeded. Assuming that fully tooled standby plants are not available but otherwise under the most favorable conditions, that is, a No. 1 priority on tools, materials and manpower, the following is my estimate of the most rapid expansion possible for production of aircraft powerplants in the case of another emergency.

According to the latest statistics this country is now producing military aircraft powerplants at an annual rate of approximately 4,500 engines. Based on this going production it is my opinion that this country could not possibly produce more than 14,000 engines in the first full year after the declaration of an all-out emergency, and we couldn't produce more than 32,000 engines in the second full year after the start of the emergency. These figures compare to 260,000 engines actually delivered in 1944.

LICENSEE PRODUCTION

In the third year after declaration of the emergency, production could be as large as the war economy of the nation could stand. In this third year, licensee production by the automotive and other industries can become effective but only on types which have completed Development Phase III as above described.

In terms of airplanes, this means that if the President issued a call for 50,000 airplanes today and every contract were headed, "Early delivery is all important and you have top priority," this country could not possibly provide powerplants for more than 5,000 airplanes between now and January 1, 1949, which compares to the war-winning 100,000 airplanes delivered in 1944.

There are many, many facts I would like to present to this Committee but time confines me to just a very few.

The engine manufacturers of this country are making progress with turbo-jet and turbo-prop powerplants. We at Pratt & Whitney Aircraft are making progress, good progress, we feel, with our own turbine projects. Frankly, we are up to our neck designing, developing and tooling for their manufacture. Nevertheless, we are convinced that reciprocating engines will continue to power the bulk of our long-range, weight-carrying military and commercial aircraft for some years to come. For that reason we feel that it is imperative that we continue to refine and develop this type of engine in order that we can retain our country's present leadership in reciprocating engines in both the military and commercial field.

NEW-TYPE ENGINE

At the same time this country must continue to most aggressively develop the newer turbo-prop and turbo-jet engines so as to attain clear leadership in these types as soon as possible. That this is a very large and expensive undertaking is apparent when it is realized that the development of a complete line of sizes, both turbo-jet and turbo-prop, is required.

We must also bear in mind the importance of the propeller to our air power. All reciprocating and turbo-prop powerplants require propellers. With increased power the propeller problem becomes vastly more complex, from a design and from a manufacturing standpoint. In fact, the rate of expansion of propeller production could well turn out to be the bottleneck in aircraft production in another emergency. It therefore deserves a most thorough overall study.

INDUSTRY'S NEEDS

In order that this country's aircraft powerplant industry can develop and produce superior engines without which superior aircraft are impossible, it is our considered judgment that

a) A continuing development and production program should be initiated to meet the needs of the military and of the air transport systems of our country.

b) Aeronautical products should be judged primarily on excellence of design and performance with price a secondary consideration. Production contracts should be awarded at prices which will return a fair profit, so that satisfactory financial returns will be forthcoming to all those companies in the industry who perform well in competition with the rest of the industry.

c) Procurements, and therefore appropriations, should be on a basis of at least five years so that the development cycle can be covered and companies who perform well can be assured a continuity of development and production.

d) Proprietary rights in design and patents should be fully recognized.

e) Allowable costs and expenses for procurement purposes should be based upon the Internal Revenue Code and the Regulations thereunder, which principle was established and equitably applied under the Renegotiation Act.

With some such ground rules as these as a stimulation to American competitive enterprise, I believe that our country can and will lead in the design, development and production of powerplants and propellers without which, as I have noted before, we cannot have superior aircraft.

"PROBLEMS of RAPID EXPANSION of ACCESSORY PRODUCTION"

by

MALCOLM P. FERGUSON
President, Bendix Aviation Corporation, Detroit, Mich.

★ *Mr. Ferguson has worked for Bendix and the Eclipse Machine Company, acquired by Bendix in 1929, all of his business life. During World War II, as a group executive of Bendix, was directly responsible for the corporation's engineering and manufacturing, as well as sales, of a volume of aircraft components valued in the hundreds of millions of dollars. War production of some items required such extraordinary expansion that several additional divisions of the corporation were established and placed in production under Mr. Ferguson's direction. He became President of Bendix on May 17, 1946.*

MALCOLM P. FERGUSON

"PROBLEMS OF RAPID EXPANSION OF ACCESSORY PRODUCTION"

SUMMARY

1. Accessories embrace a tremendous number of highly technical products which are functional parts of a plane.

2. Development and manufacture of accessories require skilled engineering know-how and production methods acquired only through years of experience. The accessory industry has grown up with the plane industry.

3. Rapid technological changes in aviation have coincided with progress in the accessory field. Continued advancement is also linked to the future of jet, guided missile and push button warfare.

4. First and biggest problem in expanding accessory production is that of maintaining a nucleus upon which future expansion must depend. This nucleus is composed of men, research and production engineering, special manufacturing arts, special tooling, and test facilities.

5. Accessory industry is not in a healthy position today. Volume of requirements so low that many companies are diverting major parts of their facilities to other types of products.

6. Recommendations:

   (a) In future planning, the accessory manufacturers should be brought in on the earliest possible discussion of future program.

   (b) More realistic scheduling should be employed. GFE and CFE procurement should be analyzed.

   (c) Steps should be taken to preclude the development of bottlenecks in scarce materials indispensable to the production of the aircraft accessories.

   (d) Engineering should be more closely associated with flight test. Standardization of designs offer possibilities — inventive ability must be encouraged.

   (e) With respect to current procurement, consideration should be given to the request for bids on fully tooled, large volume basis, wherever this is practical.

   (f) Planning must be applied to availability of process and tool design facilities. Tools should be originally associated with volume including spare parts requirements.

   (g) Elimination of Selective Service as applied to technical personnel. Problems of training supervisory groups. Training recommended for Army inspectors.

   (h) An agency approximating a Defense Plant Corporation should be maintained so that the Government and industry will be fully conversant with procedures. Subcontracting sources should be established by industry groups.

HIGHLY TECHNICAL PRODUCTS

IN DISCUSSING plans for the rapid expansion of the aviation accessory industry it is necessary to appreciate fully what this so-called accessory classification covers.

What are accessories, in the meaning of this discussion? A better word than "accessories" is "components," the term frequently used in the airplane industry. These accessories or components are not added to airplanes as bumpers or mirrors are added to automobiles. On the contrary, this classification covers a tremendous number of highly technical products which are fundamentally functional parts of the airplane. Accessory specifications are intricate and specialized skills are required in their manufacture. In some instances the cost of an accessory system for one type of airplane may exceed the total cost of another type of plane.

There is ample support for the opinion that in the development of aircraft acessories as a group — compared with the development of airframes — there is involved more engineering, more test and development, more basic engineering concepts and inventive application, and more varied skills and problems from a manufacturing viewpoint.

Attached as Appendix "A" is an enumeration of items recognized as aircraft accessories. Also, a chart which indicates schematically the vast number of accessories produced by Bendix alone which in 1945 were in use on aircraft. Obviously an up-to-date version of the same chart would show an increase both in the number and in the complexity of these devices and systems.

GUIDED MISSILES

Today the aircraft accessory industry is being further enlarged into what may come to be a separate and even more complex branch. The role played by the accessory manufacturer in the development of guided missiles and other new forms of military equipment is a large one. Contrasted with ordnance as we have known it, requiring timing mechanisms only, the missiles of today and tomorrow will require power plant controls, sensing devices, control and guidance mechanisms, and other apparatus which the accessory manufacturer is being called upon to develop and produce. To a large extent, therefore, the problems of rapidly expanding accessory production at some future date are linked to many different programs currently under way which do not relate directly to aircraft as we have known the term.

Who makes aircraft accessories?

In general these are not items made by a wide range of manufacturers nor are they products which virtually any manufacturer can undertake to make tomorrow. Attached (Appendix "B") is a list of a number of manufacturers upon whom the aviation industry depends for necessary accessory equipment. The backbone of the accessory industry has grown up as a full partner with the airplane industry. A factor of major importance is the value of this background gained through years of cooperation in research, development, manufacturing and test.

SPECIAL SKILLS

In general, accessories have not been produced by airframe manufacturers. Late in World War II there was some tendency in this direction but at the present time the situation is little changed and there is apparent a sincere realization of the special engineering and manufacturing skills involved in the supply of these widely different products and in the creation and maintenance of the facilities necessary to produce them. Although the building of a modern airplane is a huge undertaking, the material content of the final product that is dependent on the accessory manufacturer for both engineering and supply is far greater than in the case of such other fields as the automobile, tractor, steel, or home appliance industries, to name but a few examples.

We are all familiar with the rapid technological changes in aviation. What may not be fully appreciated is the extent to which they are due to progress in the accessory field. Higher speeds and altitudes were only possible with coincident advancement in aircraft fuel metering and control devices; improved ignition; superior engine valves and valve springs; engine exhaust superchargers and pressurized cabin apparatus. We now expect day or night all-weather flight and equally satisfactory performance over the tropics or the poles. These expectations are being fulfilled as accessories are perfected which are capable of meeting such varied conditions.

TECHNICAL PROGRESS

It is only necessary to note in passing that the future of jets, guided missiles and push-button warfare is similarly dependent upon the technical progress of the manufacturers of many different types of accessory units.

The first and biggest problem in expanding accessory production is that of maintaining the nucleus on which any future expansion will depend. All other problems are minor by comparison. This nucleus is composed of men and their skills; of research and production engineering; of manufacturing arts; special tooling and test facilities that will be unavailable when the expansion is required unless action is taken now.

This problem is a national problem and can be solved only on the basis of national policy. Unless it is solved any future expansion will be retarded by months or years.

How can this fundamental problem be solved?

First by underwriting production in sufficient quantities to maintain at all times the expansible nucleus of resources.

Second, by determining now upon an industry plan for the next five years which will give direction to the activities of the accessory manufacturers and will enable them to hold in their organizations the men of specialized talents upon whom the responsibilities of a rapid expansion program will fall.

ALMOST TOO LATE

These steps must be taken, and it is now almost too late. The accessory industry, of which Bendix is a part, has already returned to the government scores of plants and thousands of machines used in World War II. In the case of Bendix five complete plants and parts of many others, representing about 70% of the total square feet of floor space used in aviation have been returned. Even more important is the diversion of personnel, facilities, and other resources to products in no way associated with aircraft.

We are often asked if the accessory industry is in a healthy position today. My answer to this is a most positive "No." The volume of orders has been so discouragingly low that many companies have rearranged their plants so that major portions of their facilities are now engaged in making other products.

The problem has been further complicated by the fact that the relatively few items produced today must be of a great many different designs and types. There is insufficient volume of any one item to encourage maintenance of present facilities or their preferential use for aircraft as compared to other products.

LOSS OF ENGINEERS

In terms of men the present situation is alarming. With uncertainty ahead, it is not surprising that outstanding engineers and able production men, experienced in the accessory field, have gone and are going elsewhere. Many of them feel that better jobs, a more secure future, faster advancement and greater financial return are to be found in making electrical motors, bearings, packaging equipment, automobile accessories, and electrical appliances. Unfortunately from a preparedness standpoint these are also typical of the products that the accessory manufacturers of the aviation industry have switched to. In this connection it is important to correct the mistaken impression that know-how in producing peacetime products is such as to permit a ready switch to the production of wartime aviation accessories. The result of an analysis of this point was so interesting that Appendix "A" has been marked to indicate the relatively few accessories where know-how in automobiles, tractors, and other industries can to some degree be used in the production of aviation accessories. It will be readily seen that the list of those products for which no civilian counterpart really exists is a most substantial one and includes many items which are vital to America's air power.

FIVE-YEAR PROGRAM

If we can assume that the government will underwrite adequate procurement to provide a basis for expansion, and will commit itself to the five-year program already recommended, then we can turn to consideration of a number of problems some of which are more or less general to all industry while others are of special concern to the accessory industry in preparedness planning.

A. Recognition of the Accessory Manufacturer's Role

A number of problems which had to be solved in the past can be obviated if full recognition is given to the way in which an accessory comes into being and is supplied. The principal accessory manufacturers should be brought in on the first discussion of any program. They should not learn about it days or weeks later from the airframe or engine manufacturers. Our time cycle for planning, engineering, and production is in many cases even longer than that of the airframe people — lead times vary tremendously for individual parts of the same device. We also recommend that more industrially trained personnel, particularly those familiar with these problems, be utilized as a part of the military organization in the early stages of planning, thus making available more realistic planning and scheduling.

B. Planning and Scheduling

The accessory industry is called upon to supply through two different systems — one direct to the airframe or engine manufacturers, called CFE or Customer Furnished Equipment, and the other direct to the Army, Navy, and military services, known as GFE or Government Furnished Equipment.

By thoughtful and realistic analysis of this situation a great many difficulties could be eliminated which would make for more rapid expansion. For example, in our own case, we make struts as CFE equipment furnished to the airframe manufacturer, while the wheels and brakes which go on the struts are furnished to the Army as GFE, and the same wheels and brakes are furnished to the Navy as CFE.

The responsibility for planning and scheduling is fundamentally associated with this classification as are the later problems of technical and field service and spares procurement. It is suggested that the classification of items falling in these two different groups be exactly determined at the initial stage or that it be developed in the near future on a basis of what it would be in any mobilization.

Most every production man associated with the problems of the last war says, "Give us realistic scheduling the next time." Too many schedules were based upon hopes, ambitions, and on promises of one party without integration into the whole picture. In preparedness planning we need a master plan of scheduling and a well-developed prior plan of how scheduling would be handled, by whom, and how requirements would be correlated with the large number of accessory suppliers to engine and airframe manufacturers.

C. Material Procurement

No discussion of future expansion would be complete without calling attention to the great need for some form of insurance against bottlenecks arising from shortages of materials. The numerous and often costly and tragic delays which this factor brought about during the last war are all too familiar. This subject is so important and so broad that it cannot be covered here, but control, allocation and distribution plans can be developed in advance and it is recommended that more analysis be given toward integrating the complicated but equally important requirements of the accessory industry in arriving at total industrial needs.

D. Design and Engineering

The accessory is such an important part of the functional phase of the airplane that more attempts should be made to bring the accessory manufacturers' engineering departments into the phase of original design of the airplane and engine and particularly into early ground and flight tests. Too often unfavorable factors of performance became known to the manufacturer of the electrical equipment or the flight instruments too late.

While the word "standardization" is old and common the airplane industry has much room for its application. In only one instance in the last war was a landing gear strut used on one airplane adaptable to any other airplane. Model complication pyramided enormously as the war progressed. While superior performance must never be sacrificed for lack of change in a particular part or device, much can be accomplished by a long-term and intensified program of standardization study.

In any consideration of engineering, great emphasis must be placed upon sheer inventive ability — it must be encouraged; it cannot be hired and put to fruitful use the next day, nor even the next year. Our best fuel expert has attained his great skill largely because he has solved problems of airplane fuel metering and supply for over 25 years.

America has never fought a war on what we had in production at its beginning. It was what we had on drawing boards, in laboratories, and in engineering departments that had to be snapped into production as rapidly as possible. There will be an increasing tendency in any future war to accelerate the items that are in the laboratory. Adequacy and flexibility of engineering facilities are involved.

E. Procurement Policy

If we are to take all practical steps to be prepared for rapid expansion, attention should be focused on some of the aspects of today's military procurement policies. Such orders as are available are to be had on a competitive bid basis, for a relatively small volume at the best possible price to the services. This competitive system requires that job shop lots be made by job shop methods. Obviously, the item is both designed and tooled accordingly. While this recommendation would not be sound in many cases, we strongly urge that where it is reasonable to anticipate the production of a specific item in volume, consideration be given to the request for bids on a fully tooled, large volume basis, even though the number actually purchased be small. If adopted wherever possible, this approach would do a great deal to make possible accelerated expansion of such items.

F. Manufacturing, Planning, Processing, and Tool Design

In the rapid expansion of actual production one of the principal problems in the accessory industry, largely because of the intricacy of the items, is the importance which good tool design and good tooling assume in the production of the part and in maintaining the accuracy and quality which are so closely associated with the final performance. Because of current low production levels the group of specialists who would handle this important job in the accessory industry has suffered more than the rest of the personnel. The manufacturer cannot afford the luxury of retaining in his organization such experts, when his production is on a small volume, job shop basis.

Nevertheless, it must be recognized that when the pendulum swings to the other extreme this is one of the most difficult groups to assemble. This was the experience during World War II expansion. In fact, the World War II expansion was marked by a springing-up of hundreds of small tool design and process businesses which in general obtained their personnel from the very factories which they later served.

A better solution to this situation in a future expansion program should be studied. Many false and inadequate starts were made in the last expansion due to the fact that quantities were not soundly determined at the original planning or procurement stage. The type of tooling, method of processing, and the equipment used are all closely associated with the quantity factor. It is further recommended that spare parts programs be definitely associated with original equipment programs particularly from the viewpoint of the accessory manufacturer who too often learned of spare parts requirements too long after original procurement. The advantages of planning and procuring on the total basis are obvious.

G. Manpower and Organization

The problems of engineering, design, development, and test personnel were all handicapped throughout the last expansion by the effect of Selective Service on this group. If it is properly recognized that aircraft and components manufacture constitute critical phases of the original expansion program, this industry should be freed of draft and turnover during this critical period. It would seem that the war requirements for technical ability could be met elsewhere by normal civilian industry. In most instances we avoided to the greatest extent possible any interference with an employee's freedom of employment. If the next war comes as quickly as predicted immediate efficiency is of the utmost importance and I am afraid we must face the faults but also the advantages of freezing people in certain industries and occupations in order to prepare quickly at maximum efficiency.

It is almost universally recognized that a major problem in any rapid expansion program is the development of adequate supervisory personnel. At the risk of repetition the point is re-emphasized here again that the most effective approach to a solution of this problem is automatic if a reasonable level of production is underwritten on a continuing basis. This offers the opportunity not only for the training of supervision for the type of jobs that would have to be handled later, but in conjunction with the five-year forward program, makes possible the rotation of other men on supervisory jobs, on a purely training basis. Once the industry has been given the assurance that it is on a stable basis, it then becomes possible to initiate the sound programs for the training of supervisory personnel which will pay off greatly, if and when expansion is needed.

Inspection, quality control and final product acceptance by the services created a continued knotty problem which can be improved in future expansion by assigning Air Corps or service representatives to the larger manufacturing plants on the initiation of the program and by assisting them with a production man who has broad engineering and manufacturing experience.

A training school for development of Army inspectors is strongly recommended.

Further regarding the quality control problem, definite progress has now been made in correlation of Army and Navy inspection at plants serving both services, but original planning and definite regulations on this important point at the very start of expansion are recommended.

Continuous trouble was experienced because parts made and approved at a vendor's plant were not acceptable at the purchaser's plant. Such double determination of quality and the resultant conflict, some of which are the natural results of personalities, must be avoided.

We are too often apt to think of quality in terms of appearance, finish, and gauging for size, but the manufacturing man realizes that these go way back to the type of machine selected for the operation, its accuracy and condition, and the type of tooling which is placed on this machine. In the manufacture of intricate accessories there is not enough recognition of the fact that the making of parts frequently requires the development of the manufacturing process even before a machine is designed or procured. This calls for engineers, development men, machine designers, and manufacturing knowledge which are only possible with a healthy quantity-producing industry. In supplying fuel injection for the B-29 bomber engines the entire manufacturing program revolved around the original study and development of measuring equipment and special grinding machines capable of producing tolerances of plus or minus ten millionths of an inch.

H. Facilities and Subcontracting

In the last two World Wars the United States had approximately two and one-half years of making war materials for its later allies, before itself becoming involved in hostilities. Few believe that this situation will be duplicated if there should be another war. For this reason, we must face the problem not only of the extent of expansion but of the rate of expansion. We in the accessory industry would be fortunate to build a 50% increase in the first year of war over the preceding year if it were based upon the pattern of World War II.

One seemingly simple but important recommendation is that an agency approximating the Defense Plant Corporation be maintained at all times and that its procedures in authorizing plant expansion be firmly established and fully understood by all government agencies and industry. Many months of delay can be avoided if red tape in the authorizing of facilities is cut to an absolute minimum.

An entire paper could be devoted to the subject of subcontracting alone, particularly from the viewpoint of the accessory industry. We certainly learned that subcontractors in general had to be sold on taking over parts or complete units because they had before them the requirements of all other phases of the war expansion program, plus war devices which they were encouraged to undertake on a direct contract basis.

Many manufacturers do not like to make parts only, although many did not have the organization or the ability to make complete units and undertake the responsibility for their ultimate performance. There was considerable shifting — some required by quality, but much by the policy of the source in selecting other units. This resulted in repeated retooling, new training programs, and was far from efficient in obtaining rapid expansion.

It is of course impossible under present volumes to interest subcontractors in any part of the aviation accessory business and as preparation for rapid expansion the entire aircraft industry is already cooperating with the Army Air Force program of subcontractor planning. Too often the matter of industrial planning is generalized. It would be the writer's recommendation that more attention be given to planning by the small group of individual manufacturers which might make up the flight instrument people, or the fuel handling people, or the hydraulic manufacturers. This integrated group should give consideration to, and arrange for, subcontractor contact and planning with those civilian industries who are the more logical manufacturers of their particular type of product and if possible the nearest geographically to them. These would have to be searched out by continued contact and survey but it would seem that much preparation and understanding of expansion problems could be accomplished in this manner.

SOUND BASE NEEDED

In conclusion, I must return again to the accessory industry's unanimous conviction that the greatest asset for its rapid expansion is a sound base in existing productive operations.

The best way to get more of what you want the first year after the need arises is to have the best going operation today that can be financed even though to do so may require vision and courage. In retrospect we can see all too clearly how millions spent between the wars would have saved billions after Pearl Harbor.

Fortunately, the adoption of an adequate program will itself constitute the soundest peace insurance.

EXHIBIT "A"

	Civilian Counterpart Yes	Civilian Counterpart No
MISSILES		
Radar Guidance Systems		x
Flight Simulators		x
Free and Rate Gyros		x
Hydraulic and Electric Servos		x
Amplifiers		x
Telemetering Systems		x
Proximity Fuses		x
Target Seekers		x
Hydraulic and Electric Actuators		x
Fuel Metering Systems		x
Fuel Pumps, Turbo and Accumulator		x
Fuel Nozzles, Gauges and Meters		x
Launching Carriages		x
Thermocouples and Bolometers		x
Accelerometers		x
Radiosondes		x
High Speed Motors		x
Magnetic Amplifiers		x
Unloading Valves		x
Electric Power Supply Systems		x
Yaw and Pitch Computers		x
Tailpipes and Diffusers		x
RECIPROCATING ENGINES		
Carburetors	x	
Fuel Injection Systems — Pumps, Nozzles, Controls		x
Magnetos		x
Spark Plugs and Shielding	x	
Water Injection		x
Starters, Electric	x	
Starters, Combustion		x
Generators	x	
Valves	x	
Valve Springs	x	
Magneto Switches	x	
Electric Primers	x	
Superchargers and Pumps		x
Booster Coils	x	
Starting Relays	x	
Shielded Ignition Harnesses		x
Accessory Gear Boxes	x	
Mixing Controls		x
JET, TURBO AND PROP-JET ENGINES		
Speed-Density Fuel Control		x
Discharge Nozzles		x
Fuel Pumps		x
Fuel Metering and Control Systems		x

	Civilian Counterpart *Yes*	Civilian Counterpart *No*
Turbine Wheels and Blades		x
Electric and Torch Ignition		x
Impellers		x
Combustion Chambers		x
Thermocouples and Bolometers		x
UNDERCARRIAGE		
Struts		x
Wheels		x
Brakes		x
Hydraulic or Air Shock Absorbers		x
Retraction Apparatus — Hydraulic and Electric		x
Steering Devices — Hydraulic and Electric		x
Brake Lining	x	
Power Brake Valves		x
ENGINE INSTRUMENTS AND CONTROLS		
Suction Indicators		x
Temperature Indicators		x
Pressure Indicators		x
Warning Units — Fuel, Vacuum, Oil		x
Air Pumps	x	
Vacuum Pumps	x	
Filters	x	
Mixture Controls		x
Electric Primers		x
Automatic Supercharger Regulators		x
Centrifugal Oil Separators		x
Synchronizing Mechanisms		x
Engine Exhaust Superchargers		x
Tachometers — Electric and Centrifugal		x
Hydraulic Pumps		x
Two-way Air Valves		x
FLIGHT INSTRUMENTS		
Magnetic Compasses		x
Remote Reading Compasses		x
Gyro Flux Gate Compasses		x
Directional Gyro		x
Artificial Horizon		x
Automatic Pilot		x
Flight Path Computer (For All-weather Landings)		x
Clocks		x
Fuel Gauges		x
Turn and Bank Indicator		x
Accelerometer		x
Air Speed Indicator		x
Autosyns		x
Magnesyns		x
Altimeter		x
Sensitive Altimeter		x
Radar Altimeter		x

	Civilian Counterpart *Yes*	*No*
Radar, Anti-collision Devices		x
Radar for Bombing Invisible Targets		x
Venturi Tubes		x
Inverters		x
Dynamotors		x
Hydraulic Pumps		x
Pilot Static Tube		x
Air Pumps		x
Vacuum Instrument Pumps		x
COMMUNICATION AND NAVIGATION		
Airborne Radio Receivers and Transmitters	x	
Ground Radio Receivers and Transmitters	x	
Radio Direction Finders		x
Omni-Directional Beam Transmitters and Receivers		x
GCA (Ground Control Approach)		x
Radar Surveillance Units		x
Radio Loops	x	
Radio Antennas	x	
Static Precipitation Dissipaters	x	
Navigation Lights	x	
Landing Lights	x	
Navigation Light Flashers		x
Air Position Indicators		x
Distance Recorders		x
Radio Filter Boxes	x	
Frequency Meters	x	
Interphones and Amplifiers	x	
Driftmeter		x
Octants		x
Sextants		x
ILS (All-weather Landing System)		x
Radio Control Panels		x
AIRPLANE ACCESSORIES		
De-Icing Equipment		x
Auxiliary Power Plant		x
Wheel Position Indicators and Transmitters		x
Flexible Metal Tubing	x	
Refueling Equipment		x
Pilot Seats		x
Cabin Pressurizing Apparatus		x
Wing Flat Position Indicators		x
Cargo Hoises	x	
Gear Boxes		x
Power Operated Gun Turrets		x
Windshield Wipers	x	
HYDRAULIC SYSTEMS		
Hydraulic Pressure Regulators	x	
Hydraulic Pressure Control Switches		x
Hydraulic Flow Equalizers	x	

	Civilian Counterpart Yes	No
Hydraulic Accumulators		x
Hydraulic Check Valves	x	
Hydraulic Electric Switches		x
Hydraulic Pumps	x	
Hydraulic Four-way Selector Valves		x
Hydraulic Two-way Selector Valves		x
Hydraulic Remote Controls		x
Hydraulic Filters		x
Hydraulic Hand Pumps	x	
Centrifugal Type Oil Separators		x
Pressure and Relief Valves		x
ELECTRICAL SYSTEMS		
Reversible Retraction Motor		x
Position Transmitters		x
Motor Generator Sets and Alternators		x
Bomb Release Solenoids		x
Solenoids and Their Valves		x
Torque Amplifiers		x
Low Inertia Motors	x	
Relay and Line Switches	x	
Filter Boxes		x
Reverse Current Relays		x
Rheostats	x	
Booster Dynamotors		x
Wing Flap Motors		x
Bomb Bay and Turret Motors		x
Heavy-duty Starter Switches	x	
Frequency Meters	x	
Voltage Regulators		x
Solenoid Relays		x
Booster Coils	x	
AIRPLANE ARMAMENT		
Gun Turrets and Their Controls		x
Guns		x
Gun Chargers		x
Rockets		x
Bombsights		x
PERSONNEL AIDS AND EQUIPMENT		
Oxygen Regulators		x
G-Suits		x
Parachutes	x	
Automatic Parachute Openers		x
Pilot Ejection Apparatus		x
Temperature Control Apparatus	x	
"Gibson Girl" Emergency Sea Rescue Transmitter		x
PROPELLER		
Anti-Icing Devices		x
Governor and Controls		x

	Civilian Counterpart Yes	Civilian Counterpart No
METEOROLOGICAL INSTRUMENTS		
Radiosondes		x
Automatic Ground Weather Stations for Remote Places		x
Wind Direction and Velocity Transmitters	x	
Remote Indicator Recorders	x	
Aneroid Barometers	x	
Barographs	x	
Micro-barographs	x	
Aerographs	x	
Clinometers	x	
Aerovanes	x	
Anemometers	x	
Hydro-thermographs	x	
Psychrometers	x	
GROUND INSTALLATIONS		
Fuel Handling Equipment	x	
Engine Heaters for Cold Weather Starting	x	
Landing Mats		x

EXHIBIT "B"
ACCESSORY MANUFACTURERS

Adel Precision Products Corp.
Airesearch Manufacturing Co.
Air Associates, Inc.
Axelson Manufacturing Co.
A. C. Spark Plug Co.
American Bosch Corp.
Aeronautical Radio Mfg. Co.

Bendix Aviation Corporation
Breeze Corps.
Belmont Radio Corp.

Chicago Pneumatic Tool Co.
Collins Engineering Co.
Chandler-Evans Div.
Cannon Electric Development Co.
Cleveland Pneumatic Tool Co.

Delco-Remy Division

Electrol, Inc.
Edison, Thomas A., Inc.
Ex-Cell-O Corp.

Foote Bros. Gear & Machine Co.
Firestone Aircraft Corp.
Federal Telecommunication Labs., Inc.

B. F. Goodrich Co.
General Electric Co.
Goodyear Tire & Rubber Co., Inc.

Halley Carburetor Co.
Hazeltine Electronics Corp.
Hallicrafters Co.
Houde Engineering Div.

Jack & Heintz, Inc.

Kollsman Instrument Div.
Kidde & Co., Inc.

Lear, Inc.
Longines Wittnauer Watch Company, Inc.
Linde Air Products Co.

Minneapolis Honeywell Regulator Co.

Radio Corp. of America

Sperry Gyroscope Co., Inc.
Solar Aircraft Co.
Stewart-Warner Corp.

United Aircraft Products, Inc.
U. S. Gauge Co.

Vickers, Inc.

Westinghouse Electric Corp.
Weston Electric Instrument Corp.
Weston Hydraulics

"THE REMOTENESS of UNCONVENTIONAL EQUIPMENT"

by

JOHN K. NORTHROP

President, Northrop Aircraft, Inc., Hawthorne, California

★ *Mr. Northrop entered aviation prior to World War I, working for the Loughheed Brothers, then building twin-engine flying boats. Served in Army Signal Corps in World War I and returned to the Loughheeds, whose name is widely known today in the phonetic spelling of Lockheed. In 1923, he joined Douglas Aircraft as a designer and project engineer on many early Douglas planes. In 1927 was one of the organizers of present Lockheed Company. His first flying wing design was built and flown in late '20's but had to be abandoned until the early '40's because of finances. The Northrop Corporation was organized in 1931 for design of numerous aircraft under Northrop's direction. Present Northrop Aircraft was formed in 1939 with Northrop as President.*

"THE REMOTENESS OF UNCONVENTIONAL EQUIPMENT"

SUMMARY

Three major classifications of guided missiles suitable for intercontinental warfare are briefly described and their relative characteristics discussed.

Qualified estimates of time and cost required for the production of various quantities of missiles in the different classifications are presented, and the importance of evaluating time and cost requirements in addition to technical possibilities is stressed.

Dangers of over-optimism concerning rapid development of push-button warfare are pointed out, and some advantages of guided missiles, once they are available, are outlined.

AVAILABILITY VS. TIME

ANALYSIS OF the remoteness, or the availability vs. time, of unconventional equipment, and an estimate of the years required to translate push-button warfare theories into practice, involves a high degree of guesswork because of the fact that little or no actual experience in such fields of endeavor is available at this time.

For this reason the time and cost estimates submitted herein must be viewed as qualitative rather than quantitative data. They have been obtained from personnel who are as well qualified as possible under present conditions of limited experience in the field, but they may be largely in error even if the premises on which they are based remain unchanged by new discoveries or developments. If new discoveries should be made affecting the fields of endeavor concerned, the figures given might vary several hundred percent.

ONLY LONG-RANGE MISSILES CONSIDERED

At the risk of over-simplification it is assumed that unconventional equipment means guided missiles and that the only guided missiles that would justify a general translation of push-button warfare theories into practice are those able to carry at least a 5,000-pound warhead for a range of at least 4,000 miles.

The first of these assumptions is based on the fact that the general category of guided missiles is the only major development that could warrant a revolutionary change in our military planning. The second assumption is made because any missile capable of less than intercontinental range must be used as an auxiliary to manned aircraft, ships and armies rather than as a substitute for them.

THREE MAJOR CLASSIFICATIONS

Sufficient engineering analysis of the problems involved in the design, development and production of long-range guided missiles has been completed in the past two years to warrant dividing such weapons into three major classifications. These are, the subsonic pilotless aircraft, the supersonic pilotless aircraft, and the supersonic rocket.

SUBSONIC PILOTLESS AIRCRAFT

The first of these weapons is analogous to the German V-1 buzz bomb which was used in large quantities against London and other Allied cities in World War II. The V-1 had a range of about 150 miles, a high speed of 300 to 400 miles per hour, and a type of guidance which was only suitable for use against widespread target areas, even at the short distances over which it was employed.

Based on fairly complete design studies it is reasonable to expect that almost any competent aircraft manufacturer could, in a modern design, extend the speed of such missiles to 600 miles per hour and the range to 4,000 miles. The methods and equipment necessary to accomplish these improvements are already well known in this country. Important elements such as power plants suitable to the project are now in existence and the aerodynamic problems involved have been solved, both here and abroad, in the design and construction of numerous piloted aircraft.

The most serious problem remaining unsolved is that of accurate guidance over the greatly increased ranges required. Considerable progress in overcoming even this obstacle has been made in the past year and a half, and there is reasonable assurance at this time that guidance mechanisms could be perfected almost as rapidly as the missile itself.

SUPERSONIC PILOTLESS AIRCRAFT

The second classification of guided missiles requires increase in the missile's speed to supersonic velocities—perhaps 1,200 to 1,400 miles per hour—through the development of airframes suitable for such speeds and the solution of the aerodynamic problems encountered. Although some progress has been made in the basic research necessary for the design and construction of such a vehicle, actual development along such lines is negligible and there is nothing on which to base hope for the early or rapid successful development of such equipment other than a very limited series of model tests. A typical idea of the problems involved may be obtained from the fact that in order to produce such a missile, it will be necessary to perfect power plants having five to ten times the thrust, and more than double the thrust per unit of frontal area, of any now running. The design and construction of such power plants, even under high priority, must of necessity involve several years of intensive work.

Supersonic wind tunnels and allied equipment necessary even for model testing in the supersonic field are extremely expensive. Because of greatly increased drag and resulting poor over-all efficiencies at supersonic speeds, much larger and more complex aircraft will be required to accomplish a given objective, than though a subsonic vehicle were used. For these reasons the supersonic pilotless aircraft will take considerably longer to develop and will be much more expensive than the subsonic type. The problems of guidance of the supersonic pilotless aircraft are in large measure similar to those of the subsonic vehicle, although appreciably more difficult of solution. Nevertheless, the same general type of guidance equipment, with some additional development and complication, is conceivably suitable for either subsonic or supersonic aircraft.

SUPERSONIC ROCKETS

The third type of guided missile that must be considered is the supersonic rocket. This vehicle is exemplified by the V-2 developed by the Germans during the war for the attack on London. The V-2 effort was one of the outstanding technical accomplishments of World War II, requiring approximately six years to complete, and an estimated outlay of the equivalent of $250,000,000. When it is considered that the maximum range of the V-2 was about 200 miles and the accuracy attained permitted only general bombing of large areas at short range, it may be realized that a tremendous amount of research and development is necessary before a suitable long-range rocket with proper guidance can possibly be obtained.

Qualified experts, starting with information on the V-2, and expanding the field of knowledge in the past two years, have determined that the range of supersonic rockets can be increased to something more than the 4,000 miles assumed essential for intercontinental warfare. However, the size, weight and complications of the missile are all greatly increased and the whole project is so dependent on the development and availability of superior fuels that the time and cost estimates made for such an endeavor are the least reliable of all those submitted.

It is in the field of guidance that the most significant difference between pilotless aircraft and rockets occurs. The reasonable assurance of suitable guidance which we believe exists for pilotless aircraft cannot be claimed for the rocket at this time, and projects now well under way for the development of guidance systems for pilotless aircraft are largely inapplicable to the problems of rocket guidance.

RELATIVE VALUE OF VARIOUS TYPES

In determining and comparing the values of the three types of guided missiles briefly described above, it is necessary to consider many characteristics of each which cannot even be outlined in a paper of this scope, let alone properly evaluated. Space permits the mention of only a few of the most important, namely, time of development and production, cost of development and production, degree of accuracy to be expected, and relative ease of interception by an enemy.

Subsonic pilotless aircraft are definitely superior to other types in respect to the first three items and inferior in the last. The supersonic rocket is inferior in the first three and definitely superior in the last. The supersonic pilotless aircraft falls between the two in respect to each of the four items.

TIME AND COST CONSIDERATIONS

Many articles and discussions of the relative merits of aircraft and guided missiles, as well as the various types of guided missiles, concern themselves solely with the technical possibilities and completely neglect two essential considerations. The first of these is the time required for the perfection of such a potentially valuable new weapon. The second is the relative cost thereof.

The ability of the nation to protect itself, either through defensive or counter-offensive operation, is definitely limited by the economic willingness and ability of the nation to produce, both in times of peace and under the stimulus of war. This ability may be measured in terms of dollars appropriated by Congress, or man hours, or pounds of strategic materials available to the production effort. These economic limitations may very readily determine the final selection of new weapons, regardless of the technical possibilities.

It is apparent, in comparing the economic value of a 600-mile per hour subsonic pilotless aircraft with a 3,500-mile per hour supersonic rocket, that if the rocket cost ten times as much as the aircraft, only one out of ten aircraft need reach its objective to equal the offensive power of a 100% effective rocket, and that if cost is taken into consideration, the pilotless aircraft may be more attractive than the rocket, even if the rocket were equally available. On the other hand, the subsonic aircraft would be useless if the enemy were known to have defenses that would detect and stop a very large proportion of those launched. If the warhead of a guided missile represented a very great expenditure, as is the case with atomic bombs, it would be necessary to use the most positive method of delivery, almost regardless of the cost of the vehicle itself.

QUALIFICATION OF ESTIMATES

Based on limited information available at this time, and subject to the many qualifications outlined above, we have endeavored to summarize time and cost

PHASES AND COSTS IN DEVELOPMENT OF GUIDED MISSILES

	Subsonic (600 mph) Pilotless Aircraft		Supersonic (1,400-mph) Pilotless Aircraft		Supersonic (3,500-mph) Rocket	
Item	Time	Cost	Time	Cost	Time	Cost
Research, Development, Experimental Engineering and 5 Experimental Missiles	3 years	$ 6,000,000	6 years	$ 30,000,000	10 years	$ 150,000,000 to $ 250,000,000
Research, Development, Production Engineering and 200 Service Test and Training Missiles	4½ years	$ 25,000,000	10 years	$ 100,000,000	15 years	$ 250,000,000 to $ 375,000,000
Production Quantity of 5,000 Missiles		$375,000,000		$1,500,000,000		$2,500,000,000 to $3,500,000,000

estimates for the development of the three categories of guided missiles described. The estimates cover three necessary steps in the quantity procurement for wartime use of such weapons. The first step is the research and development required for the production and test of five experimental missiles. The second step includes the first, plus the manufacture and launching of a service test and preliminary training quantity totaling 200 missiles, which number might be inadequate in the case of rockets. The final step is the production of 5,000 missiles.

Time and cost estimates are submitted for the first two phases of the program but for the third, cost estimates only are furnished, as the time involved would depend entirely on the number of organizations used and the priorities granted to such production. The time estimates assume a definite decision as to the extent of the program to be undertaken, at the time the program is started. In other words, it would be impossible to complete and test 200 subsonic pilotless aircraft missiles in a four-year period and at a cost of $25,000,000 unless the decision were reached at the inception of the program that it was to include a total of 200 missiles. The time and cost would both be greater if the first phase experimental program were completed prior to a decision to proceed with the service test and training quantity program. They would be much greater unless the selected program were pursued vigorously and with adequate priorities.

The chart is submitted with the reiterated caution that it must be used as a comparative rather than an absolute estimate of time and costs involved.

PUBLIC DANGEROUSLY OVERSOLD

From the information now available we are forced to conclude that the general public has been greatly oversold on the possible imminence of push-button warfare, and that even if we select the simplest and cheapest program of development, about five years would elapse under peacetime conditions before it would be possible to make available sufficient guided missiles to be used as effective weapons in intercontinental war. Under the stimulus of wartime conditions it is possible that the time required could be reduced somewhat below the estimates given, but in any program of production of a new type weapon the days at the start of the program are just as important as those at the end. Therefore it is vital that a decision be reached promptly and pursued vigorously if we are to achieve even the estimated timing. The idea that push-button warfare of any type could be used for any purpose within months, or even two to five years, is a dangerous fallacy that must not be allowed to interfere with the availability of existing and improved military equipment of conventional types.

GUIDED MISSILES A SUPPLEMENT

When guided missiles come into use as effective intercontinental weapons it can only be expected that they will supplement more thoroughly proved types of equipment. An extensive period of active use after the time of their introduction in any conflict must be planned before they could be expected to form the major backbone of our offensive equipment. We must recognize that there is as much opportunity for improvment in guided missiles as there is in aircraft, and at all cost avoid a "Maginot Line" philosophy which would permit complacent reliance on the earlier types that may be built. It is essential that research and development continue on high priority in this largely unexplored field if any semblance of security is to be maintained.

It must not be assumed from the above that shorter-range missiles of various types may not be developed and perfected as auxiliaries to more conventional military equipment in less time than above mentioned. During the period of World War II very rapid improvement in fire power and destructive force of aircraft occurred through the perfection of more powerful short-range rockets, heavier bombs and more powerful guns. The backbone of the striking force, however, remained the aircraft which transported the actual weapons of destruction over the distances involved.

It is of vital importance, therefore, that all those concerned with the defense of the United States lend their efforts to the debunking of the public insofar as the imminence of push-button warfare is concerned, so that we may maintain an adequate air force of constantly improved types over a period of at least the next ten to fifteen years. On the other hand, the basic advantages inherent in the use of guided missiles warrant the continuation of research directed toward their ultimate perfection on a high priority schedule.

ADVANTAGES OF GUIDED MISSILES

A few of the important advantages inherent in their use are as follows:

First, the knowledge of the existence of such weapons may prove a powerful psychological deterrent against aggression on the part of any enemy. Very few wars are started without the reasonable assurance on the part of the aggressor that he can overpower the enemy promptly and with comparatively little damage to his own economy and existence. The sure knowledge of powerful and instantaneous reprisal in spite of anything that could be done should serve to give pause to those contemplating aggressive maneuvers.

Second, the guided missile produced in years of peace and under comparatively leisurely conditions could be maintained in a condition suitable for virtually instant mobilization, far more easily than would be possible with a manned air force of conventional aircraft. Once produced, the missiles could be stored in widely scattered and well camouflaged outposts, either above or under ground. The maintenance expense and the man power required would comprise a very small fraction of that needed to maintain a conventional air force of equal striking power in like readiness. Problems of personnel procurement, personnel training and personnel risk would all be greatly minimized if missiles were used.

Third, the know-how is presently available for the design of a 600-mile per hour missile with a range of 4,000 miles or better, which can be built at a reasonable price, and which is suitable for mass production in shadow factory organizations. Quantity production of long-range bombers to accomplish the same type of mission is a comparatively difficult, costly and complex project.

Entirely neglecting the humanitarian aspects of the case, it will always be easier to secure man power for the factory than for the field of battle. The United States has always been pre-eminent in the field of mechanized quantity production—the use of guided missiles takes full advantage of this supremacy.

QUALIFICATIONS OF GUIDED MISSILES

At least in the early stages of their use, guided missiles having the necessary range for intercontinental warfare cannot be expected to achieve usefulness against pin-point targets such as bridges, individual factories, etc. They can be extremely useful for attack on industrial areas, however, with explosive, incendiary, biological or atomic warheads. There is no particular reason why they cannot be developed in sizes to carry warheads two or three times the weights assumed earlier in this paper.

"REQUIREMENTS for MANUFACTURE of PUSH-BUTTON WEAPONS"

by

HARRY WOODHEAD

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★ *Mr. Woodhead held several executive positions in the steel fabricating industry prior to joining Consolidated Vultee in 1940. He is credited with introduction of mechanized assembly lines for aircraft manufacture. Prior to joining Consolidated Vultee he was works manager of the Parish Bingham Corp.; general works manager of A. O. Smith Co.; and Vice President and General Manager of Truscon Steel Company (later a subsidiary of Republic Steel Corp.)*

HARRY WOODHEAD

"REQUIREMENTS FOR MANUFACTURE OF PUSH-BUTTON WEAPONS"

SUMMARY

The development of a 1,500- to 5,000-mile guided missile, up to the stage where production of combat units can start, will probably cost \$200-\$300 million and, under optimum accelerated conditions in peacetime, require 10-15 years to accomplish. Flight testing of experimental missiles will require firing ranges of large geographical dimensions up to several thousand miles in length, which do not exist within the continental limits of the United States.

Facilities for manufacture of missiles will require equipment and machine tools similar to those now used in aircraft production. The work to be performed per pound of missile airframe will be closely equal to that per pound of airframe for an inhabited aircraft. The highly specialized and precision organizations now manufacturing aircraft engines and propellers, turbo-superchargers and carburetors, will be more than adequate for production of propulsion equipment, rocket motors, fuel pumps, and ram-jets for guided missiles. Some excess, unused manufacturing capacity in this category might result from a complete conversion from aircraft to missiles. Facilities for manufacture of hydraulic equipment, instruments, automatic pilots, radios, and radar for aircraft will be readily convertible to missile production. Extensive facility expansions for fuel production will be needed.

The financing of special facilities having application only to guided missiles should be carried out by the Government.

I. TYPES OF MISSILES

THE MOST outstanding developments in the field of push-button warfare were the German V-1 "Buzz Bomb" and V-2 Rockets, which appeared in World War II. The future evolution of guided missiles in this country will result first in the development of target-seeking anti-aircraft missiles, either rocket or ram-jet propelled, which should be in practical operation for military combat use within a relatively few years, possibly five at the most.

The next stage will undoubtedly be the development of self-propelled, controlled missiles for use with ground troops or surface vessels against tactical targets at ranges from 25 miles up to several hundred miles. These missiles, we believe, can be made available in five to eight years.

Ultimately, we anticipate the development of the self-propelled, controlled missile for long-range operations, for the destruction of strategically important targets. Such missiles will be used to replace or supplement strategic bombers, and will permit "push-button warfare" in its most literal sense. They will be many times larger than the V-2 (which had a gross weight of 28,600 lb. and a weight empty, less warhead, of 6,750 lb.), and will undoubtedly travel at supersonic speeds.

Based on studies which we have made and which necessarily must be rough because we're looking out "into the blue," the probable costs of development of a 1,500- to 5,000-mile missile up to the state of being suitable for combat use would be $200-$300 million. Present appropriations, however, make no adequate provisions for such a program. Under optimum accelerated conditions in peacetime, we believe 10-15 years would be required for such a development. The Germans spent 11 years on the V-2, of which the last 6 years were intensive.

II. FACILITIES

A. Facilities for Research and Development

1. Aerodynamic

Research and development of large supersonic missiles require elaborate wind tunnels which do not exist today. The Air Forces, the Navy, the NACA, and the JRDB have had under consideration the development of a satisfactory program for supersonic wind tunnels. The industry has been consulted on this project; the matter is still pending. I would like to mention, however, that one of the programs which was developed called for the expenditure of over $1 billion for all purposes including supersonic aircraft as well as supersonic missiles.

2. Propulsion

The development of propulsion equipment and fuels will require extensive burner tunnels, and open pits for testing rockets and fuels. This equipment is included in the supersonic wind tunnel program referred to above. As an accessory to these facilities, there must be laboratories for chemical research in fuels and metallurgy, and large mechanical laboratories for development and testing of fuel pumps and valves.

3. Guidance and Control

Experimental facilities for research and development of the guidance, control, and stabilizing equipment will be similar to those now used for developing high quality instruments, automatic pilots, bombsights for aircraft, and fire control equipment for ships, radios, and radar. In some cases the special shops that manufacture equipment for astronomical observatories seem most suitable.

4. Fabrication and Assembly

In addition to the facilities for the development of the components individually, it will be necessary to have fabrication and assembly facilities for the missile as a whole. The airframe can be made, using the same types of machine tools, jigs, fixtures, and processes as are used in the manufacture of conventional aircraft. There will be somewhat more machine shop work, and somewhat greater requirements for precision in view of the high speeds encountered.

5. Flight Testing of Complete Units

Everyone is aware of the importance of flight testing in the development of aircraft. Flight testing of missiles is likewise important, but much slower and more expensive than testing aircraft.

More than an airport is required. There must be a firing range of sufficient size to permit the missile to travel its course. Uninhabited regions of large geographical dimensions do not exist within the continental limits of the United States except on a very limited scale, up to approximately 100 miles at the most. A possible firing range of larger size appears to be one starting at El Centro, California, extending south down the essentially uninhabited peninsula of Lower California, Mexico. Another location, which has been under some international discussion, is one starting in southern Australia and extending in a northwesterly direction across the Australian desert and out into the Timor Sea.

B. Facilities for Production

An estimate of the requirements for production facilities can be obtained by consideration of the distribution of weight in the various components of a bomber aircraft and of a typical long-range guided missile, as set forth below:

Table I

	Percentage of Weight Empty	
	B-24 Bomber	Guided Missile
Structure: Wing, Tail, Body, Engine, Nacelle, Landing Gear	42%	52%
Propulsion Equipment	22%	17%
Controls and Accessories for Propulsion Equipment, Fuel Tanks, Lubrication Systems	16%	14%
Instruments, Surface Controls, Hydraulic System, Electrical System and Communication Equipment	8%	9%
Defensive Armament and Turrets	9%	0
Warhead Container	0	8%
Furnishings for Crew	3%	0
TOTAL, WEIGHT EMPTY	100%	100%

Under the first category in Table I is the weight of the structure which an airframe manufacturer fabricates from raw materials supplied to him in the form of sheet, tubing, forgings, castings, and the like. We anticipate that in guided missile production the airframe manufacturer will still fabricate and assemble this structure. The missile, because it is more compact than an airplane and, for a given weight, will have wings and tail surfaces of relatively less size, can be manufactured in plants which are dimensionally smaller than those needed for aircraft, with considerably less clear span and overhead clearance. The need for being adjacent to an airport is also eliminated in the case of the missile which will be transported by ground means to the firing points.

In the manufacture of the missile airframe we expect to use sheet metal working equipment similar to that used in aircraft with brakes, shears, hydraulic presses, drop hammers, and mechanical presses. The heavier structural parts will be finished on milling machines, lathes, planers, and the like. The general airframe practice of use of long spar millers for taper machining of aluminum extrusions is expected to be carried over into the missile field. The new process, just coming into aircraft manufacture, of taper machining of plates for wing skins, will probably be used also in guided missile production.

The propulsion equipment for the airplane, i.e., the engine and propeller, weigh somewhat more percentagewise than the propulsion equipment for the missile, the rocket motor, or the ram-jet with its fuel pumps as indicated in Table I. The manufacture of rocket motor cylinders is similar in some respects to that of reciprocating engine cylinders. Both are accurate machining jobs. However, the rocket motor cylinders will be dimensionally much greater than aircraft engine cylinders. They may be two or three feet in diameter so that certain machine tools will have to be developed especially for this operation. Also, the special alloy metals required to stand the high temperatures of rocket motors may make machining a difficult proposition. While the ram-jet, which is another form of propulsion device, is different in basic principle from the rocket motor, from the manufacturing point of view it is quite similar. It will involve machining of a large combustion chamber or cylinder, will need provision for injection of fuel through nozzles, and probably some method of cooling.

Both the ram-jet and the rocket motor will require fuel pumps which must handle high volumes of fuel and may possibly be turbine-driven as in the V-2. Facilities now engaged in the manufacture of turbo-superchargers for aircraft engines would be most logical for conversion to the manufacture of fuel pumping equipment for missiles. They use similar types of machines and processes. In every case, of course, a completely new tooling job will be required.

Carburetor manufacturing facilities, and facilities now used for production of fuel injection equipment, will be convertible to the manufacture of fuel metering equipment for missile propulsion. In the missiles, however, the rates of fuel flow are so much greater that new specialized test equipment will be needed.

One other important difference which affects the manufacturing is that the missile is an expendable item with a relatively short duration of flight and no need for repair and maintenance after use, while conventional aircraft engines and propellers are designed and manufactured to have a long service life with provisions for maintenance and overhaul. The urgency of precision work in aircraft engines is greater on this account.

We believe that, considered on an over-all basis, there is considerably less precision machining in the manufacture of propulsive equipment for missiles than in the manufacture of reciprocating engines and propellers for aircraft. A transition from aircraft to missiles, therefore, should give us some reserve productive capacity of precision machine work, which can be converted to performing the manufacture of other special equipment for the missile.

In Table I the percentage weight for controls and accessories for propulsion equipment is about the same for the B-24 as for the guided missile. In many cases the guided missile equipment itself will be identical to the type used on a bomber. We conclude, therefore, that the manufacturing processes will remain substantially unchanged in this category.

The next category in Table I—Instruments, Surface Controls, Hydraulic System, etc.—shows almost identical percentages in the bomber and in the guided missile. Much of this equipment will be identical in nature. Manufacturers of instruments, automatic pilots, and gyroscopic equipment, should readily make the transition from aircraft to guided missiles. An airplane automatic pilot is far too sluggish to operate on a supersonic missile. However, the manufacturer of such an automatic pilot, after suitable research and development and change in tooling, should be in a good position to make the devices for missiles. Hydraulic equipment (including actuator pistons, fittings, valves, and the like) is practically the same for aircraft and missiles. These manufacturers will probably have to make very little change in their manufacturing facilities.

Surprisingly, there is less radio in a radio-directed missile than in the B-24 bomber. The two radios are not identical, but a manufacturer with facilities for airborne radio and radar equipment should be pretty well equipped to make and assemble the components of missile radios.

Table I shows 9% of the weight empty of a bomber is in defensive armament, i.e., guns and turrets. Inasmuch as missiles do not contemplate such equipment, these productive facilities will be completely released for other uses.

Facilities for the manufacture of the warhead container will probably be something totally new, and involve processes and equipment now foreign to aircraft manufacture.

On the subject of manufacturing facilities, we, therefore, reach the conclusion that, while guided missiles are complex devices in their initial conception and an enormous research and development program will be required to perfect them, the complexities will be pretty largely resolved when they get to the actual production stage, and they will be equally as producible as are aircraft today.

C. Financing Facility Expansions

In the research and development of guided missiles a number of costly, specialized facilities will be required, which will have no application for research and development in other fields. Furthermore, there appears to be no commercial application for guided missiles; the Government is the only customer for this product. It does not seem logical, therefore, that private industry should assume the capital risks of establishing these specialized facilities. A sounder basis, which should in the long run be the most economical, is for the Government to bear the full burden of financing special facilities, making them available to private industry in much the same way as many defense plants were set up during the war.

D. Space Requirements

Inasmuch as the production complexity of long-range guided missiles is not too widely different from that of inhabited aircraft, it is reasonable to anticipate that the space requirements for the manufacture of the airframe and for the other components of equipment, as measured in square feet of facility per pound output per month, will agree with the parameters and constants as attained for aircraft.

III. MATERIALS

A. Construction Materials

The materials for construction of the airframe will be substantially the same as those used in aircraft manufacture; namely, high strength aluminum alloys, chrome molybdenum, nickel, and stainless steels. Special metals are required to stand the high temperatures of the combustion chambers and possible corrosive action of the fuel.

B. Fuels

The most commonly used fuels for missiles today are alcohol, gasoline, and liquid oxygen. Some use is made of fuming nitric acid and Monoethylaniline. Gasoline, the most plentiful of these fuels, does not have a high enough specific impulse to meet the desired military objectives for range. Considerable research is being carried out to develop or discover new fuels having higher specific impulse. As you can well imagine, these new fuels are available now only in small laboratory quantities and at costs which run to \$10 per gallon. For true push-button warfare this new fuel must be found and developed. Undoubtedly, very large and extensive production facilities will also need to be set up.

IV. LABOR

A. Research and Development

To solve the numerous research and development problems, a large number of technically-trained specialists of the highest caliber are indicated. These technicians do not exist today in sufficient quantity. One of the big tasks is to develop them. It is particularly important, therefore, that scientific colleges and universities be adequately equipped with facilities such as supersonic wind tunnels in order that they can train these needed scientists and technicians.

B. Manufacturing

The problem of obtaining and developing adequate skills for the manufacture and assembly of the components of guided missiles does not seem too serious. Once the missile is properly designed and tested and the tools built for its manufacture, the manufacturing processes can be carried out by the type of labor which we now employ in aircraft factories, which is, of course, of very high caliber relatively. Special abilities will be needed in certain fields, particularly in inspection. These abilities will have to develop as we get experience and learn to know where we must be particular and where some tolerances are permissible.

We anticipate that the labor requirements measured in manhours per pound will follow quite closely the trends and curves for aircraft. The most fundamental influencing factor in this is the quantity of production. Each time the quantity doubles, we anticipate the manhours per pound will diminish by 20%.

V. CONCLUSION

In conclusion I hope that I have pointed out to you the development and manufacturing problems of guided missiles. Substantial and expensive facilities will be required for research and development. Once the missiles are developed, we anticipate that the manufacturing processes will be fundamentally similar to those of inhabited aircraft, and aircraft production facilities can be converted to missile work. However, new productive facilities of a substantial nature will probably be required for suitable fuels.

"THE PROBLEMS of AIRCRAFT DEVELOPMENT"

by

GLENN L. MARTIN

President, the Glenn L. Martin Company, Baltimore, Maryland

★ *Mr. Martin began in 1907 to build gliders; designed and built pusher type airplane in 1908 and taught self to fly; established factory in 1909; flew first air mail in 1912; conducted Army's first bombing experiments, 1913; produced several new models for Army prior to World War I. Merged interest with Wright Co., in Wright-Martin Co., in 1917, withdrew during same year and organized Glenn L. Martin Co., of Cleveland in 1918, designing and building first American designed plane for Liberty engines and produced Martin bombers for Army and Navy. Current plant started at Baltimore in 1929.*

"THE PROBLEMS OF AIRCRAFT DEVELOPMENT"

CREATING THE IMPOSSIBLE

The development of aircraft holds the key to aviation progress in our national security. For that reason, I am particularly happy to be able to address this statement to the President's Air Policy Commission at a time when air power is of such obvious importance.

The increased cost of aircraft development is amazing and completely beyond the imagination of the average layman. The development of modern aircraft and its associated implements of war combines the development of all the various branches of engineering science. We are constantly delving into the unknowns which we must do if this nation is to remain the foremost nation of the world and if our national independence is to be assured. All of you recall that the development of the atomic bomb cost two billion dollars. This is just one of the research developments now confronting the nation in an effort to maintain our position in the world of armament research and development.

It is often said that we are striving for the impossible, but where a nation's security is at stake it is mandatory that we create the impossible.

PROTOTYPE COSTS

Our prototype airplanes that 20 years ago cost a few hundred thousand dollars to develop, now cost up to 25 million dollars and more. It is true that increased labor and material costs have added to such expenditures, but that is only a small part of the many factors that go towards increased development costs. It is the increased requirements and complexity of present day aircraft that have so tremendously increased costs. I do not say for one minute that such requirements are not necessary because, in my own opinion, they are very necessary. We are moving into new speed ranges, going to and beyond the speed of sound. Each increment of such increased speed brings many new problems to be solved.

We are continually operating at higher altitudes which also creates many problems that must be solved to insure operation at such extreme heights. Airplane accessory equipment that operated successfully at the low altitudes fails to function in the higher atmosphere. There are many hazards always confronting the manufacturer when undertaking such advancements. Possibility of explosive vapor, of vapor lock in the plumbing system and similar conditions are forever present. Engine lubrication systems fail. Engine cooling, because of reduced air densities, demands more cumbersome and complex cooling aids. Ignition systems break down in the higher atmosphere.

World War II saw the development of many new aircraft installations, such as jet power, radar, radar countermeasure, radar remote and automatically controlled gunfire equipment and a wide variety of special bombs and rockets. Complex navigational equipment came into being. These are just a few of the many items of associated equipment in which advances must be made in order to function in the higher altitudes and higher speed ranges. Such advances must be taken step by step, and the research and development necessary for such advancement is by necessity extremely costly, but again I say mandatory.

PROPRIETARY RIGHTS

The Aircraft Industry enjoys an ununsual position with respect to proprietary rights in its product. Our history is one of rapid inventive progress. Whenever it has been established that an invention or improvement has been made, the improved device may be adopted throughout the industry. We have operated under this system of free interchange of developments for over thirty years through our Manufacturers Aircraft Association, which gives to each member of the industry the right to use the airplane inventions and improvements of the other members. This Association was set up at the request of the Government during World War I to eliminate disputes between members of this industry concerning patents and inventions. The wisdom of this policy of eliminating disputes over proprietary rights was further demonstrated by the ready adoption during World War II of a large number of aircraft improvements.

REDUCING DATA TO EXPERIMENTAL PLANE

Such basic research data as is made available from other sources, in the form it reaches the aircraft industry, cannot be put to immediate use by the aircraft designer. These data must be analyzed in relation to the specific design project and then perhaps become the subject of further specific tests and study before their usefulness can be fully realized. An example of this is the basic research involved in the development of low-drag airfoils, or wing sections, carried out by the NACA over a period of several years. These studies resulted in the wing sections now being used on high-speed aircraft. However, the actual design and manufacture of airplane wings using these sections involved a great deal of additional development research on the part of the manufacturer. It was necessary to analyze, for the particular airplane, the effect of the various tip and root cross sections to use for optimum weight and performance. Structural design by the manufacturer required further study and test to develop wings of minimum weight utilizing the new sections. Wind tunnel models of wing attached to the actual aircraft fuselage required testing for interference and overall aerodynamic effects. Tooling and manufacturing methods required revision in order to get the surface smoothness which the new contours demanded. Many other design problems of similar nature required solution.

INDUSTRY FACILITIES REQUIRED

The problem of applying basic research data culled from many existing laboratories, both government and privately owned, involves the establishment and maintenance of expensive facilities to develop and test different units of the experimental airplane being developed from the basic element data. We have listed below some of the major facilities that either must be procured individually by each aircraft manufacturer or must be available for his use within a reasonable distance and at the proper time. Obviously the facilities needed, in first cost and operating requirements, are far beyond the individual manufacturer's financial reach under existing Government procurement policies and the present condition of the commercial airplane market. Present Government procurement policies do not permit the inclusion in contract costs of such overhead items as the cost of building and operating research facilities.

a. Wind Tunnels

For high altiude and high speed aircraft, there should be available at least three types of wind tunnels: (1) low speed tunnels capable of developing air speeds up to about 300 mph, to be used for establishing the basic configuration of the airplane without expending the large amount of money and time required for building the complex models needed for tunnels of higher speeds; (2) medium speed tunnels capable of developing air speeds up to about 750 mph, to be used for obtaining the final quantitative aerodynamic data required before actual construction of the full-size airplane begins; and (3) supersonic tunnels large enough to accommodate small scale models and to be used for the investigation of flight characteristics of airplanes and guided missiles at higher speeds.

In addition to the above, there is a need for tunnels to simulate icing conditions on various components and to investigate duct flows in the various air systems, such as cabin supercharging, ventilating, wing anti-icing, power plant induction and supercharging systems.

b. Flight Development Laboratories

There are many new design ideas which during the course of development require that they be proven experimentally by installing them on existing airplanes in order to determine their functioning excellence and the reaction on the pilot, or to develop new techniques of operation. This requires adequate instrumentation laboratories, airport facilities, flight personnel, engine test stands and beds, and aircraft capable of simulating the design conditions required for the new airplane or pilotless aircraft. An example of this type of investigation is the development on a B-26 airplane of the bicycle landing gear for the Martin XB-48 six-jet bomber. This type of work usually can be handled by the manufacturer at his plant if the aircraft and facilities needed are available to him.

c. Structural Testing

Static and dynamic structural test laboratories, large enough to test a full sized component. This type of laboratory should also include facilities for the investigation of the elastic and vibration characteristics of the structure and for the development of equipment and procedures for full scale measurement of stresses in flight and landing operations.

d. Miscellaneous Facilities

Completely equipped general laboratories adequately staffed and containing facilities for high altitude, low temperature testing, electronic development, hydraulic, electrical, and fuel system installation performance, as well as facilities for the firing of fixed and movable guns.

e. Propulsion Testing Facilities

For high speed missile propulsion applications, especially in the use of atmospheric engines such as turbo-jets, ram-jets, pulse-jets, a great deal of development testing must be done in rather large testing facilities. For example, air capacity of approximately 100,000 cubic feet per minute at 35 pounds per square inch is required to simulate high Mach number conditions for such a power plant. This blower capacity is equivalent to that required by the major steel plants for blast furnace work. This is needed to eliminate the high cost and slower time schedules which are the best that can be realized for alternate flight testing.

TIME ELEMENT

The application of new research data to an experimental airplane design will, in many cases, take place while the research investigation is still in progress because of the need for the military to retain a position of leadership in combat aircraft. For this reason, and because of the highly competitive nature of the industry, the aircraft manufacturer will make every effort to secure the maximum performance for his design by the utilization of the latest research ideas, proven or unproven. Our experience is that, expedited as much as possible, the time element will extend anywhere from 2 to 4 years just to translate basic research into experimental airplane, with another 2 to 4 years needed to turn out first production airplanes. This is one of the reasons it is so necessary that the United States maintain air forces of moderate war strength in peacetime.

DESIGN COMPROMISES

Experimental airplanes are not ordered unless there is a possibility of producing a quantity later. While uncertainty of future production makes it mandatory to spend as little as possible on an experimental airplane, certain production features have to be incorporated into it because it would be impractical to change them later.

The cheapest way to build a quantity of airplanes is to divide it into a number of parts, simultaneously build each part in a separate area and assemble them all together in still another area. The extent of this sub-division depends on the anticipated rate of production; the higher the rate of production the greater the number of sub-assemblies.

The experimental airplane would still be built in one assembly for the sake of economy, but all of the joints between assemblies would be in it and would be tested for strength and performance so that if a production contract were undertaken the experimental tools and processing could be expanded to provide for the additional sub-assemblies that already exist in the proven design.

Designing an experimental airplane in that manner increases costs beyond the absolute minimum, but many times the increase can be saved in subsequent production.

FREEDOM TO MAKE CHANGES

Since experimental airplanes must be production prototypes as well as test articles, the contractor must have considerable freedom in making design changes that will facilitate production. For economical execution of a contract the manufacturer should be free to determine what units of the airplane can be made interchangeable within the limits of the design and tooling required by that contract and without additional expense to the customer. He must also be allowed to adapt the design to new and more economical processes of manufacture which are continually being developed.

Governmental procurement regulations and specifications are written primarily to give the Government complete control over all details of the design. At the same time, the contracts and contract specifications require the manufacturer to guarantee the weight and performance of the airplane. These two requirements are inconsistent. Attempting to freeze the detail specifications is anomalous in itself, since the very nature of the problem is such that the final design of the airplane is never frozen until it is actually built and ready for delivery. It would be far more economical and expeditious to draft the contracts and specifications in such a manner that the basic characteristics of the airplane are established, the tactical mission is clearly stated, and specific guarantees are required. The details of the design would then be the contractor's responsibility. This would reduce the elapsed time from inception of the program to delivery of the first airplane anywhere from 6 months to one year.

SERVICE TESTS

After a manufacturer has expended the large amount of money and has taken anywhere from two to four years to bring an experimental airplane to the point where in his opinion it is satisfactory for delivery under the contract terms, the airplane is then evaluated by the Services or the CAA from a standpoint of suitability for service operation.

The difficulty with this program so far as military aircraft are concerned is that the testing is done at an Army or Navy base remote from the manufacturer's plant, and there is no way at the present time of expediting such a program or of obtaining information concerning the evaluation concurrently as the tests progress. It is possible under that set-up for the evaluation of an experimental airplane to be delayed to such a point that deficiencies are not made known to the contractor until production design is well under way. The results of this practice are obvious. Changes must be made in drawings, tools and parts, with a consequent increase in cost.

We would propose, therefore, that Service evaluation, particularly that pertaining to flight characteristics, be performed at the manufacturer's plant with personnel assigned from the Service test centers, so that control could be maintained of the flight schedule and that information could be obtained at the earliest possible date.

The CAA certification testing of commercial airliners is performed at the manufacturer's plant, and our recent experience on our twin-engine 2-0-2 indicates that the CAA Flight Test Branch is willing to meet any reasonable flight schedule that the manufacturer desires to establish. Furthermore, the people engaged in the certification work devote their entire time to the model at hand, and are not distracted by any other business. A typical example of this cooperative approach was the 8-day, 17,000-mile accelerated service test recently completed by our 2-0-2 airliner. While some changes were made in personnel during the test, the CAA maintained a force of six specialists on the 2-0-2 at all times, along with the Martin Company personnel aboard.

That type of service testing does constitute a sizable additional cost especially when you consider that it usually follows many months of rigorous flight and ground testing of the new airliner to prove its soundness as to structure and flight characteristics. The accelerated service test for the 2-0-2 was completed, on schedule, at a cost of approximately $20,000. It should be noted, however, that no service or maintenance difficulty or delay was encountered. If a new airplane being so tested ran into such troubles, costs would mount rapidly.

COMMERCIAL AIRCRAFT DEVELOPMENT

While much of this statement has been addressed to the problems of military aircraft development, we should keep in mind that the problems of commercial airplane development follow much the same pattern and are growing as speeds and operational altitudes increase. The Martin Company's own recent experiences may serve to illustrate the seriousness of difficulties facing the manufacturers and their airline customers in regard to new equipment development. Immediately after V-J Day, in August, 1945, we undertook, as a part of our operations, the development of two types of twin-engine airliners designed to fill the needs of the airlines in short and medium haul transport.

Because the airlines were finding it impossible to make a profit at reasonable load factors with obsolete equipment, we took steps to foreshorten the development period by beginning production operations concurrently with the building and testing of the first airplane of each type. It appeared to be the thing to do to aid the airlines in quickly solving their financial problems. As a result, the Martin Company had approximately 42 million dollars invested in 2-0-2 and 3-0-3 airliner engineering, tooling and manufacturing before the first certificated airplane (a 2-0-2) was delivered to Northwest Airlines on August 1, 1947. Our plans to meet the problems of development cost, tooling and the beginning of manufacture were based on what we thought was a reasonably assured market, but the airline difficulties of 1947 have paralyzed the market we anticipated.

EQUIPMENT RESERVES

The airlines never have been able to make and retain a sufficient amount of profit over any period of time to be able to accumulate reserves adequate to finance the purchase of new equipment and provide necessary operating capital. These difficulties have been further heightened by the fact that the large banks, since early this year, have been cold to the idea of extending credit to the airlines for equipment needs.

If the commercial airlines are given a rate base sufficient to permit reasonable profits, are enabled to carry all first class mail on which they can deliver a time saving and are given the further new business of air parcel post, they should be able over a period of time to work themselves onto sound financial ground. However, they also must have new, modern airliners, economical to operate, if their financial progress is to be steady and appreciable. I believe that if the banks continue to withhold recognition of the ultimate soundness of the air transport industry, Government lending agencies, or perhaps equipment trusts underwritten by the Federal Government, should be brought into the picture to extend credit and permit the airlines to replace the outmoded equipment which is bleeding off so much of their revenue.

It is imperative from a national security point of view that we have a healthy, financially sound airline network.

The still untapped potential of passenger and air cargo business available to the airlines is tremendous. Provided a satisfactory economic basis has been developed for their operations, the airlines will be able to work out their own difficulties and replace outmoded equipment with modern, faster, more efficient transports which will be more economical to operate. They will be able to adjust to meet changing conditions while maintaining sound financial status.

With the airlines operating soundly and profitably, the market for new commercial transport airplanes will assume its proper importance to the aircraft manufacturing industry and long-range national security. The privately financed manufacturer will be able to keep his development and production operations going and, to a greater degree, be ready and able to take on the extra rsponsibilities called for in time of any national emergency.

AN IMPORTANT ADVANTAGE

The American aircraft industry has profited greatly from one significant advantage over some of the other countries—the fact that there has been free and open competition between the manufacturers in new aircraft development, even in peacetime. We have entered periods of frantic expansion in time of emergency with an active, alert competitive spirit already at work in behalf of faster progress.

When you are working in the fields of unknowns which the aircraft design engineer contemplates as he bends over the drafting table, you cannot always be certain, even after reviewing carefully all the information at hand, that the line of approach you have chosen to follow will bring the greatest possible degree of advanced performance. With more than one company tackling the same problem, or developing a competitive type to meet the same need, the nation stands far more chance, even if one or more projects miss fire, to come up with the best answer ahead of all the other countries which are restricting competition or attempting to specify which company shall make the "best" airplane. You can't legislate aeronautical progress into being; nor are you operating realistically when you tell one manufacturer, "Now, you're it. Pick one approach to the problem and come up with the best answer—even if the chosen approach proves to be wrong."

Out of more than 35 years of doing business with the military services, I am convinced that their continued stand in behalf of competitive aircraft development has been one of the soundest of all the policies they have observed.

PRODUCTION CONTRACTS

In discussing the problems of aircraft development, it would be easy to overlook the fact that design and construction of a prototype airplane provides only part of the aircraft development experience which manufacturers will need to be capable of rapid expansion of production when needed. Unless production contracts for reasonable quantities of aircraft are awarded, the companies find it impossible to retain an adequate number of skilled tool designers and tool makers, production experts and experienced manufacturing employees. Perhaps even more important is the need for airplanes in reasonable quantities to permit the air services to use them in actual service—maneuvers designed to prove the tactical adequacy of the design, to develop improvements for the next lot to be produced and to train flight and ground crews in operating and maintaining the latest types of aircraft.

FOREIGN DEVELOPMENTS

It is no secret that other nations are devoting important time, attention and appropriations to the development and manufacture of new aircraft. Where this country stands in relation to such international developments is difficult to judge in the absence of up-to-date and first-hand surveys of other nations. One of the executives of our company returned from Europe just last week. He was able to report that in commercial airplane development he is convinced that we maintain a considerable advantage. He pointed out, however, that Great Britain has a number of developmental projects under way which should "keep us on our toes." In jet and turbine power plant projects, he reported that Great Britain is considerably ahead of this country, timewise, although only comparative operating data when new American jet and turbine power plants now being developed are in use will reveal whether the British engines are more advanced in performance. What advanced projects other, less friendly, nations may have under way is not so well known but we may be certain that they are speeding their development of new aircraft and missiles while hoping that this country choose to rest on its past laurels.

THE INDUSTRY CAN SURVIVE, BUT . . .

I do not look upon the problems which the aircraft industry faces today as being insurmountable. The companies which are soundly grounded and competently managed will survive. That is, they will be able to keep their corporate names alive and stay in business. Whether or not the companies which make up the aircraft industry retain or lose their ability to meet any future challenge depends upon whether aircraft development and aircraft procurement programs, in peacetime, maintain minimum levels adequate to the purpose.

"ACCESSORY DEVELOPMENT and PATENT and PROPRIETARY RIGHTS"

by

P. R. BASSETT

President, Sperry Gyroscope Company, Inc.

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"ACCESSORY DEVELOPMENT AND PATENT AND PROPRIETARY RIGHTS"

SUMMARY

A. Instrumentation

I. Aircraft instrument and accessory industry has become essential factor in military and civil aviation.

II. Emphasis on those aviation "accessories" which extend the faculties of the human pilot.

(a) Flight impossible in bad weather unless assisted by electronics, gyroscopics, automatic controls.

III. Objective of the "accessory" industry.

(a) Development of instrumentation to permit safe and reliable operation of aircraft at high traffic density in all weather.

(b) Cost of development in time and money often surpasses that of airframe or power plant and has caused instrumentation to lag behind them.

(c) Specific developments urgently required include: Airborne and ground equipment for communication, air navigation, traffic control, automatic flight and instrument approach and landing.

IV. Mass production of useful flight hours.

(a) Commercial aviation to be economically successful must operate in all weather at high traffic density and quick turn-around.

V. Recommended urgency of programs.

(a) Short-range use of quickly available equipment.

(b) Long-range program for integrated system.

VI. Problems of integrated air traffic control system.

(a) Make maximum use of automatic devices.

(b) Most equipment should be designed for ground control stations with a minimum airborne.

(c) Conserve radio spectrum; operate all flight services in one frequency band; combine all receivers and all transmitters into one only of each.

VII. Except for specialized military weapons, airborne and ground equipment requirements are practically identical for military and civil aviation.

VIII. Recommendations.

(a) Support the RTCA (Radio Technical Commission for Aeronautics) and the Air Materiel Command as the supervisory technical agencies.

(b) Government should finance the development, manufacture, installation and operation of ground equipment; airlines and private flyers buy necessary airborne equipment after development at government expense.

(c) Heed advice of National Security Council as to strength and composition of Air Forces.

B. Patents

IX. Current trend of patent policies regarding government contracts if not checked will be harmful to government as well as to industry.

(a) Restrictive patent policies stifle industrial research initiative; make government business unattractive; and undermine development of a healthy industrial mobilization plan.

(b) Recent proposals of the Attorney General constitute such restrictive policies.

X. A fallacious notion.

(a) That manufacturers and businessmen are keen to develop and market ideas whether they control the patents or not.

(b) On the contrary, business needs patents to protect initial outlays and prevent chiseling by others.

XI. Factors relating to sound patent policy.

(a) Progress is quickened by adaption of discoveries made in one field to another.

(b) Policy must encourage small organizations to undertake development with reasonable assurance of profitable production contract.

(c) Liberal patent policy of the past has developed interdependence between public and private interests, and has promoted "progress of science and useful arts" according to Constitution.

(d) Majority of new lines of development first undertaken by private enterprise at own expense, therefore,

(e) Destroy hope for private commercial opportunity and you destroy the willingness of a company to accept government contracts.

XII. Patent policy and mobilization planning.

(a) It is in the public interest to maintain the health of selected companies with good military product potentials by financing some tooling for mass production and some production from that tooling.

XIII. Success of government procurement depends on liberalized patent policies.

(a) Increase incentive of established companies to maintain efficient research, development and manufacturing organizations and of new companies to enter the field as follows:

1. Permit all rights arising from work in companies' normal line of endeavor to remain with contractor.
2. For government financed work outside of companies' normal line of endeavor, government retains free, non-exclusive license.
3. For procurement contracts, no patent rights should be required by the government.

Ø THE AIRCRAFT INSTRUMENT and accessory industry has grown to be an essential factor in aviation. I am confining my remarks to the discussion of some of the problems which face this important part of the aircraft industry.

A. INSTRUMENTATION

1. First, I want to emphasize the vital importance of aircraft equipment, instruments or accessories as they are variously referred to. Throughout the history of aviation, planning groups have usually overlooked or belittled the importance of the accessory classification. This is partly because the term "accessories" is used as a catch-all for things other than airframes and power plants, and because of the connotation of accessories as used in the automobile industry, where they are extra things attached to a standard car. In the airplane, however, this classification has long since outgrown the initial meaning. It has, in fact, evolved to the point where it includes many complex systems that are integrated into the airplane to perform essential functions, and without which the modern high performance airplane could not operate. A rather complete list of "accessories" has been given to you by Mr. M. P. Ferguson.

2. I can best explain the point by comparing an airplane with a man. The airframe might be considered his skeleton and body, and the power plant his muscular system; but the accessories are not, in our analogy, his clothes and jewelry. Aircraft accessories are more vital than that, for they include all of the instruments and devices which perform for the aircraft the great variety of functions that the sense organs do for a man. For example, the senses of vision, hearing, equilibrium, communication, plus the nervous system and the glandular controls which are so important in human physiology, would be lumped into one classification as "instruments and accessories" in aeronautical nomenclature.

Automatic Devices

3. Since a modern airplane must function as a completely integrated unit, it is quite apparent that its performance depends on the high development of these components, which you might say extend the now inadequate senses of the human pilot. For example, the human pilot cannot communicate by voice and hearing except by the addition of a very highly developed accessory—the radio communication system. Again, the human pilot is limited in his vision to clear atmosphere. For him to "see" in clouds, fog or darkness, the addition of highly developed radio or radar components is necessary. Another example—the human being very early in the science of aeronautics found that his sense of equilibrium, or semicircular canals, was not competent to cope with airplane balance. Only the development of gyroscopic instruments has made flying possible when there is no visibility. Then, again, in the human anatomy there are many automatic controls operated by the glands or our nervous system which are performed involuntarily and unconsciously. The same thing applies in the modern airplane. There are many functions now carried out by automatic devices which the human pilot is not aware of and which have multiplied to a point of complication beyond his ability to watch or control.

4. With this picture of the accessory category, which still begs a better name, it is quite apparent that to omit its consideration or belittle its place in an over-all plan is actually dangerous. Some of the most expensive mistakes that have been made in hurried airplane programs have been the design or scheduling for production airframe and power plants almost to completion before giving full consideration to incorporating the necessary accessory systems. The results have often been terrible: either a botched job on the airplane, or, due to omissions, an airplane which could not adequately carry out all the functions demanded of it.

Complex Accessories

5. Another very important reason why accessories must be considered in any plan of research, development or production is the fact that the complexities of many of these accessories are greater than those of the airframe or power plant. The length of time necessary to develop and put into production a new radar gun-laying system, for example, is greater than the length of time to develop and put into production the military airplane for which it may be designed. A new instrument landing or approach system takes longer to develop than the new transport airplane which is to use it.

6. I, therefore, urge that in all aeronautical plans, the accessories classification receives equal weight and equal opportunity with the airframe and power unit, for maintaining a healthy industry and continuing incentives.

7. Those of us who have contributed to the pioneering of this great new world force have long known that aviation is a precocious child, and that no other adolescent offers a greater potential toward world trade and world security. Due to its complexity and unique characteristics, this infant industry has necessarily become a ward of the State in many respects. It is most fitting, therefore, that a national air policy commission establish a pattern for promoting the growth of such a great potential. If its inevitable growth is to be healthy, the pattern must be established now.

Bottlenecks of Future

8. To keep this presentation brief, it will be impossible to discuss all the well established accessory equipment items such as engine instruments, brakes and propeller controls. My paper is, therefore, largely devoted to the navigational and flight control instruments and systems which will become bottlenecks of the future. Some are critically hampering aviation today. Specifically they are: airborne equipment for communication, air navigation, traffic control, automatic flight and instrument approach and landing in bad weather. Inseparable from the airborne equipment problem is that of related ground equipment. This subject of instrumentation for all weather flying is of prime importance. A system of air navigation and traffic control which will permit the maintenance of reliable and frequent schedules equally as well in bad weather as in good weather is imperative as the next step in our air transport system.

9. Safety of operation is, of course, a necessity. But, safety alone is not enough. The American public demands dependability of schedules, and they instinctively and rightly feel that it can be accomplished with no sacrifice of safety.

10. Not only does the public demand reliability of schedules for its convenience, but the economic health and, consequently, the very existence of commercial aviation depends upon its ability to fly large pay loads on schedule rapidly from termnial to terminal with quick "turn-arounds." Modern airplanes have very high performance including speed, but their speed is of no value except when in direct flight. They are so expensive that they can show an economic justification for their existence only by full utilization of their speed. Loss of time due to delays on the ground or holding in a stack due to bad weather must be reduced to a minimum.

All-Weather Flying

11. Even if the "turn-around" time were reduced to an absolute minimum the airlines could not survive economically with only a few airplanes in operation because of the terrific overhead in equipment and personnel necessary for their operation. The problem that must be solved is to permit modern airliners, both freight and passenger, not merely to take off, fly and land in bad weather, but to do so in large numbers, in a high density of traffic and on schedule.

12. The problems involved are highly technical matters. It is recommended that technical bodies who are now giving the problem their best and undivided thinking be supported. Two programs are necessary: first, to make the best use of equipment that can be made available quickly; second, to prosecute vigorously a longer-range program designed to integrate into a system those components which embody the most advanced techniques of the electronic art. A few simple statements of requirements for the ultimate solution will indicate the complexity of the problem:

12.1. When in the control of aircraft, an action or operation of the pilot or ground controller becomes repetitively routine, it should be performed by automatic means if possible, because repetitive manual tasks reduce human efficiency by causing monotony fatigue. Automatic devices also reduce the possibility of human error, and in some cases react to stimuli more quickly than human brain and muscle can possibly do. Full development and use of such automatic devices as the following will enable the pilot to be an alert monitor and hence truly captain of his ship as he should be, rather than the tired pusher and puller of knobs and levers as he often is.

12.2. To conserve weight and space in aircraft, to facilitate maintenance, and to increase reliability, as much equipment as possible should be designed for use at ground control stations with a minimum airborne.

12.3. Equipment must be economical of radio spectrum as the global range of aircraft makes it necessary to provide many hundreds of clear channels. (Actually, the need for about 1,000 channels is now foreseen.)

12.4. The ultimate conservation of weight and space in aircraft and of radio spectrum will be realized when all flight services are designed to function in one frequency band and are handled by one airborne receiver and one transmitter. These services include the landing system approach beams, omni-azimuth and distance measuring signalling and reporting, voice communications, and radio controls for airways traffic guidance and spacing.

12.5. The objective always to be kept in mind in planning a system for all-weather flying operations is that the safe and reliable performance of aircraft on the schedules set up for flying in fair weather can be met equally well in bad weather.

Radio Technical Commission

13. The Radio Technical Commission for Aeronautics, better known as the RTCA, is the only body which comprises technical representatives from all aviation interests, including government, private flyers, airlines, manufacturers, and research and development engineers. For many months it has faithfully devoted itself to analyzing the problems involved, and it should be counted on to come up with the answers. It is deserving of the strongest possible backing, for without cooperative effort of this kind, no solution is possible.

14. To illustrate the technicalities involved let me briefly outline the conditions which exist at a high density traffic terminal or center such as the New York terminal. Flights are scheduled throughout the day and night to and from Chicago, Pittsburgh, Washington, Boston, Montreal, Bermuda and Europe. Right now, at peak periods the scheduled movements are at the rate of more than 300 per hour or one every two minutes. These schedules can be maintained in clear weather, but when lowered visibility and ceilings occur at a terminal or along the airways, safety requires that instrument procedures be adopted immediately, and aircraft are held up either on the ground, or in flight by "holding in the stack." Instruments now available for use in aircraft and on the ground are inadequate to handle the traffic on schedule. It was estimated last winter that between $20 and $40 million in revenues was being lost each year by the airlines on account of weather. As the trend is toward aircraft from 1½ to 2½ times the passenger capacity of the DC-3, and many more of them, traffic delays and consequent financial losses will be accentuated until adequate instrumentation is provided.

15. Instrumentation has been developed over the years, and pilots have been trained in its use, which enables about 3 or 4 single aircraft an hour to be handled along the airways and at most terminals in rather bad weather. The trouble is that operations at such low traffic density are not economically possible, and the entire aviation industry suffers accordingly. However, the necessary improvements in ground and airborne instrumentation are so costly to develop that only government can afford to finance the project. All ground equipment must be developed, manufactured, installed and operated at government expense. The airlines and private flyers can be expected to buy the airborne equipment they need after its development with government financing.

Basis for Solution

16. For further details of this important subject I should like to refer to a brochure published in February 1947 by the Air Transport Association of America, Air Navigation Traffic Control Group, entitled "Recommendations for Safe Control of Expanding Air Traffic." This brochure has received wide acceptance as a good statement of the problem, and as a basis on which to proceed to a solution. I believe that the effectiveness of a national air policy will depend in large measure on the emphasis placed upon the further development and use of radio and radar instrumentation for all weather flight and the control of heavy air traffic.

17. It is appropriate here to mention the conscientious and effective efforts of the Air Forces in their attempts to find the best solution of the problem of all weather flying. The Air Materiel Command, Wright Field, has created an All Weather Flying Division whose recent "push-button" transatlantic flight from Newfoundland to England aroused widespread and well-deserved acclaim. All Weather has actually set up an airline with terminals about 400 miles apart extending from Andrews Field near Washington, D. C., over the Alleghenies to Wilmington, Ohio. For about a year their planes have flown over 600 flights entirely on instruments from take-off to landing and on regular schedule. Records show that not one flight has been cancelled or delayed on account of weather, and that many flights have been completed under weather conditions which completely stopped all other flying. The Air Materiel Command carefully investigates all devices proposed for use in all-weather flying. If any looks promising and if it can fulfill a need in an integrated system, they sponsor it and test it by actual use. They and the RTCA must be strongly backed if our national air industry is to break through this bottleneck.

National Security Council

18. So far I have discussed what should be done, not how many aircraft and how much instrumentation should be provided. I should like here to refer to the National Security Act of 1947 which created the National Security Council, the first agency in our history capable of and charged with the integration of national foreign policy and military policy. The advice of this council must be heeded. If it is heeded, I feel sure that our military establishment, of which our air forces constitute a main part, will be adequate in numbers and composition to support our foreign policy.

19. If I have appeared to stress the civil aspect of this whole question, it is because:

19.1. The military air forces of the nation constantly use the civil airways in peace and war and accordingly must have essentially the same equipment and operational technique as civil aircraft.

19.2. The airlines, the civil airways, and some types of private aircraft must be considered as an integral part of our air power.

19.3. Specialized military instrumentation such as automatic radar gun-laying equipment and bombsights are so obviously complex and expensive that the related roles of government and industry in their development are well understood, and in general satisfactory except for patent matters and procurement policies.

B. PATENTS

20. In addition to presenting to you the views of the equipment and accessory industry with respect to the development of instrumentation, I have been asked to make recommendations on the matter of government procurement policies with particular reference to patents. Other members of the aviation accessory industry have been consulted and the views here expressed represent the consensus of those consulted.

21. Current trends within government procuring agencies are rapidly stifling

the initiative of industrial laboratories and engineering departments and are making government business unattractive to them. I refer at this point to restrictive patent policies which are particularly onerous to the airplane accessory manufacturers for the simple reason that they develop and produce instruments and accessory systems for other than aviation fields, whereas the airframe and aircraft engine manufacturers do not. The reason we work in other fields is most logical. Progress in our fields depends on advances in the arts of electronics, hydraulics, remote control, and the application of all branches of physics. Such advances aid numerous fields of instrumentation, such as industrial and marine, and the contributions made in one field can be utilized in others. One of the main reasons for the leadership of this country in the instrument and accessory field is this flexibilty of adapting discoveries from one field to another.

Setback to Progress

22. Due to a complete misunderstanding of the functioning of this independent method of development, the government is pressing to take over by assignment the inventions that are made in carrying out aeronautical development contracts. This movement is brought to a head by recent recommendations of the Attorney General that the government take over ownership and administration of all patents generated in the performance of work on government contracts. Although such a procedure may be advisable in certain special fields, such as atomic energy or military secrets, its application in the general field of instruments and accessories would be a great setback to aviation progress and to the ultimate best interests of the government itself.

23. The government has insisted that it be granted non-exclusive rights to any inventions or discoveries made during the performance of all research or development contracts sponsored by it and of late this policy is being extended to include many procurement contracts. In addition, the government in many cases demands similar rights under any prior patents wholly owned by the contractor if the items called for under such contracts are covered by such patents. Such a policy tends to destroy incentive and even prevents the company which knows the most about a project from bidding since it has the most to lose in giving away its rights to prior research or development work. This would certainly be an erroneous basis upon which to build a sound industrial research or mobilization plan.

Production Contracts

24. A large percentage of the most vital and important research and development work being done under government sponsorship is in the laboratories and engineering departments of small organizations which do the work at little or no profit, in fact, in many cases at a substantial loss in anticipation of obtaining a production order on a fair profit basis. However, even under existing government policy relating to patent rights, these small companies are reluctant to undertake research or development contracts offered by the government because competitors will later be asked to bid on their work for any production contracts that may result. There is no assurance that the developing company will be awarded the production contracts for the developments its experience and ability have made possible. Therefore, since there is seldom any profit except in production contracts, many companies, large and small, are shifting their limited engineering

resources from government work to the development of ideas for direct sale to the public, which can be fully protected under our patent system.

25. The recent proposals of the Attorney General that "where patentable inventions are made in the course of performing a government-financed contract for research and development, the public interest requires that all rights to such inventions be assigned to the government and not left to the private contractor," and that "public interest will best be served by opening government-owned inventions to general public use, without discrimination or favoritism among users," are based on complete misconceptions of what makes an engineering development and manufacturing organization function successfully. The adoption of such patent policies would definitely turn the best research and development brains from government developments to commercial and industrial developments, and would accordingly not be in the public interest.

Attorney General's Theory

26. The Attorney General's theory is based on the notion that manufacturers and businessmen are keen to develop and put on the market new ideas and new inventions whether patented or not. On the contrary, when a new idea or product is offered to a manufacturer, one of the first inquiries he makes is whether it is protected. In other words, he wants to know if he puts sufficient money in this new product to get it on the market, will he have reasonable assurance of being able to get a return from it for a sufficient time to reimburse him for the preliminary outlay, or will the chiselers, large or small, be able to copy it right away without development expense and thus deprive him of his fair profit? The great majority of businesses, especially small businesses, will go into a new field only if patent protection is obtainable because they know that the large corporation with its production facilities behind it, or the fly-by-night company with no overhead can sell an article for less than a small established business.

27. Those industries which have been long associated with government in the manufacture of military equipment, and aviation equipment not necessarily miliary, have constantly demonstrated their accord with both the spirt and the letter of the Constitutional basis for the patent system, which is, "To promote the progress of science and the useful arts." We believe that the patent system, as administered in the past, best serves the Constitutional objective by (1) providing the hope of reward which encourages a continuous program of research and development through times of depression as well as through times of prosperity, and in peacetime as well as in war; (2) providing an incentive to scientists, engineers, inventors and others to whom a patent grant is one of the few important citations recording their contribution to society and industry through research; (3) assuring groups of scientists and engineers that the cooperative endeavor in which they are engaged will receive the protection required to justify its continuance; and (4) providing some measure of protection against pirating of ideas by the unscrupulous.

Workable Policy

28. A workable policy might be one whereby the government, when it pays for a research and development contract, will acquire a free, non-exclusive license to inventions originating under and applying to the contract, but this would be fea-

sible only if title to such inventions remains with the contractor so that he retains the commercial and foreign rights thereto. Any less favorable arrangement is certain to make it unattractive for industry to bid for such contracts.

29. The question of preserving industrial incentive is not only that of optimum encouragement to engineers and other scientists, but of protection for the commercial opportunities which lead companies to make sizable preliminary outlays for research and development prior to receipt of orders or contracts. In fact, it is well recognized that a good proportion of new lines of development are first undertaken by private enterprise at their own expense. An item such as a new type of electron tube would initially mean nothing to a government contracting agency, but after its development had been carried to a point where its application becomes apparent in some needed piece of apparatus, the development of this new apparatus is then initiated by the government. The costly pioneering which brought the initial development to the point where its value could be recognized would definitely be discouraged if the proposed patent policy became effective.

Know-how

30. Analysis shows that the public, as well as the government, benefits from patent laws which encourage the accessory manufacturer to spend liberally of his time and talents with the hope of inventing and producing a profitable product. When the public, through its government, lets a contract to this manufacturer, there goes into that contract all of the past knowledge and know-how of that company, its engineers and scientists. It is this hard-to-come-by know-how which is the best assurance to the government that the contractor will satisfy contract specifications at a fair price and on schedule.

31. In two world wars the government has depended upon companies having commercial as well as government connections to supply products involving large quantities. Restrictive patent policies have contributed to the withdrawal from government business of some of the best of such companies, and under such policies, it is difficult to see what will induce other companies to replace them in peacetime governmental research and development. Government laboratories cannot and should not undertake the vast amount or variety of development work which must be carried on. We could not afford it. Under the stimulus of war, government laboratories were built up in 18 months' time which did excellent work, but next time it will be too late to go into development after war comes. We will have to fight with what we have. Our peacetime asset must lie in the numerous healthy companies which are equipped not only to develop, but to produce military equipment in at least limited mass production. Such companies are essential in peace to fulfill industrial mobilization plans in case of war. It is not enough to develop and manufacture by hand methods a few of the modern instruments of war. Some tooling for production and some actual production from that tooling by private industry is essential in peacetime. During World War II many engineering and manufacturing companies furnished the drawings, the engineers, and the know-how to other concerns which were efficient mass producers, but which did not engage in engineering. This will be necessary if war should come again and the maintenance in health of such nucleus companies is certainly good national insurance.

Hazards to Industry

32. The hazard to industry involved in research and development are many even when financially supported by government. Research is exploration into the unknown, and no way has ever been found of predicting whether the undertaking will be successful or not, or of forcasting the cost. It is often equally inpossible to know even how long the research must be pursued before it may be successfully culminated or proven to be a failure. Sometimes what appears to be a relatively easy problem may develop into one having many contributory problems, each requiring separate and additional research sub-projects which must be successfully completed before the original research can be further advanced.

33. This is particularly true in the field of aircraft accessory and instrument development in which many organizations are currently searching for unknowns in radio, radar, instrument landing, guided missiles, polar navigation and so on. Much of this development is now so expensive that only the government can finance it. It must however make the inducements to carry on this work at least as attractive as other types of research or development.

34. An effective national air policy requires that (1) the aircraft instrument and accessory industry be recognized as an important element of air power; therefore (2) its participation and influence in aviation planning must be expanded and supported; and (3) its incentive to maintain able and efficient research organizations must be increased, not destroyed by unwise patent policies.

Liberalized Patent Rights

35. In order to give companies now engaged in research and development work for our government the necessary incentive to use their experience and ability to the utmost in the performance of their work and to encourage other qualified companies to undertake such work, it is urged that the government's policy with respect to patent rights be liberalized rather than further restricted.

35.1. Where research and development work is undertaken for the government by a contractor which falls within his normal line of endeaver and merely carries forward a development pursued initially by the contractor at his own expense, it is recommended that the contractor be permitted to retain all rights under any inventions or discoveries pertaining thereto—the government's patent rights being limited to the right to reproduce the developed product with payment to the contractor on some royalty basis for the use of his proir basic patents. Certainly the contractor in such cases should not be required to grant the government a free license under any invention made by him prior to the receipt of the development order.

35.2. Where research and development work is undertaken for the government which is outside the contractor's normal line of endeavor, the present (but not in any case the proposed) government policy with respect to patent rights on purely development contracts could be followed, under which the government retains a free, non-exclusive license in such development; but we strongly feel that this policy should be restricted to research and development contracts and not extended to procurement contracts in which the government merely pays for the articles it purchases.

"RECOMMENDATIONS for ADEQUATE INDUSTRIAL PLANNING"

by

J. CARLTON WARD, JR.

President, Fairchild Engine and Airplane Corporation, New York, N. Y.

★ *Mr. Ward has been President of Fairchild since 1940. Prior to that he had been Vice President of United Aircraft Corporation and General Manager of its Pratt & Whitney Aircraft Division of United Aircraft Corp. He was in charge of the advisory mission to French government on airplane engine production in 1940 and member of the War Production Board Mission to Great Britain in 1942.*

"RECOMMENDATIONS FOR ADEQUATE INDUSTRIAL PLANNING"

ESTABLISH PROPER BASE

THE FIRST CONSIDERATION is to establish a proper industry base. The proper industry base can only be derived from first having determined the place of air power in American national policy and then accepting the Army's and Navy's evaluation, in specific items and quantities of equipment, of what they need in order to implement the given predetermined air power policy.

It must be kept in mind that an air power policy can be a constant or reasonably constant determination, but that military requirements to implement it will constantly change as the scene shifts in international relations and, hence, the role that America must play.

Next, a reasonably long-term policy and not a one-year policy dependent upon one-year Congressional appropriations. It has been determined that aircraft, engines, and the like require, on the average, a five-year development period. Hence, there should be a five-year authorized program against which appropriations should be released yearly by the Congress, in accordance with the older pattern established by the Navy for the building of battleships, which took five years to build and for which funds were appropriated yearly. Two-fifths of a battleship is as inadequate as a two-year appropriation for a five-year aircraft development.

IMPORTANT ELEMENTS

Statistics of World War 2 show that the national aircraft production trebled each year during the expansion program. Thus, working backwards from the military determination of quantities in being to quantities needed to support airplanes in being, laid down against a war emergency, it becomes clear how the proper industry base can be calculated, using as tools the pre-determined role of air power; the military force required, by types and quantities; and the size of the industrial base necessary to provide it, on the assumption that it will triple every three years from the inauguration of the program. The factors of national intelligence and the period of warning for the inauguration of such a program are equally important elements in this calculation.

RECOMMENDATIONS

In order to put into effect the above recommendation, it would seem advisable to:

1. Eliminate the confusion that exists in many minds with respect to the duties of the existing joint Army-Navy Munitions Board and the new National Resources Board.

2. The proper agency should be designated to work out the requirements for stockpiling of strategic materials to implement the air power policy in the above recommendation. (It is obvious that this can only be properly done when other national needs are also evaluated.)

3. A study should be made as to the amount of and location for war standby plants that may be needed to carry out this expansion plan. Such plants, if made use of by the peacetime economy, should be recapturable for wartime purposes on short notice. It is not felt advisable to tool them up in advance of an emergency due to the rapid obsolescence of design detail features of modern aviation materiel. This would be too costly to consider.

4. The role of sea commerce, air transport, and ground transport must be planned for in advance and the Government mechanisms for welding these into the war economy must not only be set up, but the peacetime personnel should be in training or available to handle these important assignments as part of an overall war effort should the emergency occur.

Selective Service

5. A Selective Service policy must be worked out which will preserve highly trained individuals needed for the industrial economy and which will induct into the Armed Services only individuals who can best be spared from the peacetime economy. This must be done in advance and be a matter of agreement between th military services and the key munitions industries.

6. Stockpiling of war surplus machine tools should be continued as the machine tool industry has roughly the same problem as the aircraft industry in wartime expansion, and the machine tools must be procured before aircraft can be manufactured from them.

7. Planning must provide for an adequate supply of petroleum fuels and derivatives and the necessary expansion or conversion of the peacetime petroleum industry to solve the problem.

8. Regulations concerning working conditions of munitions plant employees must be prepared in advance, and where State laws or municipal regulations would interfere with the emergency use of munitions manpower, procedures for eliminating such restrictions should be planned and operable at a moment's notice. If salary or wage stabilization techniques are to be employed, they should be worked out with industry in advance as these have serious implications in plant morale and, hence, production. The principles of war manpower utilization must be determined and planned for in advance of "M" day.

Skeleton WPB

9. A new War Production Board or other civil production agency should be planned in advance. A skeleton personnel in peacetime should be indoctrinated and available to guide it and set it in motion as soon as an emergency should appear.

10. Procurement procedures, suitable to wartime procurement, should be worked out in advance to eliminate the delays occasioned by such factors in World War 2. Methods of quickly building plant additions or new plants should also be so prepared that delays will not occur.

11. A controlled materials plan, or its equivalent, should be ready for release, and the confusion evidenced by priorities systems eliminated.

12. An emergency service should be planned and ready to meet the problems of bomb damage, taking advantage of the techniques used so effectually in Britain and Germany during World War 2.

13. Civil defense measures and organizational setups should be planned in advance.

Planned Subcontracts

14. Indiscriminate subcontracts should be avoided by industrial planning studies in order to prevent East Coast manufacturers from using West Coast subcontractors at the same time West Coast manufacturers are using East Coast subcontractors for similar articles. This increased the transportation load in World War 2 and caused severe bottlenecks.

15. With each important peacetime item of materiel, there should be the equivalent of Phase 1 and Phase 2 industrial planning studies, along the lines of those now procured by the Air Forces. This presupposes that industrial planning funds will be a part of each annual budget and will be earmarked for such use.

16. Where several aircraft firms will be called upon to produce the same design of aircraft, the procedures for interchangeability, engineering changes, tooling, allocation of materials, and subcontractors should be determined in advance from the best experience available from World War 2.

17. The Industrial College of the Armed Forces should be raised in rank and importance for the further training of career officers in the specialized fields of military procurement and industrial planning. It should be noted that Commandants of this College have always been outranked by the Commandants of the other top military professional training schools.

18. Advancement should be as rapid for career officers in finance and procurement as for line officers. In the past, many qualified officers have preferred line duty because of the greater advancement opportunities afforded in it.

High-level Planning

19. A high-ranking senior industrially trained military specialist should be a member of the top war planning groups in order to present on this top level of planning those factors that are important to the national economy and without which specific strategic and tactical war plans may be ineffective. The present procedure is not wholly effective in this regard, as can be cited from World War 2 experience. The professional military men have shown great readiness to accept the principle of industrial planning and emergency mobilization, and enormous progress has been made by them in doing something to effectuate it. Nevertheless, it is believed that further time and effort will be required to place it on the same plane of efficiency with the specialized military functions and, also, to bring it up into the highest level of military planning and administration.

20. Wherever peacetime procurement, through new research developments, places abnormal emphasis on specialized materiel, great care should be taken to see that the basic pattern of a healthy industry does not suffer unduly. It is not believed that in ordinary cases proprietary designs can be given to competitors in peacetime to manufacture. If the problems are too complex to permit adequate distribution by subcontracting, the problem can become a severe one. In such a case, if not met by stretching out production schedules in the unbalanced section

of the industry until subsequent years' requirements can step in and make up the deficiencies, there is bound to result serious industry dislocation. This cannot be prevented if the elements in the industry do not show sufficient flexibility to permit them to fit themselves engineering and production-wise into the new pattern. Such situations require highly trained industrial procurement officers with wider industrial experience than has been evidenced in pre-World War 2 military procurement procedures. This consideration also accents the need for professional military men with a high degree of industrial experience and knowledge.

Competitive Procurement

21. Competitive procurement by the three specialized Armed Services for creative materiel, as opposed to staple or specific materiel, is believed highly advantageous. It presupposes coordination on the Joint Committee level, such as by the Joint Aeronautical Board and similar professional committees.

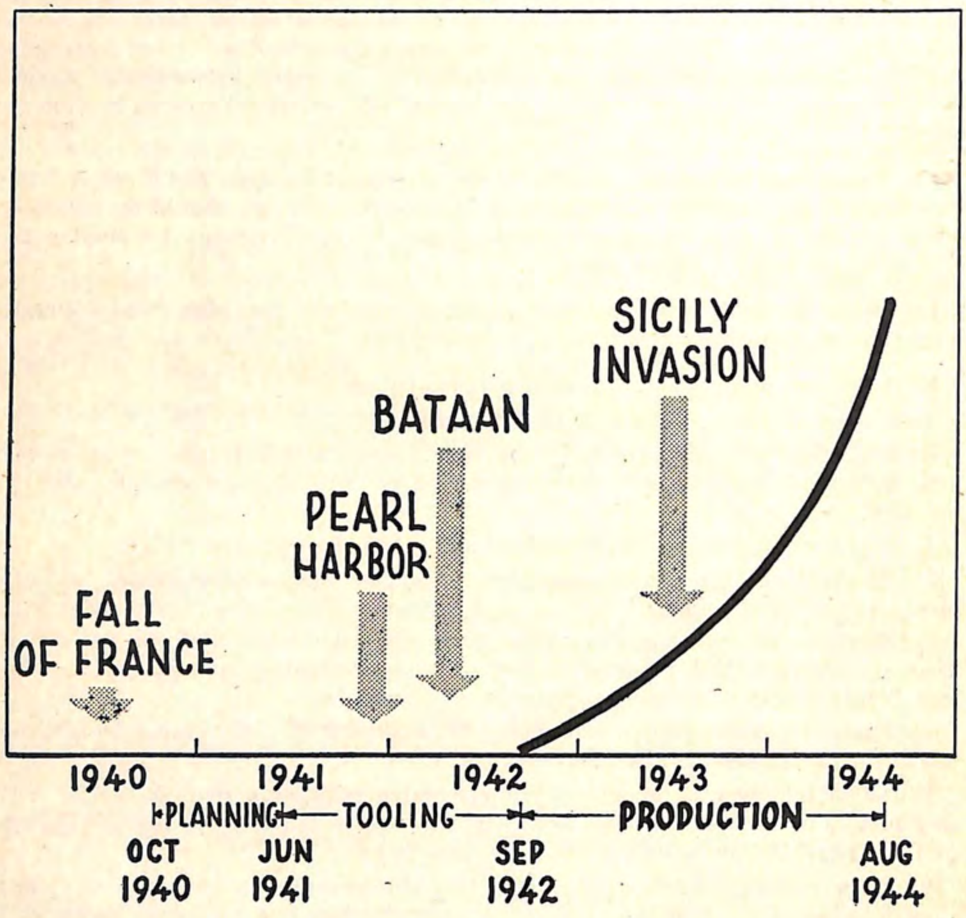
22. The pressure for continued and accelerated standardization of materials, specifications, test procedures, and purchase specifications between the Armed Services, and after consultation with the appropriate industrial groups, is strongly urged.

23. The industrial training of officers as carried out between the Navy and the industrial firms, members of the Navy Industrial Association, should be carefully evaluated and if pronounced successful, should be supplemented by similar activities in the other military arms.

In closing, it may be said that the important principles for proper and adequate industrial planning are:

1. A foreign policy and a national defense policy.
2. A determination of the role of air power.
3. A professional strategic and tactical military implementation of air power with industrial planning and procurement keyed into the military plan on the top level.
4. A five-year authorization procedure and a five-year air power plan.
5. Stockpiling of materials, machine tools, and the earmarking of standby plants as part of the plan.
6. Wartime agencies and procedures governing manpower, material allocation, Selective Service, and procurement should be planned in peacetime and key individuals should be trained in peacetime.
7. Funds for industrial planning should be a part of each annual budget and should be earmarked for the purpose.
8. Industrial planning should be an attractive military career, on a par with line duty as to promotions, rank, and other awards, in which the Industrial College of the Armed Forces should play an increasing role.
9. Peacetime aircraft should be retired by obsolescence factors and not from a consideration of whether they will fly; in other words, complete dependence on a modern air force in being.
10. Recognition that industrial mobilization must go hand in hand in an emergency with military mobilization and in modern war can be the larger undertaking of the two.
11. Peacetime designs generally cannot be fully tooled for war emergency because of rapid design changes and limitations to any peacetime budget.

RECORD OF AUTOMOTIVE CO. "X"



"THE NEED for a LONG RANGE AIRCRAFT PROCUREMENT PROGRAM"

by

ROBERT E. GROSS

President, Lockheed Aircraft Corporation

★ *Mr. Gross, prior to 1932, was associated with Walter Varney in the operation of Varney Speedlines, pioneer West Coast air transport line. In 1932, with some associates, he purchased the Lockheed Company, then in receivership, and built it from a firm of 94 employees to a wartime peak of 90,000, and a current 12,000.*

ROBERT E. GROSS

"THE NEED FOR A LONG RANGE AIRCRAFT PROCUREMENT PROGRAM"

WELL-BALANCED INDUSTRY

DURING THE COURSE of your Committee's hearings you have heard testimony regarding many aspects of the complex problems of maintaining American air power. It is manifest that air power consists of many integral parts, and weakness or failure in any one part weakens or destroys the whole.

One of these essential elements is a strong, well balanced aircraft manufacturing industry capable of rapid expansion to meet the production demands of any emergency, and one of the absolute prerequisites of such an industry is a sound, long range military aircraft procurement policy.

5 TO 10 YEAR PROGRAM NEEDED

I am hear to plead for a long range procurement program under which we, as manufacturers, will know for five to ten years in advance the number, the general types and the performance requirements of military aircraft to be purchased by the armed services. We must also know the rate of production required and the degree of expansibility that must be maintained. This procurement program is but one small segment of a much broader long range national air power policy or plan which must be established by Congressional enactment.

PRESENT POLICY COSTLY, INEFFICIENT

Today no such policy exists. Instead we are operating under a short range, hit or miss, feast or famine policy that is uncertain, costly and inefficient, and under which the aircraft industry cannot hope to remain strong and be able to perform its basic function in our national security program. It is this aspect of our national air policy that I would like to discuss.

Some references have already been made to the general subject of procurement for it is a basic problem common to all manufacturers. In order not to be repetitious, I will therefore try to confine my comments to those aspects of the problem that have not heretofore been extensively discussed.

What is the present military procurement program?

Under the present system, the military services do not make known to the manufacturers their procurement programs more than a few years ahead, except in extraordinary cases. Generally, future delivery schedules are for a considerably shorter period. This is not a reflection on the armed services, for under existing legal restrictions, they have no alternative.

In wartime—when all productive facilities are consistently operating at capacity—such a procurement policy presents no particular problem. In peacetime it does.

ONLY ONE CUSTOMER

Because the airplane has turned out to be such an effective weapon, as well as a means of transporting military personnel and equipment, the Government has become by far the industry's largest customer, and military purchases represent more than ninety percent of the nation's total aircraft sales even in peacetime. The military market is unlike any other. There is only one customer, and—unlike the normal commercial goods markets—if he doesn't buy your product, you can't go out and drum up other customers. Recognizing this fundamental characteristic of the military sales market, it becomes clear that our future stability as an industry depends upon the extent and duration of the planning the armed services do toward the procurement of military aircraft.

We, as manufacturers, suffer from the lack of long range planning—and it's not good for the services or for the taxpayers. It means fewer and inferior airplanes at higher costs, and it means that we can't maintain a strong, well rounded manufacturing industry in peacetime capable of quick, efficient and economical expansion to meet the requirements of a national emergency.

"LEAD" AND "FLOW" TIME

Two of the complicating factors in aircraft production are "lead time" and "flow time". It is startling, and yet understandable, that the public and even our law makers have virtually no comprehension of their meaning and importance. An understanding of these two factors in aircraft production is so basic to this problem that I would like to give you a brief, non-technical description of each of them.

Simply stated, **lead time** is the elapsed time from receipt of Government approval and "go ahead" on a new airplane model until the contractor reaches reasonable volume production on that model. This time varies from a minimum of approximately three years to a maximum of seven or eight years depending upon the type, complexity and size of combat aircraft. For example, the lead time on the Lockheed P-80, which was designed under the pressure of war, was somewhat over two years. On the Navy P2V anti-submarine patrol bomber, it was about five years, and on the B-29 Superfortress—with the press of the war unquestionably accelerating the lead time span—approximately six years.

Flow time is the time required in the plant to build an airplane from the date materials are ordered until the completed airplane is ready for delivery. This again varies in length of span from about twelve to thirteen months in the case of small fighters such as the P-80 to slightly over two years for a heavy aircraft such as the R-60 Constitution or a typical heavy bomber.

To get the case squarely before you, let me cite a straightforward example of a problem currently facing my own company brought about mainly for want of a long range plan. And this example is typical of the situation that exists throughout the industry.

MAINTAINING STEADY PRODUCTION LINE

As you know we build the P-80 Shooting Star. It is the principal jet fighter currently in use by the Army Air Forces. At present we have a modest production line in operation, but on the basis of orders now on hand, we will deliver the last P-80 in November, 1948. If we are to maintain the continuous operation of even a trickle of a production line, we must have additional orders today—and I mean literally today. This is because the extremely long flow time through procurement and fabrication and assembly requires that certain items must be procured as much as twelve months prior to November, 1948 if we are to continue production without a definite shutdown of the line at the end of our present contracts. The twelve months' flow time comes about by adding the time required to procure certain critical materials to the normal fabrication span under our low production planned methods. Twelve months' flow time for the first lot of follow-on airplanes of an already established type indicates one of the weaknesses of a year by year, short range air power program. It should be emphasized that this twelve months' span, just referred to, can be considered valid only if the follow-on airplanes are the same type as those we will be building at the end of the present order. From the testimony previously presented, you are well aware that design changes are inherent characteristics of military aircraft development and that there must inevitably be changes even in successive series of an existing production model, and thus the flow time problem is further complicated.

Very little can be done under present conditions to materially shorten these times, as aircraft, both civil and military, are continuing to increase in size and complexity and decreasing in numbers procured which in turn increases or complicates lead and flow time. Airplanes designed to break through the sonic barrier or to fly in the stratosphere require months and years of research, analysis and testing before the new designs are ready for the production line. Time slips by rapidly and there has never been developed a method of calibrating an engineer's or inventor's mind so that we can schedule the day a complex problem will be solved and the design can go forward from proposal—to prototype—to production with little or no interruption.

Now, in order to illustrate graphically the importance of lead and flow time and to provide an actual example of their practical application, I would like to call your attention to three charts.

GOOD AND BAD PLANNING

Chart I provides a simple illustration of what happens when the time relationship of two successive models, or different versions of the same model, are properly planned and then when they are improperly planned.

In the first case, Model A goes into production, reaches a peak, holds that for a definite time, then tapers off and is closed out completely. Then follows a dry spell as indicated by the shaded portion. Six to eight months later, Model B goes into production and follows the same cycle.

The shaded area is the important part of this chart for it represents the "dry spell" when we must either maintain our organization as a dead loss or disband it and pay the heavy penalty of reorganizing when production is resumed. Either course is tremendously costly and inefficient.

PRODUCTION DIPS COSTLY

And that segment represents big money. In the case of the Lockheed Constellation, it cost us about $14,000,000 when a combination of circumstances prevented us from telescoping our new model 649 into the preceding model 49. And the same principle applies to any two successive models in any company.

CHART I
MANUFACTURING CYCLE
HOW MAN-POWER IS USED ON SUCCESSIVE MODELS

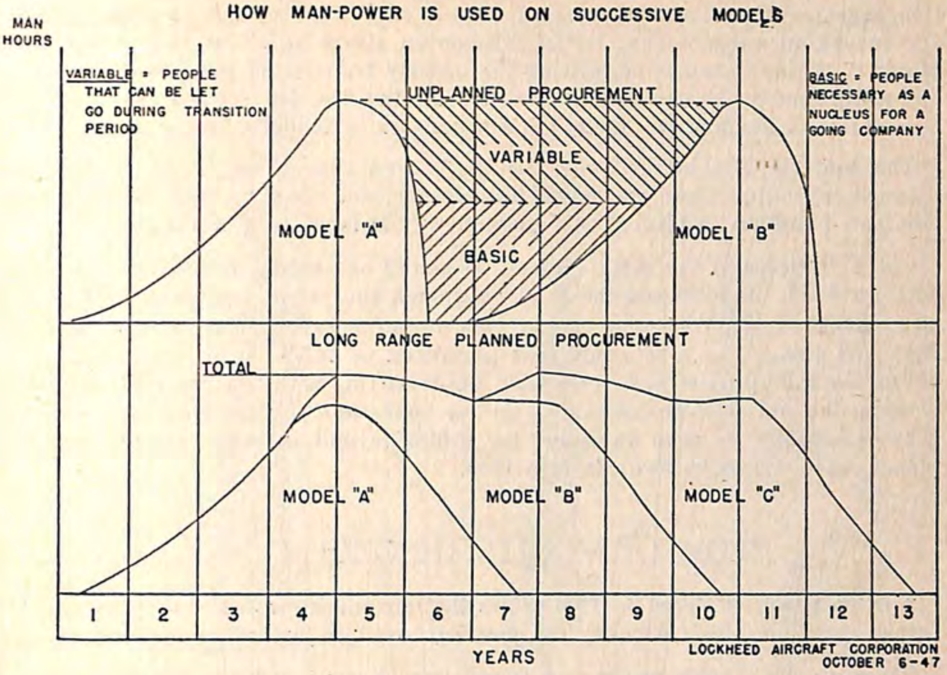
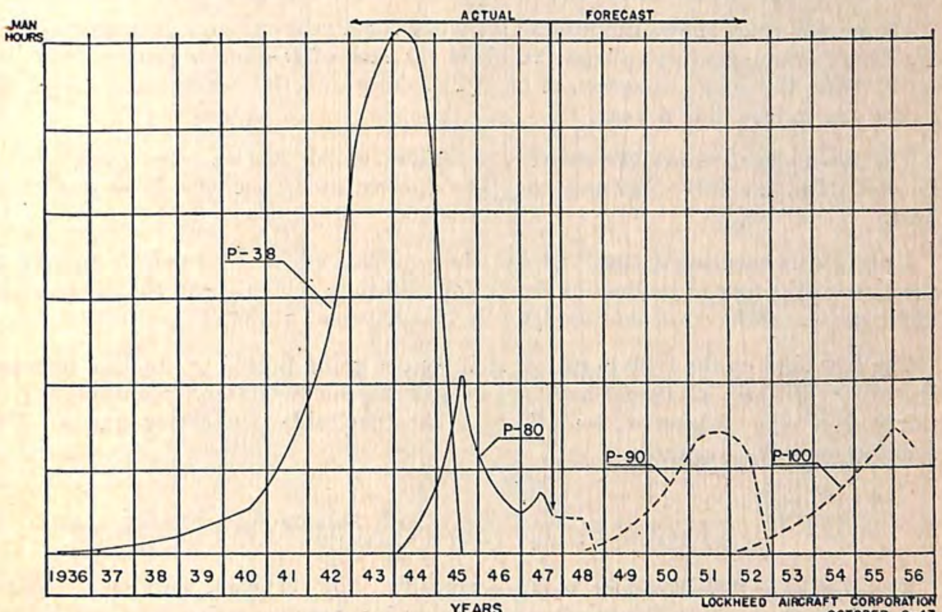


CHART II
LOCKHEED FIGHTER PLANES
MANUFACTURING CYCLES



The second case shown on this chart is an example of planned transition from one model into another. It starts out the same with Model A, going into production, reaching a peak and tapering off. But in this case Model B has been planned far enough in advance that initial production starts at about the point where Model A begins to taper, permitting the orderly transfer of manpower, facilities and equipment to the new model. By the time the first project is washed out, the second is well under way. Model C's relationship to Model B is the same.

The contrast is a marked one. In the second case there is an orderly and planned transition from one model to another and the dry spell is practically eliminated and the sustaining cost consequently reduced to a minimum.

Chart 2 relates to the same subject. It shows our actual follow-on experience with the P-38, the P-80 and the P-90. Although the production peak of the P-38 was abnormally high because of war time requirements, it can be seen that the P-80 was planned on a schedule that permitted us to get into production on it before the P-38 project was closed out. Contrast this with the dry spell indicated between the end of P-80 orders now on our books and the forecast production of P-90's. Actually we have no orders for P-90's beyond the two experimental airplanes scheduled to be flown in late 1948.

FLOW OF MODELS THROUGH PLANT

Now let's look at Chart 3. This shows the immediate past, the present and the future of the Lockheed Aircraft Corporation based on orders on our books today.

The top chart represents the very foundation of our company—the research and engineering people who are working on the development of current projects and the design of future models. It is significant that although production workers and aircraft deliveries pinch out completely in mid 1949, engineering personnel continues at a rather high level. This is an illustration of the absolute necessity for maintaining a basic work force if we are to continue as a going concern.

The middle chart shows the productive work force requirements in terms of the number of direct productive hours required for each of the major projects now in work. With the single exception of the P2V, the productive work force drops off to nothing in less than a year.

The lower chart shows the delivery schedules on all our various models—the Constellation, the P2V Neptune, the R-60 Constitution, and the P-80 Shooting Star.

I previously mentioned the P-80 and the problem we have to maintain even a semblance of a fighter production line. You will note in the chart that deliveries under present orders will be completed in November of 1948.

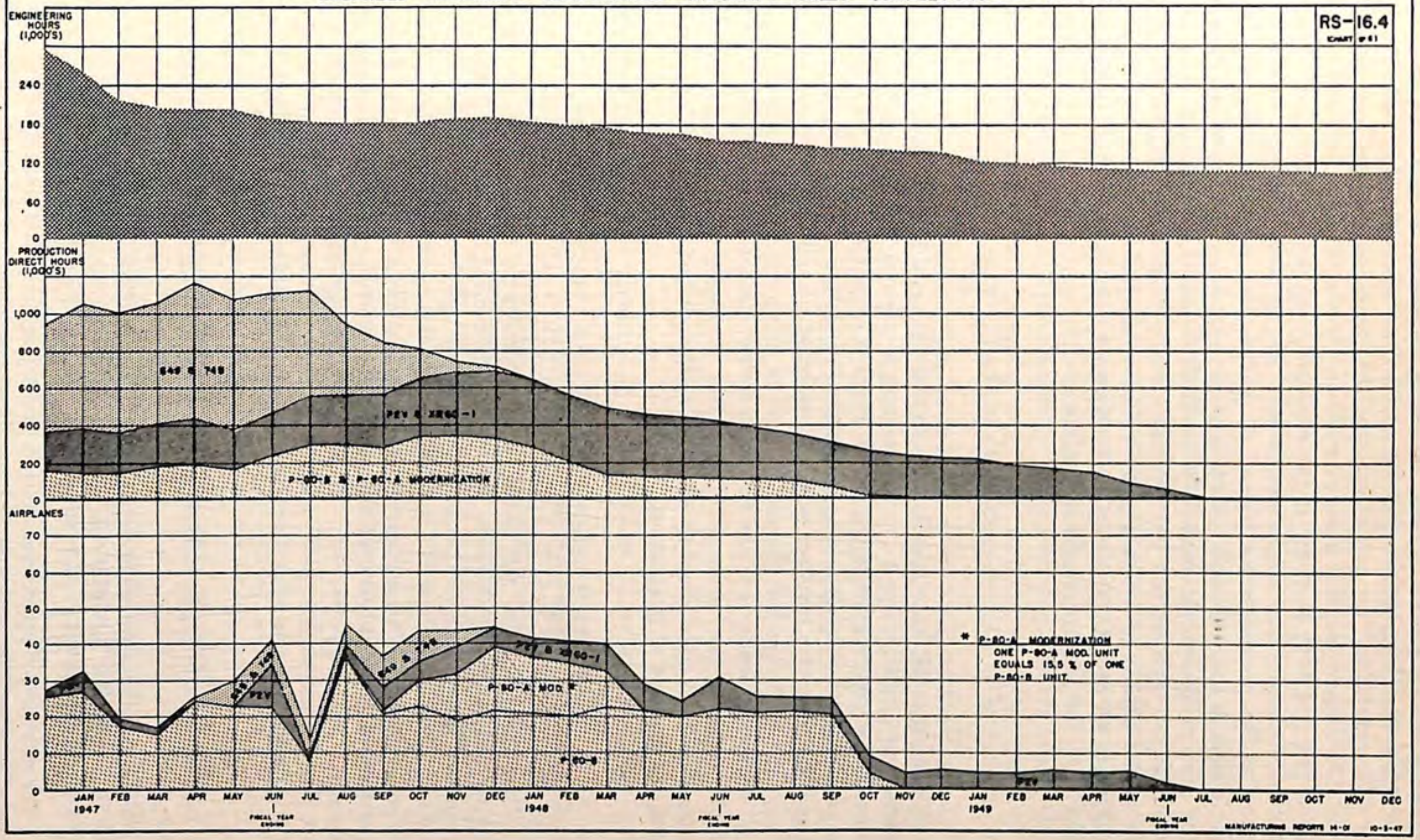
The flow time on the P-80 is such that if we are going to add production beyond November of 1948, we should have begun ordering materials and planning for it thirty days ago. Otherwise, we will have the inevitable production gap or dry spell between the contracts.

STEADY FLOW MEANS LOW COST

The cost of a P-80 airframe today—exclusive of government furnished equipment—is in the seventy thousands—reasonably low because we've been privileged

CHART III

LOCKHEED AIRCRAFT CORPORATION — AIRCRAFT SALES COMPLETIONS BY MONTHS



to build a few hundred of them with good production tooling and with a degree of steadiness. If we have to shut them off before we can get into a P-90 or a P-100 or a "P-something," the cost of carrying the organization to get over the dry spell and into the new model is going to make the follow-on plane cost many thousands more per unit than it would if the continuity could be maintained. The several million dollars of dry spell money might just as well be given to the Army in more of the present series instead of getting less airplanes over all, requiring more time to construct and having them all cost more. Or, stated another way, if the present production cannot be maintained on the level that will keep the organization together and that organization is let go—then the ultimate cost, in delay and quality of product, of the follow-on model is going to be all out of proportion with decent value to the Government. In the end, the Government will pay more for fewer and poorer airplanes.

MUST MAINTAIN TEAM

The essence of the whole thing is that we have to have a basically integrated, permanent organization to do a temporary business and we can't live on this basis. The organization necessary to make a satisfactory airplane has to be an organization of specialists who have worked together for years, not just a pickup team that is gotten together overnight to build a handful of articles and then let go. The people who put the remote control firing apparatus in the B-29, and the power boosted controls in the P-80, and flying characteristics in the A-26 and the F-6F, were not just a crowd of transient or floater workers gotten in for the occasion. They were members of a team—the product of continuing organization and the practice of production.

"BASIC" AND "VARIABLE" WORK FORCE

This does not mean that there is no flexibility in the size of our work force which will permit contraction during the transition period from one model to another. We can, and do, expand and contract our work force as circumstances require. But while there is a portion of our total work force that can be adjusted up and down without serious consequence, there is a basic element that must be maintained if we are to continue as a going concern. In addition there are substantial overhead costs such as taxes, plant maintenance, insurance, etc., that continue constant irrespective of production volume. The relationship of the variable to the basic work force is shown is the shaded area of Chart I.

MUST HAVE PRODUCTION PRACTICE

It takes a lot more than just engineering and materials and a pilot to deliver an airplane. For a production program, and to keep our industry alive, we must engage in this practice of production.

The practice of production doesn't mean just materials and jigs. It means personnel hiring. We must know how to hire and train and handle people. The procurement of materials is a science in itself. You cannot take the thousands of things that go into the making of an airplane—many of them very special and complicated—and expect to have them all arrive at the staging area of a factory at one time without knowing how to do it.

IMPORTANCE OF VENDOR SOURCES

The lack of a long range procurement and planning program likewise causes an impossible condition in the vendor and subcontractor community from which we buy hundreds of articles and materials and services. We are absolutely dependent upon them—and for that matter so are the military services in their plan of purchasing G.F.E. parts and equipment. During the war when we were building thousands of units and the whole industrial economy of our country was geared to war operations, we could go to the General Electric Company and the Aluminum Company and the Square "D" Company and others and get what we needed because we had high priorities and because we were talking in terms of big quantities.

But in peacetime it's different. They can't be expected to tie up their facilities for the development or production of a few units of some item with no assurance of any repeat business. What they want to know is—"how many units will you want next year, and the following year, and the year after that." And that's what we can't tell them because the present procurement program and policy of our Government doesn't permit it. They might be persuaded to stay on if we could tell them that.

ELEMENTS OF PRODUCTION TEAM

There are a lot of other elements of this practice of production which are important.

We have to have industrial relations people. We have to have personnel people. We have to have financial people. We have to have tooling people. We have to have craftsmen. We have to have managers. We have to have all of these elements of organization. In short, it takes the whole integrated team, a complete organization, not just one little group of engineers or a group of craftsmen.

I would like to mention briefly another facet of this long range planning problem that I consider important—and on which there may be a different viewpoint even among members of the industry.

SPECIALIZATION NEEDED

I personally believe that with the industry expanded and the market contracted some plan should be adopted which will, for all practical purposes, limit the sphere of activity of any given aircraft company to certain fields. Sufficient forward planning would put each company in a position to look forward with reasonable dependability to something, rather than unpredictable speculation—perhaps to nothing.

As matters now stand, the 14 different companies that built 96,000 airplanes in 1944, competed for 1,330 military airplanes built in 1946.

Because the Army and the Navy themselves probably do not know, they are unable to tell us that we as individual companies may count on certain business—assuming, of course, satisfactory performance by the companies. As a result, with no one knowing where he stands, an individual company has to try for anything and everything, or perhaps be out in the cold with nothing.

I do not believe that the aircraft industry can exist in its present pattern, and I believe that in order to provide the most efficient springboard from which in time of war to accelerate quickly, and produce aircraft of high quality, in large quantity, and at low cost, the companies must be somewhat more specialized in their fields and models than they now are.

UNCERTAINTY PREVENTS SPECIALIZATION

Our industry has not been a specialized industry because there hasn't been enough fighter business, for instance, that any one company could be fairly sure of getting, to make it dare to specialize. We have had to struggle around and build any type we could to keep going.

I certainly am not suggesting that any company be given a sheltered monopoly in any field. I am simply saying that for each company, for the sake of survival, to have to maintain a potential that can build anything from a trainer to a cargo plane is an economic waste. And I am suggesting that a long range procurement program, as part of a national air policy, would help to correct it.

Some will say that a long range aircraft procurement program is good to talk about but that as a practical matter we can't get it because of Constitutional provisions limiting the time span of military appropriations, and because of a lot of administrative restrictions under which the armed services must operate. But I believe what I'm talking about can be done and as a matter of fact is being done today in other departments of our government.

PROPOSAL FOR LONG RANGE PROGRAM

What I'm suggesting is that Congress, through proper channels, study the long range defense and civil aviation requirements of this country and on the basis of such a study establish and declare a five- to ten-year national air policy for the United States, specifying the strength at which our Air Forces would be maintained. Having established such a policy, it would then become incumbent upon them to make appropriations year by year adequate to implement it. Thus, the armed services would be in a position to tell the manufacturers what their aircraft requirements would be over a long period of time and what might be expected from individual manufacturers, with reasonable assurance that the appropriations necessary to implement the program would be forthcoming. On this basis the manufacturer would be enabled to plan his company's operations and program in such a way as to eliminate the peaks and valleys characteristic of our present operations.

It is fully realized why the Constitution of the United States set some control on the military expenditures, both as to amounts and duration of authoriy. However, conditions have changed in this new field of weapons, and where in the 18th

Century there seemed no reason to extend contractual authority for any great period of years, some 160 years later, we find ourselves faced with an entirely different situation. Legislation has been proposed that will, if passed, correct many of the cumbersome details of yearly procurement procedures that were in effect prior to the war; however, it does not dispose of the fundamental planning problem which can only be corrected by Congress.

NAVY PROVIDES PRECEDENT

There is nothing new about what I'm proposing. A similar procedure is followed in the procurement program of our floating Navy. In that case, Congress, after studying the Navy's recommendations, passes an Act which defines the strength at which the Navy is to be maintained for a long period of time. It provides for the construction of a given number of tons of combatant ships, provides authority to contract for their construction and provides for the subsequent appropriation of funds to effectuate the purposes of the Act. Thus the Navy is able to tell the shipbuilders what will be required of them over a long period of years and they can plan their program accordingly. That is the kind of long range procurement program we need in aviation.

I would like to mention one other point which I believe must be appreciated to fully understand the present position of the aircraft industry and the need for immediate action.

WAR LEFT INDUSTRY WITH HEAVY BURDEN

There is a great and general misunderstanding about our air industry today. I think that government officials, certainly the public, and perhaps even some of the members of our armed services feel that the war built us all up into a strong position and left us with strength that will see us through any difficult period for a few years—and that, therefore, nothing particular need be done now.

Nothing could be farther from the truth! The war built us up all right—but it built us to heights from which we cannot possibly retreat without special planning. Except for the moral issues which were settled, we would have been sounder if there had been no war. The air business would have been on a modest but sound increase. Instead, we were rocketed into war and left with facilities we cannot employ, organizations we cannot support but still cannot do without, and financial strains for which even our war accumulated reserves are not the answer. Financial resources do not alone make for security. Special measures were deemed necessary to get us up—special measures are equally necessary to get us down again.

The thing we need is the long range national air policy I have been talking about, and a planned procurement program that will enable us to engage in the continuous practice of production. With such a program we can iron out the costly and inefficient peaks and valleys of production, give the armed services more and better aircraft for less money, and sustain the nucleus of a healthy industry capable of expansion to meet the time and quantitative requirements set forth by the military forces.

"RECOMMENDED ADDED EMPHASIS of PRODUCEABILITY"

by

RICHARD B. CLEVERING

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RICHARD B. CLEVERING

"RECOMMENDED ADDED EMPHASIS OF PRODUCEABILITY"

SUMMARY

Airframes and related equipment are being designed and produced with little consideration as to availability of materials in the event of an emergency. This same equipment is being produced in small quantities required by the peacetime Air Forces without consideration for the necessity of mass production in the event of an emergency. Very little consideration is being given to interchangeability of major components, with the result that capacity to build is reduced and distribution becomes a major problem. Therefore the following recommendations are made.

Design of all items of equipment for the U. S. Air Forces should have as their objective utilization of the absolute minimum of raw materials which would be critical in the event of an emergency. All items of equipment should be designed for production by mass production methods. Tools for this production should be designed and built in order that they may be thoroughly proven in the event that they are required in large quantities. Designers and builders of aircraft should be required to use standard articles of equipment to a maximum degree. Procurement should be released for a minimum of five years to permit reasonable depreciation of mass production tooling and logical planning of new and improved designs, as well as encouraging the interest of reputable contractors who are not now interested in building items for the U. S. Air Forces.

In discussing this problem it must be assumed that there will be no opportunity for this country to prepare itself for combat after war has actually started, such as was the case in World War II when our allies were able to hold back the armed might of the enemy until we were in a position to convert and activate our peacetime industry to wartime production. I believe we may also assume that, in the event of another war, the United States undoubtedly will be the first nation attacked and the attack will come without warning. The record of the last war reveals the following: Although France fell in 1940, it was 1943 before one of our major industries, namely the automotive industry, was able to produce aircraft and related equipment for the U. S. Air Forces in sufficient quantities to be of any material value. See Exhibit "A." There were many contributing factors to this situation. However, these remarks will be confined to those factors concerning produceability of aircraft and related items which contributed to this excessively long period of mobilization. If the trends which are now apparent are permitted to continue, a great many of these same problems will confront the U. S. Air Forces in the event of another national emergency. These trends can be summarized briefly as follows:

PROBLEMS

a. Airframes, aircraft engines and many other extremely complex items which are required to complete the combat airplane are now in process of development without serious consideration being given to the availability of critical materials in the event of a national emergency. It is perfectly true that the objective of our manufacturers should be to produce articles of the highest possible quality for the armed services. However, there is very little value in having available equipment which has been developed and designed to utilize excessive quantities of such critical materials as columbium, cobalt, etc. It is known and accepted that all items developed for the U. S. Air Forces are for the sole purpose of fighting a war. Yet only small quantities of these critical materials will be available for production of the necessary items under wartime conditions. However, under present designs, the U. S. Air Forces will require vast quantities of these scarce materials in order to meet their minimum needs in the event of a national emergency.

Production Redesign

b. Components and airframe parts are being designed with the commendable objective of providing the greatest amount of strength and dependability and the least amount of weight to accomplish the development of aircraft with the highest performance possible. However, in many cases parts so designed will require complete redesign before they can be produced by mass production industries, such as the automotive industry. Past experience has proven that this redesign for adaptation to mass production tooling requires from a minimum of a few months to as much as two years. A case in point is a jet engine now being produced. The engine manufacturer could expand to a capacity of 2500 or 3000 engines per month, but there is not sufficient forging capacity in the United States to supply the required number of compressor and turbine blade forgings. The only items being designed or produced today over mass production tooling are those which were produced in a very similar form during the last war. As these items become obsolete, the majority of new equipment is being designed and fabricated by tool room methods. This is due, in a large degree, to the fact that the requirements involved are so small that no manufacturer can justify the terrific expense involved in the production tooling of a plant to build the quantities required. It is particularly true when procurement is made for only one year at a time. This is more critical in the aircraft industry than in any other industries because such rapid strides in development are being accomplished that tooling constantly requires changing to meet revisions in engineering designs. As an example, over 2000 changes in drawings were made on one type of turbo jet aircraft engine within a twelve months' period, while the production rate on this engine averaged approximately 100 units per month. It is obvious that no private contractor can possibly hope to remain in a competitive market where weight, performance and cost to the Government are the governing factors and still attempt to manufacture his product from non-critical materials, design the article for mass production, and design and keep current the machine tools over which the article is to be fabricated. However, if planes and the extremely complex related equipment are not designed to utilize a minimum of critical materials and to be produced over mass production tooling without complete redesign in the event of a national emergency, it is obvious that equipment will not be available to the U. S. Air Forces in sufficient quantities for successful prosecution of the next war.

Interchangeability

c. The problems of maintenance and interchangeability encountered in the last war were of major magnitude and caused an unnecessary and excessive load on transportation, as well as creating excessive requirements. To a large extent, these problems were due to the fact that airframe builders were loath to adapt their airplane designs to utilize standard installations of the thousands of items of Government furnished equipment. Such items as engines, pumps, valves, etc., are incorporated as a major part of the total assembly of the modern complex airplane. In addition to the major components, special types of fittings, valves, electrical plugs, etc., are designed and produced for use in one specific type or model of airplane. This procedure reduces the overall quantity of any item which can be made by a given manufacturer and increases the numbers of machine tools, special tools, jigs, dies and fixtures required. The result is a decrease in the overall production capacity and an increase in the number of machine tools, special tools and personnel required. In addition, it presents the Maintenance and Supply Divisions of the U. S. Air Forces with a problem in logistics which is practically insurmountable. For example, a major item of Government furnished equipment, such as an engine, must be built to five or six different configurations, simultaneously, in spite of the fact that the basic engines are identical. The peculiarities of the models are due to the manner in which the individual airframe builder desires to install the engine in his particular model airplane. It then becomes a major problem for the U. S. Air Forces Supply Division to provide engines of the proper configuration to the various theaters of operations. These engines, which are supplied as spares or replacement engines, can be used only in a particular model airplane in spite of the fact that other planes based in the same area may require the same basic engine built to a different configuration. This results in double the quantity of spare engines being required. A situation could and did arise where a particular group would have an ample inventory of spare engines to maintain combat efficiency but would have a large percentage of their bombers or fighters (depending upon which specific model of engine was available) grounded for lack of spare engines. When you continue this theory through the thousands of items of equipment required to maintain airplanes in combat theaters, the magnitude of this problem is staggering.

RECOMMENDATIONS

During peacetime, it is the first responsibility of all of the armed services to be prepared to successfully repel the initial attack of any invader. The second responsibility is to successfully accomplish the defeat of that invader. Therefore the following recommendations are submitted.

Availability of Materials

a. In the process of development of new articles of combat equipment, very careful study should be made by the U. S. Air Forces to determine whether materials from which the article is fabricated will be available in quantities required in the event of a national emergency. In many cases it will be justifiable to accept an article of slightly greater weight and shorter life, built of materials which will be available. This is preferable to accepting an article in a form designed for maximum performance and stamina, built of materials which will not be available in sufficient quantities in the event of war. It has been suggested that an article should be accepted in its optimum state with regard to weight, strength and performance and then redesigned to utilize less critical materials. This is an extremely hazardous viewpoint, as can be demonstrated by the experience of Germany in the latter part of the last war. A case in point was the Jumo turbo jet engine. The original design of this engine had been developed over several years by some of the most capable scientists and engineers available. It required large quantities of critical alloys for successful operation. However, as the war progressed, the availability of these alloys was reduced almost to zero. As a result, the engine had to be completely redesigned not only to utilize available materials, but also to properly reinforce and cool the various parts. This was necessary to maintain the strength of available materials and reduce temperatures to the point where these materials could be operated successfully for a reasonable period under combat conditions. This particular instance probably delayed by many months the time when the Luftwaffe was able to send up jet fighters against our heavy bomber formations. It undoubtedly had a great effect on the duration of the war with Germany. Accepting the premise that our positions might be reversed in the event of another war, it is possible that we would suffer the same disastrous consequences before our interceptor fighters could be produced and activated in quantities necessary to develop a satisfactory defense from air attack.

It is realized that the armed services are confronted with an extremely difficult problem in estimating the following: (1) The total amount of critical materials required for full scale production of all types of combat material and equipment; (2) The maximum quantity of these materials permissible in any one of the tens of thousands of various pieces and components involved. It is therefore recommended that all articles be procured on the basis of utilization of the absolute minimum of all types of critical materials. At the same time, the objective of attaining the ultimate in all prime requirements of the item involved should be maintained.

"Push Button" Tooling

b. Every item of equipment procured during peacetime by the U. S. Air Forces should be designed for production on high output automatic, or so-called "push button," tooling. This is of vital importance since, as we all know, it is impossible to train sufficient numbers of machine tool operators during a national emergency.

Even if it were possible, production requirements are so great that the types of machine tools used to produce small quantities could not possibly be made available in the numbers required. Therefore, automatic machine tools and high output tools, dies, jigs and fixtures are imperative. In view of these proven facts, every piece required for use in any component of combat equipment should be designed for fabrication on mass production tools. The design of each article should be complete in every detail down to the last drawing. All drawings should be revised periodically to meet the latest design of the article and should be kept on file where they would be immediately available for delivery to a member of the mass production industry. Furthermore, the peacetime producer of the article should be required to design the special tools, jigs and fixtures necessary to produce the item and should actually fabricate "pilot-line" requirements for these tools. The article which he is producing for the peacetime Air Forces actually should be fabricated over these tools. The same procedure should be followed with regard to drawings for special tools, dies, jigs and fixtures as should be followed for the article itself. I know of no other way to assure satisfactory tooling when it is needed in the event of an emergency. This procedure is, of necessity, costly, particularly when utilized to produce the small quantities of articles now required by the U. S. Air Forces. The situation is further aggravated by the extremely rapid obsolescence of combat type aircraft and complex related components. However, when we consider that the United States will be the first nation attacked and, if this policy is not followed, many months will be lost due to pre-production tool design, it is believed the expense involved is more than justified. One month saved during the initial period of another conflict would probably justify any reasonable amount of peacetime expenditure due not only to the ultimate savings in money but also to the savings of life and property.

It is probably true that the above outlined procedure will not be feasible in every intsance, such as some airframe parts where tooling costs for one major piece would run into hundreds of thousands of dollars. However, in the vast majority of instances, it is believed this procedure will be feasible and economically sound. In those instances where such a procedure is not deemed practicable due to the expense involved, designs and drawings for the special fixtures and jigs should be completed and maintained in a usable condition.

Standard Units

c. It is recommended that every emphasis be placed upon the problem of interchangeability of all items of aircraft equipment. This is necessary to reduce to a minimum the number of different parts required by the aircraft industry in order to accelerate production in the event of a national emergency, reduce unnecessary load on the machine tool and die industries, and reduce the number of personnel required in the overall program. It is further recommended that aircraft builders be held to a minimum on their requirements for special configurations of major items of Government furnished equipment. They should be required to utilize standard units wherever possible, even if this requirement necessitates delay in deliveries under the peacetime program or redesign of some particular parts of the airframe involved. This should be done even if a minor sacrifice in performance is involved, although in the vast majority of cases, this should be unnecessary.

5-Year Procurement

d. It is recommended that the U. S. Air Forces release procurement over at least a five year period rather than yearly as is now required by existing regulations. Such a procedure will permit manufacturers to plan depreciation on production tooling over a more reasonable period. It will also permit long range planning on development. Further, it would encourage additional manufacturers, who are not interested at present because of their inability to plan production over reasonable periods, to produce many of the minor items of equipment for the U. S. Air Forces.

The recommendations outlined should warrant the full cooperation and support of the industries involved. However, it is the responsibility of the U. S. Air Forces to accept leadership and provide the industries with a long range program, coordinated with the other services, upon which to base industrial mobilization planning.

It is realized that the recommendations contained herein cover only a small portion of the overall problem confronted by the armed services and the industry as a whole. It is also realized that some of these recommendations will of necessity increase the cost of aircraft and equipment delivered to the U. S. Air Forces during peacetime operation. Nevertheless, it is believed this type of program is the most economical insurance which can be procured for the ultimate benefit to this country as a whole. It is sincerely believed that, had such a program been initiated immediately after World War I, funds expended in the first year of World War II would have been ample to maintain this program over the entire 25 year period. Had such a program been in force, with a potentially powerful U. S. Air Forces as a result, World War II might possibly have been avoided. In this event, the great drain on the financial and natural resources of the country, as well as the terrific sacrifices and losses in manpower, would have been unnecessary.

"PROCUREMENT PLANNING METHODS and PROCEDURES"

by

MAJOR GENERAL OLIVER P. ECHOLS, U.S.A. (Ret.)

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"PROCUREMENT PLANNING METHODS AND PROCEDURES"

SUMMARY

1. Many past surveys of the aviation situation, including that of the Lassiter Board, the Lampert-Perkins Committee and the Morrow Board of 1925, and the Federal Aviation Commission of 1935, clearly point out the chief problems confronting the Air Forces and the aircraft industry in the field of procurement. They are:

(a) Lack of continuity of orders, and the need for a long-term program.

(b) The need for a procurement statute permitting flexibility in purchasing procedures and procurement planning.

(c) The requirement for competitive bidding on such complicated and costly products as aircraft often prevents rather than encourages competition.

2. The Air Corps Act of 1926 contained a remedy for this situation by providing that competitive bidding could be waived under certain circumstances. However, this provision was whittled away by legalistic interpretations and re-interpretations, and after a few years became meaningless.

3. Competition in aircraft design and aircraft procurement can be assured only by deliberate policy and planning of procurement. No firm can afford to design and develop an aircraft costing thousands of dollars on the mere hope of winning out in a design or production competition. The procurement program should be planned so as to provide competition in each stage of the development cycle in aircraft: original design, experimental models, and production planes. In carrying out this program I should like to emphasize that wartime experience proves the wisdom of always maintaining at least two competing models in every basic category of combat airplanes.

4. With regard to procurement, I recommend to the Commission:

(1) Establishment of a procurement program of at least five years' duration. This would enable consistent, economical, forward planning of aircraft production. It would also encourage and foster competition by encouraging concerns to plan ahead and stay in the business.

(2) Enactment of a procurement law allowing flexible contracting procedures. It should clearly authorize negotiation instead of sealed competitive bids wherever such procedure would provide superior equipment, encourage competition and design production, or otherwise advance the industrial mobilization plan. Splitting of awards and the use of mandatory subcontracting should be authorized under the same conditions.

(3) The procurement policy, the procurement law, and the procurement program must be coordinated with the industrial mobilization plan.

OLIVER P. ECHOLS

PROCUREMENT PLANNING

Ø THE PROBLEMS facing the Government and the Aircraft Industry, in regard to Procurement Planning, Methods and Procedures, today are more difficult and complicated than ever before because:

(1) the importance of maintaining our Air Forces in an immediate state of readiness is vital to the interests of the Nation;

(2) the greater complexity and the more rapid rate of change in the equipment to be produced; and

(3) finally, because there are larger annual appropriations involved.

PAST SURVEYS OF THE PROBLEMS

However, a study of these problems over a period of years seems to indicate that the basic principles of the problems with which we are now faced are the same as those to which we have been trying to find a solution since World War I. We therefore have much experience and background to aid us in the solution. I believe that it is well to review very briefly some of the studies made and experience with these procurement problems.

After World War I, as now, the Government was faced with the problem of developing aviation, maintaining an adequate aircraft industry to support the national defense, and procuring modern aircraft in accordance with the needs of the Services. The aviation industry which had been built up as a result of World War I was rapidly disintegrating. The conditions existing at that time were summarized in a study of the Air Judge Advocate Air Technical Service Command, dated 9 March 1945.

> "Before 1926, the procedures relative to the purchase of aircraft were interwoven with and based on statutes which related to the purchase of all other supplies and materials for the Government. Procurement under such statutes and procedures after World War I proved to be so cumbersome and restricted that as early as 1919 the American Aviation Mission, in its report of 19 July of that year, stated that 90 percent of the wartime aircraft industry had been liquidated, and the remainder would inevitably disappear under the conditions which then prevailed. To the same effect were statements made by the Lassiter Board in its report of 24 April 1923."

This problem was given much study by various boards and agencies, the most important of which were—

The Lassiter Board—April 24, 1923

The Lampert Committee—appointed by the House of Representatives in 1924

The Morrow Board—appointed by President Coolidge in 1925

The Federal Aviation Commission—appointed by President Roosevelt in 1935

I realize that the reports and recommendations of these Boards and Commissions are well known to you and your staff, but in order to relate the present problem to previous experience I am quoting a few selected summary phrases from certain of their conclusions.

Lampert Committee: Conclusions in part:

"(a) Lack of continuity in Government orders."

"(b) Losses on Government contracts, both experimental and production."

"(c) Failure for recognizing and protecting design rights."

"(d) A destructive system of competitive bidding."

Morrow Board: Recommendations in part:

"(a) The adoption of a policy of continuity in orders and of a standard rate of replacement."

"(b) Production orders to be given only to companies which maintain design staffs and keep them active."

"(c) Proprietary rights in design be fully recognized."

"(d) During a period of production of a type accepted as standard there be placed a succession of small orders for experimental designs to be given limited service tests, the best of these designs produced during a two- or three-year period being adopted as the next standard. Such orders, distributed among firms having design and production staffs if proven competent, should be awarded at a liberal price high enough to cover all the overhead expense involved in the upkeep of the design and experimental departments."

"(e) Existing statutes covering the procurement of supplies and requiring competitive bidding be modified where necessary to allow putting the recommendations previously made into effect."

The Federal Aviation Commission of 1935:

"(a) Every effort should be made to organize procurement policy so that the supply of each general type of aircraft for replacement and for modernization should proceed at a substantially regular rate. . . ."

"(b) The development of new types of aircraft should continue to be provided for either by design competition or for experimental contracts for a specific article, but the rules now governing formal design competition should be modified to allow **administrative flexibility**. . . ." (Emphasis supplied.)

"(c) When purchases are made as a result of a process of competitive bidding, the Secretary of War or Secretary of Navy should be authorized either to award for the whole quantity sought to the bidder who can best perform the work, or to divide the work among two or more bidders if that be in the best interest of the government."

"(d) In order that there may be no incentive for an uneconomic expansion of plants that could not be kept regularly running at anywhere near their capacity, it should be procurement policy to avoid any concentration in any one plant of an abnormally large proportion of the total military and naval work then outstanding."

"(e) Industrial mobilization plans in the field of aeronautics should be pressed by the joint effort of the Army and Navy."

I note the above in order to bring out the similarity of the conclusions of the reports of the Boards. Each emphasized the necessity for long range procurement planning, and for flexibility in procurement laws and policies to enable services to carry out these plans.

As is well known, the Morrow Board is outstanding among the many Boards and Commissions which conducted surveys and investigations of aviation during the period between World War I and World War II, not only because of its thorough investigation and excellent report, but also because its report was implemented into legislation. These laws, the Air Corps Act of 1926 and Naval Aviation Act of the same year, became the basis for Army and Navy aviation research, development and procurement planning and procedures from 1926 until the beginning of the emergency prior to World War II.

As quoted above, one of the recommendations of the Morrow Board was that **"Existing statutes covering the procurement of supplies, and requiring competitive bidding be modified where necessary to allow putting the recommendations previously made into effect."**

As a result, the Air Corps Act of 1926 contained provisions to carry out these recommendations. Section 10 of this Act prescribes procedures to govern the procurement of aeronautical equipment in great detail.

Section 10(a)-(j) prescribes the law under which design competitions are to be held. It prescribes advertisement and submission of sealed bids.

Section 10(k) authorizes experimental procurement by negotiation, and according to the interpretation of some authorities permits the placing of production orders by negotiation.

Section 10(q) authorizes the placing procurement orders for aircraft constructed according to **designs presented by any individual, firm, or corporation prior to the passage of this Act, which designs have been reduced to practice** and found to be suitable for the purpose intended, or according to such designs with minor modifications thereof, the Secretary of War or Secretary of Navy, when in the interests of the United States will be best served thereby, may contract with said individual, firm or corporation, at reasonable prices for such quantities of said aircraft, aircraft parts or aeronautical accessories as he may deem necessary: Provided that the action of the Secretary of War or Secretary of the Navy, in each such case shall be final and conclusive.

Section 10(t) Provides for advertising for bids and prescribes that the Secretary of War or Secretary of Navy shall make the award to the "lowest responsible bidder that can satisfactorily perform the work."

CONFLICTING PROVISIONS

In other words, with reference to designs and experimental equipment, one provision of the law makes design competitions by advertisement and sealed bids prior to the procurement of new aircraft, aircraft parts or aeronautical accessories mandatory (or so it was interpreted at a later date), while another provision of the law permits procurement of designs, aircraft parts, or aeronautical accessories to be procured **without** advertisement and sealed bids.

Also, in regard to the procurement of standard or production equipment, one provision of the law clearly permits purchase without advertising—**for aircraft constructed in accordance with designs presented before the passage of this Act**, another provision seems to permit procurement of designs constructed **AFTER THE PASSAGE OF THE ACT**, by negotiation, and at the same time a provision requires that the awards be made to the "lowest responsible bidder that can satisfactorily perform the work or the service required." (This was later interpreted to require competition on a sealed bid basis, with price as a major consideration.)

Procurement under this law provided on a fairly satisfactory basis as long as the provisions of Section 10(q) remained in effect. When this provision expired, coincident with a change in the Administraton, and the resultant changes in administrative officials and Congress, the interpretation of the law became a major problem. The Navy Judge Advocate General interpreted it one way, while the Army Judge Advocate General handed down a different interpretation. This resulted in two different procurement procedures.

The Military Affairs Committee investigated the Services' interpretation of the law during the Seventy-third Congress. Thereafter, the Navy Department issued instructions requiring competitive bidding on aircraft procurement. The War Department which had been severely criticized by Congress likewise issued a directive calling for the procurement of airplanes by sealed bids, under Section 10(t) of the Air Corps Act, shortly thereafter.

AGE-OLD PROCEDURE

Then in 1935 the Army instituted the sample airplane with bid procedure—this being the age-old procedure used by the Quartermaster to buy shoes, blankets, shovels and probably wagons. Under this method, each bidder was required to submit a sample airplane for examination and test in connection with the evaluation of his sealed bid.

The results of this method should have been apparent even before the procedure was put into effect. In brief, the sample with bid procedure tended to create monopoly and to retard progress in design.

The manufacturers who already had airplanes in existence were able to submit samples. Those who did not had to go to the expense of building costly experimental articles on short notice. Unless they won the competition they had to bear the entire cost of an expensive experimental development. The system was breaking down rapidly when the emergency just prior to World War II came, as the aircraft industry was not able to stand the financial risk incident to the construction of the sample article.

LACK OF COMPETITION

Naturally a monopoly would have soon resulted as those who had samples in existence would have gotten the business, and those who did not have samples could not afford to design and build them without some reimbursement. It was this lack of actual competition which threatened progress in design.

I have cited these past experiences in so much detail in order to bring out the fact that the problems with which we are faced are not new, except in their magnitude, and I am very much afraid that we will in this instance, as in so many others, be inclined to repeat our mistakes. It is more serious now since a repetition of the mistakes is likely to be much more costly to the nation and the industry than ever before.

COMPETITIVE BIDDING AND COMPETITION

We have quoted the expressions used by the Lampert Committee: "A destructive system of competitive bidding." Also, I wish to recall that the Morrow Board said: "Existing statutes covering procurement of supplies and requiring competitive bidding be modified . . . etc.", and that the Federal Aviation Commission urged that the procurement laws be made more flexible with respect to competitive bidding.

Citation of these repeated sharp criticisms of the use of competitive bidding in the procurement of aircraft doubtless will lead to the question—"how can we have competition in procurement unless there is competitive bidding?"

This question reveals the persistence of a common fallacy—the belief that competitive bidding guarantees competition or that in the absence of competitive bidding there is no competition. Nothing could be further from the truth as the actual experience in aircraft procurement demonstrates. It is this experience which forms the basis for the repeated references to "destructive competitive bidding" in the quoted aviation reports.

When the Government buys standard off-the-shelf items such as shoes or groceries, the standard method of getting competitive procurement is the use of advertising and sealed bids. The record of identical bids shows that this method has not always obtained competition even in price in those other standardized products. Certainly the only competition the method ever produced was limited to price.

DESTROY COMPETITION

On the other hand, the use of sealed bids and advertising to procure highly technical items such as modern aircraft tended more to destroy rather than preserve competition. It does not foster competition in price, in performance nor in any other detail. This becomes clear when only a few of the more obvious difficulties are examined.

Before requests for bids can be advertised, specifications for the article to be procured must be prepared by the Services. These original specifications must be written in general terms, otherwise they will limit the creative genius of the aircraft company's designers. Yet, sometimes these specifications proved in practice to be so general as to bring about entirely unanticipated results.

For example, in one case specifications were sent out in anticipation of the letting of a contract for a two-engined bomber—the B-23. Yet, under these specifications, the Boeing company was able to submit its B-17, a four-engined bomber.

Yet, when such an outcome was followed by the development of more rigid or detailed specifications in a subsequent request for bids, the result was to rule out numerous bids on some minor detail that were actually superior in overall performance to the successful bidder.

These are only examples of how "red tape" prevented the Services from getting the equipment they actually needed. But in addition, the "competitive bidding" did not and could not bring about competition. The creation of competition in a product requiring years to develop and involving thousands of dollars of engineering costs **cannot** be attained by the insertion of advertisements and the requirement of sealed bids. Unless competition is planned, the almost inevitable result would be that only a single sample and bid would be presented in such competitions. No concern can afford to develop modern aircraft unless there is some assurance of a market.

Competition in aircraft procurement must come from a deliberate procurement policy and plan, not from contract forms or contract procedures. There should be continuous competition on every type and model of airplane and every piece of equipment. It should begin on the drawing boards and should continue until the item or article is obsolete.

The administrative details as to how the competition in design and procurement should be carried out are much too long for discussion here, but in general if four or five manufacturers are competing in the early phases of the design stage, and two or more in the experimental, and perhaps service test stage, then we have a highly competitive situation which will result in the continual availability of modern and up-to-date equipment.

COMPETITIVE MODELS NEEDED

Also, I would like to urge that the principle of maintaining two competitive models in service not be too quickly discarded for the reasons usually advanced against it. These reasons are: The initial cost, the necessity of training pilots and mechanics on different models, the supply overhead in storing and shipping the different types of spare parts.

I believe that the record indicates that these arguments are entirely outweighed by technical excellence from the resulting competition, and the tactical flexibility permitted by the varying characteristics of the different models. Experience has proven that it is entirely unreasonable to expect the requirements writers to anticipate the various situations which will arise in the next war. No nation ever has done so.

The Germans developed a few types and were committed to a certain type of warfare as a result. The British with their Spitfire, a very superior interceptor and defensive fighter, and their Lancaster night bomber, were committed to a certain type of warfare. We with our variety of types and models were highly flexible and able to operate effectively in radically different theaters. We encountered a demand from each theater that in almost every instance they be supplied with some of each type for a specific purpose.

The competition that existed between the various manufacturers was also of the highest importance. I could cite a dozen or more examples, but the competition between the P-51 and the P-47 is worthy of note. They both started out to be short range fighters based pretty much on the same military characteristics. They both became long range fighters, the P-51 making its eventual reputation as the world's best high altitude escort fighter, and the P-47 as the ideal fighter-bomber.

We had no procurement characteristics for a fighter-bomber, but in the P-47 we came up with the world's best airplane in this category when the need arose. I consider flexibility of types extremely important to national security. The all-purpose aircraft has never been built, the dual-purposee one has nearly always been a failure.

There should be continuous competition on every type and model of airplane and every piece of equipment. It should begin on the drawing boards, and should continue until the article or item is obsolete. To my mind the Lampert Committee, the Morrow Board and The Federal Aviation Commission, the Army Air Force, and the Bureau of Aeronautics have recognized these basic principles for years. The failure to implement them in practice has been due to shortage of funds, and the confused construction of an interpretation of Section 10 of the Air Corps Act of 1926. The General Purchase statute which prescribes Government purchases by a competitive sealed bid procedure was enacted in 1861, and has been interpreted and re-interpreted down through the ages to the point where precedent and custom prevent the exercise of any discretion by any administrative agency whatsoever without the fear of being accused of wrong-doing.

It would seem that in the atomic age with the ever increasing complexity of the problem that a positive approach to the procurement of aeronautical equipment should be made. The approach has not been positive in the past. Every contracting officer has known or learned through bitter experience what he **cannot** do. But the question as to how to proceed expeditiously in a business-like manner to purchase the best design or the best piece of equipment has been an extremely difficult problem for all concerned.

RECOMMENDATIONS OF THE FEDERAL AVIATION COMMISSION

The Federal Aviation Commission was appointed in 1935 to study, among other things, these questions which were then critical due to the complete confusion resulting from the various interpretations of the Air Corps Act of 1926. No action was taken on the recommendations of the Federal Aviation Commission, but at the risk of repetition I am again quoting some of these recommendations:

(a) "The development of new types of aircraft should continue to be provided by either design competition or for experimental contracts for specific articles. . . ."

(b) "Every effort should be made to organize procurement policy so that the supply of each general type of aircraft for replacement and modernization should proceed at a substantially regular rate. . . ."

(c) "When purchases are made as a result of a process of competitive bidding, The Secretary of War or Secretary of Navy should be authorized either to award the whole quantity sought to the bidder who can best perform the work, or to divide the work among two or more bidders if that be in the best interest of the Government."

(d) "In order that there be no incentive for uneconomic expansion of plants that could not be kept regularly running at anywhere near their capacity, it should be procurement policy to avoid any concentration in any one plant of an abnormally large proportion of the total military and naval work then outstanding."

(e) "Industrial Mobilization Plans in the field of aeronautics should be pressed by the joint effort of the Army and Navy."

I have pointed out that these principles were recognized then as now, and also some of the reasons why the principles have not been observed in practice.

RECOMMENDATIONS WITH REGARD TO PROCUREMENT

It is our hope that the Commission's study will support necessary changes that will cause these principles to be observed in future procurement. Among the recommendations which we feel are essential to full observance of these principles are the following:

1. Establishment of a procurement program of at least five years' duration

Such a program would establish the minimum size of the Air Force in Being, and would require as a matter of law that the equipment of the force be replaced at a consistent annual rate, say 25% per year. The program would be almost exactly similar to the Naval Construction programs that have been authorized in the past for the fleet. Such a program would also have to be accompanied by changes in the period of time allowed for contract authorizations just as was done in the case of the Naval Construction programs.

Such a long-term program would enable consistent, economical forward planning of aircraft production. It would thus save money for the taxpayer. It would also encourage and foster competition by enabling concerns to plan ahead and stay in the business instead of being forced to liquidate because of the uncertainties.

2. Enactment of a procurement law allowing flexible contracting procedures

Such a law probably should make advertising and sealed bids the exception rather than the rule in aircraft procurement. It should clearly and unequivocally authorize negotiation instead of sealed bids wherever negotiation could be expected to provide superior equipment, encourage competition in design and production, or otherwise accomplish the objectives of the mobilization plan.

It should permit the **splitting of awards** and the use of mandatory **subcontracting**, whenever split awards or subcontracting is essential to encourage competition or procure better equipment or preserve a nucleus of an expansible industry.

3. Coordination of the procurement policy, the procurement laws, and the procurement program with the industrial mobilization plan

Hitherto, the procurement policies as limited by peacetime budgets, and the procurement directives and regulations resulting from legalistic interpretations of a confusing statute have directly blocked the attainment of the stated objectives of the mobilization plan. National policy should make clear and unequivocal that procurement statutes and policies should be intended solely to advance the mobilization plan to block for all time future interpretations of contracting requirements that would defeat fundamental objectives. This can be done only if policies, law and program are essential components of an integrated mobilization plan kept modern at all times.

THE NEW PROCUREMENT BILL (HR 1366)

The question arises as to whether the proposed procurement law, H.R. 1366, meets the requirements outlined above. Under this bill, procurement by a formal advertising and bidding procedure is the rule. The only exceptions that appear to cover aviation are contained in Section 2c, Paragraph 11, covering experimental procurement, Paragraph 14, covering quantity procurement, and possibly Paragraph 16, concerning keeping facilities available in the interest of industrial mobilization for national defense. Each of these exceptions must be based on a determination, supported by written findings of the agency head (meaning the Secretaries, Under Secretaries, or any Assistant Secretary of War or of the Navy, and the Commandant, U.S. Coast Guard, Treasury Department) that the competitive sealed bid procedure will not give satisfactory results.

The power of the agency head to make the determinations in order to use the exception covered by Paragraph 11, covering experimental procurement, is delegable only to the chief officer responsible for procurement providing it does not require an expenditure of more than $25,000. Furthermore, all procurement under this exception must be reported to Congress every six months.

Power of the agency head to make the determination in order to use exception 14 and 16, is **not** delegable. Furthermore, any contracts issued under the exception outlined in Paragraph 16 must be reported to Congress every six months.

This would indicate that the agency head will be held responsible at some future date to defend each exception made to this general rule that was orginally enacted into law during the Lincoln administration. Experience has indicated that most agency heads are unwilling to be placed in the position of making continous exceptions to the general rule contained in the law.

In view of past experiences, it is believed that the law should be positive and clear not only to those now in the Administration and Congress, but also to those who are to follow. The law should also be easy to understand by the Secretaries, Under Secretaries, Procurement Officers and engineers who are to work under it in order to avoid constant and changing legal interpretations as to its intent.

What is needed is a law which will permit wide policy discretion to set up a program and administer it on a competitive basis.

With particular reference to Paragraph 14 of Section 2c, which is the section that appears to be applicable to the procurement of aircraft in quantity, it is believed that it would be improved if amended to read as follows: (new matter is emphasized)

Section 2c, Paragraph 14,

> "for supplies of a technical or specialized nature requiring a substantial initial investment or an extended period of preparation for manufacture, as determined by the agency head when he determines that advertising and competitive bidding may require duplication of investment or preparation already made, or will unduly delay procurement of such supplies **or for supplies or services of a technical or specialized nature as to which the agency head determines that advertising and competitive bidding would not secure supplies or services involving the experience, expertness, preparation, know-how or design; provided that in the event two or more suppliers, not to exceed three, are qualified under the provisions of this subsection 14, the agency head may negotiate contracts for a portion of the requirements with each of the two or more suppliers, not to exceed three, if he considers this to be in the interest of the Government."**

This amendment would permit the agency head to award contracts to those manufacturers, regardless of whether or not the Government had an initial investment in the particular type of aircraft to contractors with know-how and to split awards when necessary and in the best interest of the Government.

CONTINUATION OF EMERGENCY POWERS

Enactment of a technical statute such as a procurement law takes time. In view of the current crisis affecting American air power, it may be that the various issues with regard to a procurement statute required to meet the needs of all the armed services cannot be reconciled as rapidly as the current emergency calls for. In such case, it is suggested that until the present air power emergency is over, it might be wise to continue the Armed Services' present wartime purchasing and procurement powers, which do give them the flexibility they need. An extension of the time for the expiration of these wartime powers will provide more time to work out a procurement statute that will meet the needs, be clear and not be subject to confusing interpretations at some later time.

Final Recommendations

In conclusion, I should like to summarize to the Commission the basic recommendations with which the industry is concluding its presentation. They are:

1. Prosecute research and development of new aircraft and aerial equipment as vigorously as is required to obtain and preserve leadership in the air. The Research and Development program should be closely interwoven into the procurement program.

2. Maintain a minimum volume of procurement calculated to supply the necessary replacement airplanes to the air force in being so that it would be an effective combat force in an emergency with a minimum advance warning.

Such a volume of replacement is not now being supplied.

It should be a matter of national policy to make such replacements.

3. Establish a long-term aircraft procurement program of at least five years' duration, with a mandatory replacement rate of 25% a year.

This has been described above.

4. Give greater consideration to air transportation in national defense planning.

In view of the speed with which wars of the future will move, the mobilization plan must proceed upon the assumption of maximum utilization of air transportation.

5. Enact more flexible procurement laws to permit Services to procure needed equipment with a minimum of delay and to effectuate the mobilization plan. Or continue current wartime powers until such a law can be drafted.

This has been discussed above.

6. Encourage and support an adequate industrial mobilization plan as the only economically feasible and safe method of insuring adequate supplies of equipment in an emergency. Integrate all of the above recommendations into the basic plan.

Such a plan would provide for the maintenance of a healthy nucleus of industry capable of rapid expansion and of stockpiling, planning for producibility, encourage subcontracting, and other measures that will shorten the long period of time required to expand aircraft production in an emergency.

7. Encourage and foster the development of commercial aviation, including air transportation, air cargo, and private flying so that civil aviation can make its maximum contribution to the maintenance of a nucleus of an aircraft industry necessary to the national security.

"Assessment of Current Research Programs"

by

A. E. RAYMOND

Vice President—Engineering, Douglas Aircraft Co., Inc., Santa Monica, California

★ *Mr. Raymond has been vice president—engineering of the Douglas Aircraft Company since 1934, and prior to that was assistant chief engineer, having joined the company in 1928. He is a Fellow of the Institute of the Aeronautical Sciences and a member of the Executive Committee of the National Advisory Committee for Aeronautics.*

A. E. RAYMOND

"ASSESSMENT OF CURRENT RESEARCH PROGRAMS"

STEELMAN REPORT

φ I SHOULD LIKE to say at the outset that my point of view regarding aeronautical research is conditioned by the following facts: (1) I have been associated with Engineering at Douglas Aircraft for some twenty-two years, for half of which time I have been Vice President in charge of Engineering; (2) I spent seven years (1927-1934) in part-time teaching at the Guggenheim Aeronautical Laboratory at Cal Tech; and (3) I have for the last year been a member of the NACA. In this statement, I am expressing my own opinions, based on this specialized experience, but they are shared by many with whom I have talked. My remarks should be viewed with these facts in mind.

The report of the President's Scientific Research Board, known as the Steelman Report, is now being published, the third volume having reached me two days ago. It contains many observations and conclusions applicable to aeronautical research as part of research in general and with much of it I would agree. The major questions it raises in my mind are the extent to which aeronautical research should be centralized under Government direction and control, and the extent to which it should be submerged as a part of a general research program for the nation.

Many people think that the NACA conducts nearly all the aeronautical research being done, but this is far from true. Such research is widely dispersed now, being carried on by:

1. **Industrial plants.**

   All industrial concerns working on aeronautical products conduct some research. Some have very expensive, well-equipped laboratories, a number have wind tunnels of their own, and there is at least one large cooperatively owned wind tunnel.

2. **Privately endowed research laboratories.**

   There are a number of these that do work on aeronautical materials, fuels, etc.

3. **Laboratories supported by Government but operated under the jurisdiction of educational institutions.**

   Several of these have survived the war and are doing extremely valuable work.

4. **Educational institutions.**

   Many of these are conducting aeronautical research in their own laboratories, using students and instructors to do the work. Some of this is paid for by the institution itself, some is financed by Government through a number of agencies, of which the NACA is one.

5. **Military service laboratories.**

   The Air Forces, Bureau of Ordnance and Bureau of Aeronautics of the Navy, and Army Ordnance all operate laboratories in this field and all pay for research done in some of the categories already listed.

6. **Civil Aeronautics laboratories.**

   The CAA operates research laboratories and has some research done on contract.

7. **Bureau of Standards.**

   This does considerable aeronautical research on materials.

8. **National Advisory Committee for Aeronautics.**

   Last but not least, this agency operates solely in the field of aeronautical research and development; 98% of the work done is in its own laboratories, 2% outside on contract.

DESIRABLE DISPERSION

Even this may not be a complete list, but it at least contains enough of the elements to show the great dispersion and diversification of the research effort. I believe that this is in the main a desirable thing. Certain weaknesses are apparent, however.

1. There is a serious deficiency in the supply of properly qualified research personnel. This has been clearly pointed out by the Steelman Report and others. Since the number of instructors relative to the number of students is at an all-time low, the number of students cannot be increased without first training instructors.

   In the middle '20's Guggenheim Aeronautical Laboratories were established at about eight major universities. These were the result of private grants for facilities and for operation including teaching fellowships. If a census were to be taken now of the present position and past accomplishment of graduates of these schools in the intervening years I am sure it would be found that the sum total of these private grants (which probably totalled less than $5,000,000) has done more to advance aeronautical research and development in this country than any like sum spent on anything else. What is needed now is more of the same. Modern high-speed facilities must be provided and more schools brought into the program. To the extent that this cannot be done with private funds it should be assisted by the Government. The NACA is the logical agency to sponsor such a program, which should include facilities, fellowships, and research contracts.

Unitary Plan

2. The country needs certain large extremely expensive facilities for studying the phenomena of transonic and supersonic flight. It so happens that there are various techniques for obtaining the required information, some involving the use of wind tunnels, some free flight. These techniques are changing, and as time goes on, ingenuity devises less expensive ways than those previously thought of. A so-called Unitary Plan comprising the wind tunnel part has been worked out, combining the desires of NACA, Air Forces, Navy, and the guided missiles people and has been under study by the JRDB for some months, in conjunction with a plan for related facilities

worked out by the Air Forces called the AEDC, or Air Engineering Development Center. Due to the sums of money involved and the changing technology, there has been great difficulty in getting these proposals jelled to the point where anything concrete can be done about them. In the meantime the need is great and the lack of a program is delaying progress.

The need for some such facilities should be admitted and a sufficient appropriation made to permit the initial steps to be taken. There should be a periodic review of the plans, adjustments made as required, and continuing appropriations made year by year until completed. The time to start is now. If we wait for the perfect plan we will never get started.

Coordination Imperfect

3. Coordination of the whole program of aeronautical research is imperfect. This leads to repeated attempts to set up some super-coordinating agency. To my mind this is a mistake. No matter how hard we try in an effort of this magnitude we will always fall short of the twin ideals which are:

    a. To have all new projects so thoroughly reviewed before they are authorized that there is complete assurance of lack of duplication and of presence of merit. This would build up paper work and delay to insufferable proportions.

    b. To have everyone interested in a subject completely informed at all times of what is going on and has gone on everywhere regarding that subject. This would build up an even larger mountain of paper work and the recipient would not have time to read it anyway.

    The mechanism for ex post facto review of projects soon after they are started is now well developed, through the addition and implementation of the Research and Development Board. This is a good compromise, for if a mistake has been made it can be rectified before very much money is spent. Of course, this is superimposed upon the interdepartmental review procedures, which continue to operate with some modifications. The mechanism for collecting and distributing information is not yet operating as it should, although improvements have been made. Here the NACA could cover the entire field if its appropriations would permit. I think it is the logical agency for the purpose.

4. The program is inadequate in some particulars:

    a. Not enough money is being devoted to basic aeronautical research, although this cannot be greatly enlarged until the facilities and personnel are available.

    b. Not enough money is being devoted to development. There should be at least two projects in each important field, in order to provide the stimulation which competition affords and in order to avoid the danger of having all one's eggs in one basket. This applies equally to airplanes and guided missiles.

National Science Foundation

At the beginning I said in passing that the Steelman Report has left me with some question as to the extent to which aeronautical research should be submerged into a general national research program. I am referring of course to the remarks which that report makes concerning the proposal for a National Science Foundation. While it is true that the field of aeronautics is broad and now invades most if not all the physical sciences, I feel that it is sufficiently important to warrant specialized treatment. It would be just as dangerous to amalgamate aeronautical research into general research as it would be to lump aerial transportation in with other forms of transportation in one federal regulating agency, a proposal which is still periodically made.

If a National Science Foundation is ultimately established, the relation between it and the NACA should be carefully defined, with the latter made responsible for coordination and distribution of research information in the field of aeronautics and for research contacts and fellowships in that field. It will be very important in this connection for a substantial and inviolable portion of the NACA budget to be earmarked for use outside its own laboratories.

CONTRACT DIFFICULTIES

In conclusion I should like to say a few words about the difficulties being encountered with Government research contracts. The main troubles are:

1. They tend to be for too short a term. Sometimes the contract is for two or three years, but the appropriation is renewed yearly. I know of no case in which a research contract has been let for more than two years plus the year of appropriation, though ONR is empowered to let them for a five-year period.

2. Various forms of contract are used, differing in their suitability. For educational institutions in particular, it is important that bookkeeping be kept to a minimum and that property accountability rules be workable. The NACA contract form is quite good, being almost the same as a grant in aid; it is fixed price, requires no audit, and merely calls for delivery of a report of results.

3. Universities should not be required to exercise too much of a management function. The coordination of a number of sub-contracts in connection with product development is a function that can be better carried on by an industrial organization.

4. Classified work can be handled by a university but it presents difficulties and should in general be avoided. Security regulations, as is well known, interfere with the free interchange of ideas which fertilize good research and must be intelligently applied, regardless of the type of organization which is concerned.

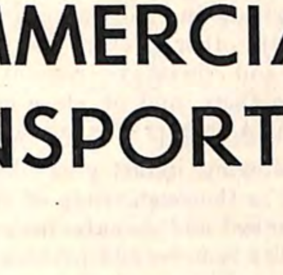
In these brief notes it has only been possible to cover a few of what seem to me to be the more important points in connection with the nation's research program and policy that seem to me to warrant the attention of the Commission. I should be very happy during oral testimony to elaborate upon any of them or to discuss others within my experience.

"PRESENT and FUTURE PROSPECTS of COMMERCIAL AIR TRANSPORTATION"

by

DONALD W. DOUGLAS

President, Douglas Aircraft Co., Inc., Santa Monica, California



★ *Mr. Douglas has headed the Douglas Aircraft Company and its predecessor company since 1920. He served as chief engineer of the Glenn L. Martin Co., in 1915-16, as chief civilian aeronautical engineer of the Signal Corps in 1916-17, and as chief engineer of the Martin Company from 1917 to 1920. His company has been the largest producers of air transports and cargo planes over the past decade.*

DONALD W. DOUGLAS

"PRESENT AND FUTURE PROSPECTS OF COMMERCIAL AIR TRANSPORTATION"

ENCOURAGING DEVELOPMENT

IN ACCORDANCE with your request, I submit herewith my views, studies and recommendations on the subject, "Present and Future Prospects of Commercial Air Transportation."

The statement is presented in two parts: The first reflects a summary of conditions, problems and trends facing manufacturers of commercial air transports in the United States today and in the near future. The second offers in more detail discussion of these factors and the statistical and technical data supporting the views and recommendations expressed.

Facts and figures in this report are the most accurate and latest available and were assembled in cooperation with other aircraft manufacturers, members of the Aircraft Industries Association, and official government sources. Conclusions and recommendations based on these facts, and on close contacts and extensive experience in aviation for more than a quarter of a century, are my own.

Because the aircraft manufacturing industry is "basic to our leadership in both military and civil aviation," a thorough study of the subject assigned to me must deal not only with the technical and manufacturing details but include considerations of our national aviation policies and problems and methods of encouraging needed developments in the aviation and air transportation industry.

Under existing conditions at home and abroad, present and future prospects of commercial air transportation offer no encouragement to the aircraft manufacturer or to government officials concerned with our national defense and with maintenance of a strong efficient aircraft industry.

PROGRESS BECOMES BARRIER

It is unfortunate but true that the notable improvements and accomplishments recorded by aircraft manufacturers in the last few years have become temporary barriers to further progress in the development of air transportation and a threat to the preservation of our industry as an arm of national defense. We have built so well and so much that we are in danger of over-running our markets and dissipating our resources. Yet we cannot close our plants, disband our organizations, or permit the skill and know-how of the industry to disintegrate.

The situation, as it confronts the aircraft manufacturers and related industries, presents a paradox and creates problems requiring for their satisfactory solution nation-wide support and cooperation.

Although air travelers in the United States, and passengers using American built equipment in all parts of the world, today enjoy the benefits of greater safety, comfort, speed and economy, preservation of these benefits in air transportation and further development and improvements in aviation cannot be assured unless basic economic problems and factors threatening the industry and the nation are clearly recognized, thoroughly understood and jointly solved by all concerned.

Aviation is a dynamic, vital force in modern existence. Commercial aviation plays a major part in our lives and activities. As designers and manufacturers of airplanes and commercial air transports, we cannot stand still or be content with past accomplishments. As a nation, we cannot relinquish our leadership in aviation. We must progress and keep pace with the rest of the world.

ADVERSE FACTORS

We cannot assume, however, that because we have made notable progress in the past we can automatically and unaided continue to progress in the future. A realistic appraisal of the situation immediately discloses adverse factors which must be corrected or eliminated. Let us look at the facts as they confront the manufacturers of air transports in the United States.

First and foremost we must cope with the inescapable fact that the development of a new type of modern aircraft requires tremendous expenditures of money for research, engineering and production. Great sums must be spent long before it is possible to start construction of the aircraft. Should the airplane pass the design stage and be placed in production, the financial burden increases tremendously. Additional capital must be tied up in factories, materials, inventories, and work in process, for which reimbursement is normally not received until the product is sold. As the airplane is produced and delivered, more expenditures must be made on corrections and changes found necessary in any new design. It cost the Douglas Aircraft Company more than $13,400,000 to develop the DC-6 and today, with 80 airplanes actually delivered and in service, we have spent $42,000,000 more than we have received from these DC-6 sales. If all goes well, the break-even point will not be reached until the 300th airplane is delivered. This condition is not something peculiar only to our own company or to this model. It is typical of all aircraft manufacturing, as testimony already before the Commission undoubtedly will disclose.

Ability of potential markets to absorb new airplanes in sufficient quantities to justify expenditures of such magnitude is another grim factor that must be considered realistically and unerringly.

Modern airplanes today fly faster, carry more passengers and serve more routes with less equipment than they did even three years ago.

Detailed analysis of potential markets at home and abroad, presented in statistical and chart form in Part II of this statement, does not support the hope that domestic and foreign markets now available or likely to develop in the next few years can materially improve this situation.

MILEAGE MULTIPLIES

In the last 16 years there has been a tremendous increase in airlines passenger-miles flown in United States domestic travel. In 1946 this mileage was 80 times greater than it was in 1930. Available estimates indicate that under favorable conditions by 1950 the total passenger-miles-flown increase over 1930 will be 120 times greater than the 1930 domestic mileage. As will be shown by attached statistics and charts, this increase, tremendous as it is, and additional mileage expected to be developed by foreign and feeder lines, is not sufficient to overcome the adverse factors of increased production costs, better and more efficient utilization of equipment by the airlines and the tremendously expanded seat capacity and speed of the modern air transport.

Air routes developed by the United States Army Air Forces during the war, and subsequent developments of new and improved aircraft have immeasurably boosted international air travel potentials. But foreign exchange difficulties and unsettled economic conditions abroad prevent an accurate, or hopeful, estimate of this market as a factor warranting development of new and improved models under present conditions. Existence of a large number of feeder lines in the domestic air transportation picture is another factor that gives little comfort and less assurance to the aircraft manufacturer in risking production of new models. Large operating losses incurred by the few feeder lines already in operation suggest extreme caution in the appraisal of this market potential. Most of the feeder lines will probably operate the full 3 years allowed by the temporary C.A.B. certificates. But C.A.B. action at the end of 3 years is uncertain and precludes, at this time at least, the possibility of realistic forecasting.

OLDER EQUIPMENT

Release of surplus transports by the Government after World War II helped increase passenger-mile totals of our domestic travel and foster the development of non-scheduled cargo carriers. After 18 months of operating, these carriers have reached a prominent place in the industry and undoubtedly are scheduled for continued growth with prospects for C.A.B. certificates in the near future. Past experience indicates, however, that growth of this cargo business will not necessarily, or immediately, produce corresponding demands for new and improved types of airplanes. As domestic airlines replace their former equipment with the newer, bigger and faster transports currently in production by at least five large manufacturers, the older equipment will become available to the non-scheduled and cargo operators.

On the basis of our experience in the past, we ordinarily would assume that the rate of continued expansion of the domestic airlines industry will be a function of the following factors:

1. Technological developments promoting still greater flying safety and all-weather flying.
2. Education of the general public in advantages of air travel and elimination of fear of flying, which is still present to some degree.
3. The apparent stability, or even possibility of increases, of railroad and pullman rates, contrasting with the continued drop of airline rates in the past. The present differential between the two types of travel is less than 1c per passenger-mile.

But can we, as an industry and as a nation, wait and how long?

As stated several years ago, I have an abiding faith in the future of aviation.

I believe in it, because aviation is one of the modern servants of mankind and because air transportation is the most modern method of travel in the modern world. But faith in the future is not enough. We must first take care of the present. No nation, or industry, can rightfully hope to be great tomorrow unless it takes care of today's problems and solves today's difficulties on sound, constructive lines. Today's problem, as I have attempted to show, is to stay in business so that the airlines and the Armed Forces can get new and better equipment when and as needed.

TODAY'S CONDITIONS

In our appraisal of future possibilities we must look at the domestic airlines picture in the light of today's conditions rather than yesterday's figures.

After a period of consistent annual profits, domestic airlines in an effort to have fleets large enough to carry the tremendously increased traffic volumes purchased large numbers of new aircraft by means of several well-known financing instruments, such as stock issues, long-term credits, and bank loans. This additional equipment necessitated general expansion of other departments of the airlines, and with this expansion came increased financial burdens and necessity for new economies. A realistic survey of this situation brings us rather forcibly to the facts that there are certain clearly defined limits to such expansions and that the aircraft manufacturers cannot consider the domestic airlines as a market potential without limitations.

In the foreign airlines market we again find a number of self-limiting factors which must be kept in mind. Although many foreign airlines are acquiring the latest product of United States airplane manufacturers, postwar expansion abroad to a greater degree will be retarded until airports and flying aids and techniques are comparable to those in the United States.

ECONOMIC STABILITY

These improvements obviously must await orderly developments and of necessity must depend on greater measures of economic stability and security abroad. Furthermore, although the foreign airlines are in desperate need of more modern, up-to-date equipment, many of them are hampered by a limited dollar exchange. Although several means of financing are offered to foreign airlines to assist them in this dilemma, uncertain conditions in the various countries tend to dampen action in this regard.

Even a brief summary of the problems and difficulties facing the aircraft manufacturers when they attempt to evaluate present and future prospects of commercial air transportation readily makes it apparent that our industry cannot continue to supply the nation and the Government with a constant flow of new and improved models and keep pace with improvements and developments of other nations without Government cooperation and assistance. The value to the Armed Forces of a smooth running airline network, as well as the availability of suitable cargo equipment, was demonstrated during the last war.

COST PROHIBITIVE

When the emergency came, our Armed Forces had instantly available to them air transportation in being. As a nation we were fortunate in that several new, improved models of commercial air transports actually were in production. Even with this head start, these transports came none too soon. Today, as outlined in this statement and supported by these studies, the aircraft manufacturer cannot on his own resources keep the nation in readiness for another emergency. The cost to the individual producer would be prohibitive, and to the nation it would be not only tragic in time and consequences but tremendously expensive in re-establishing production continuity and starting almost from scratch. Such costs in dollars, to take but one known example, would increase by 80% from a delay of only 3 months.

In the light of these facts the Government cannot overlook or ignore its definite responsibility for fostering and preserving an adequate aircraft manufacturing industry and a strong comprehensive airlines system.

VITAL NATIONAL ASSET

The Government, with its grave responsibility for security and safety of our homes and institutions, cannot gamble with the future any more than the aircraft manufacturers, with their limited resources, diminishing markets and great production costs, can gamble on development of new models so badly needed to keep abreast of aviation's progress. The situation, in my opinion, calls for quick action and a definite policy. The policy should state clearly and frankly that the national Government recognizes its obligation to help develop new and improved air transports and efficient networks of air transportation, that the Armed Forces of the Government consider it essential to national defense to participate in these developments, in times of peace as well as in emergencies, and that preservation of a free, competitive and efficient aircraft industry in all its branches is a vital national asset.

On considerations presented to this Commission by those who preceded me, and on the basis of factors discussed here, I believe that the Government, in the national interest, should immediately undertake constructive cooperation with the industry to preserve continuity of production and progress in the manufacture of modern air transports. I hold it is sound public policy and sound national economy for the Government to bear its proper share of development costs of new air transports in exchange for assurance that in an emergency it would have instantly available for defense and for military operations, dependable and efficient air transportation in sufficient quantity and ready for the type of global operations required by modern warfare.

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I. DEVELOPMENT OF COMMERCIAL AIR TRANSPORT (1930-1950)

A. United States Domestic Airlines

The growth of commercial aviation in the United States during the past twenty years represents the most remarkable achievement of progress in America's transportation history. The present airline system is the result of persistent effort in the face of innumerable obstacles and far surpasses any other airline system in the world.

The story of its accomplishments can best be presented by figures. In 1930 the airlines carried 329,943 revenue passengers and in 1946 the figure was 12,250,400. Revenue miles flown in 1930 amounted to 31,992,634 compared to the 1946 figure of 316,182,574. Revenue passenger-miles in 1930 amounted to 73 million and in 1946 totaled 5.95 billion. Fares have been reduced from 8.3¢ per passenger-mile in 1930 to an approximate 5.0¢ in 1947.

1. Passenger-Mile and Ton-Mile Growth

Table I shows the growth of domestic passenger-miles and ton-miles from 1930 to 1950 with estimates for the years 1947-1950. Non-scheduled freight ton-miles are included for 1947-1950 on the assumption that the larger operators will have become certificated. Revenue passenger-miles and ton-miles for 1947 to 1950 have been conservatively estimated by integration of the normal monthly volumes from a trend line drawn through the annual lows. Plate I illustrates this growth graphically and further shows the probable trend of growth without the influence of World War II. This assumes there will be no major business recession which would drastically reduce the passenger and ton-mile volume of all forms of trans-

Table I
Growth of Domestic Passenger-Miles and Ton-Miles
1930-1950

Year	Passenger-Miles (millions)	Express & Freight Ton-Miles (millions)	Mail Ton-Miles (millions)	Total Ton-miles (millions)
1930	73.09	.10	2.60	10.01
1931	92.60	.22	3.14	12.62
1932	110.52	.29	2.70	14.04
1933	150.94	.42	2.56	18.07
1934	163.44	.60	2.46	19.40
1935	279.38	1.09	4.13	33.16
1936	388.24	1.86	5.74	46.42
1937	407.30	2.16	6.70	49.59
1938	476.40	2.17	7.42	57.23
1939	677.67	2.71	8.60	79.08
1940	1,041.17	3.47	10.04	117.63
1941	1,369.58	5.24	12.90	155.10
1942	1,398.04	11.69	21.07	172.56
1943	1,606.12	15.12	35.92	211.65
1944	2,229.57	17.09	50.02	290.07
1945	3,362.46	22.20	65.10	423.55
1946	5,947.05	38.60	32.96	654.53
*1947	6,710.00	144.00	34.00	849.00
*1948	7,480.00	208.00	37.40	993.40
*1949	8,250.00	268.00	41.10	1,134.10
*1950	9,070.00	327.00	45.20	1,279.20

Passenger-miles are converted to ton-miles on basis of 200 pounds per passenger (including excess baggage)
*Estimated

portation. As a comparison with this estimate reaching 9.07 billion passenger-miles in 1950, the following independent estimates are shown:

Passenger-Mile Estimates

Made by	Date Made	Estimated Traffic in 1950
General Electric	July, 1943	11.6 billion passenger-miles
Curtiss Wright	March, 1944	7.0 billion passenger-miles
Air Transport Bankers	April, 1945	8.0 billion passenger-miles
T. P. Wright (C.A.A.)	May, 1945	7.8 billion passenger-miles
Port of New York Authority	Dec., 1946	19.8 billion passenger-miles
Alvin P. Adams	April, 1947	11.0 billion passenger-miles

Another approach to airline growth may be presented by comparison with passenger-mile traffic handled by the Pullman Company. Domestic airlines reached new heights in 1946 in competition with rail carriers for the high fare passenger travel market when airline passenger-miles totaled 28.4% of Pullman passenger-miles. Estimates for 1947, as shown in Table II, indicate a ratio amounting to 53.3% with the trend favoring further airline penetration.

Table II
Passenger-Mile Comparison Domestic Airline and Pullman Company
1935-1947

Year	Domestic Airline (millions)	Pullman (millions)	Ratio of Air to Pullman %	
1935	279.4	7,146.3	3.9	
1936	388.2	8,354.8	4.7	
1937	407.3	9,170.4	4.4	
1938	476.4	8,269.9	5.8	
1939	677.7	8,485.4	8.0	
1940	1,041.2	8,213.9	12.7	
1941	1,369.6	10,070.4	13.6	
1942	1,398.0	19,071.6	7.3	Reduced Number of Aircraft
1943	1,606.1	25,891.4	6.2	
1944	2,229.6	28,267.1	7.9	
1945	3,362.5	27,275.8	12.3	
1946	5,447.1	20,972.4	28.4	
*1947	6,710.0	12,583.0	53.3	

*Estimated

2. Seat-Mile and Ton-Mile Capacity Growth

Domestic seat-mile and ton-mile capacity growth is primarily a story of aircraft development. Prior to 1934 the airlines were operating planes of the Ford Tri-Motor, Curtiss Condor, Boeing 80 and Fokker 32 type. With the advent of the Boeing 247 and DC-2 in 1933-34 all of the other aircraft became obsolete. By 1936 with the Douglas DC-3 as the standard airplane the seat-miles flown increased to 680 million with 272 airplanes from a 1932 total of 300 million with 456 airplanes. In 1942 when the Armed Forces took over about 50% of the commercial fleet there was only a small reduction in passenger seat-miles flown because of increased utilization. By 1945 the number of aircraft exceeded the prewar total and by 1946 it had more than doubled over the 1941 figure. The 1950 estimate in number of aircraft is approximately equal to the 1946 total but the number of available seat-miles is doubled, showing the influence of larger and faster equipment in replacing DC-3s, DC-4s and Lodestars.

Table III shows the growth of passenger seat-miles and ton-mile capacity from 1932 to 1950. Data on capacity ton-miles were not available prior to 1938.

Table III
Growth of Domestic Seat-Miles and Ton-Mile Capacity
1932-1950

Year	*Average Number of Aircraft in Operation		Passenger Seat-Miles Flown (millions)	Ton-Mile Capacity (millions)
1932	456		300.0	
1933	408		370.1	
1934	417		362.5	
1935	356		572.5	
1936	272	Replacement of	680.7	
1937	282	Smaller Aircraft	828.2	
1938	253	with	949.4	128.6
1939	265	DC-3	1,207.9	158.1
1940	358		1,797.3	227.2
1941	359		2,316.2	290.9
1942	179	War	1,937.6	255.6
1943	194	Reduction	1,824.8	238.3
1944	279		2,533.7	338.7
1945	414		3,815.6	508.5
1946	723		7,552.7	997.0
**1947	657	Replacement of	9,647.3	1,312.6
**1948	666	DC-3 with	11,221.8	1,593.1
**1949	638	Larger Aircraft	13,123.5	1,870.8
**1950	730		15,078.0	2,307.0

*Average number of planes in revenue service; 1932 to 1946 are actual number of planes operated as of December 31

**Estimated (See Plates VI, VII, VIII and IX)

B. American Flag International and Territorial Airlines

International and territorial air carrier operations were established by American companies at about the same time that United States domestic airlines were beginning to operate. The first line between Miami and Havana was opened in 1927 by Pan American Airways.

International air carrier operations have developed more slowly than the domestic carriers for two important reasons, namely, the difficulties encountered in obtaining landing rights from foreign powers and the absence of suitable long-range aircraft. It was not until 1935 that the first trans-Pacific air mail clipper flight was made and not until 1939 that the first trans-Atlantic air mail service was established.

1. Passenger-Mile and Ton-Mile Growth

World War II had a striking influence on commercial trans-oceanic services and the experience gained by the Armed Services in pioneering routes all over the world in four short years has proven invaluable in fostering the growth of postwar international carriers. Likewise, the experience gained by the aircraft manufacturer during the war years in designing, producing and perfecting long-range aircraft has materially benefited the trans-oceanic operator.

Table IV shows and Plate II illustrates the growth of international and territorial passenger-miles and ton-miles from 1936 to 1950 with estimates for the years 1947-1950.

Table IV

Growth of International & Territorial Passenger-Miles & Ton-Miles
1936-1950

Year	Revenue Passenger-Miles (millions)	Mail Ton-Miles (millions)	Express & Freight Ton-Miles (millions)	Total Ton-Miles (millions)
1936	41.5	.21	.65	5.01
1937	53.6	.27	.83	6.46
1938	55.3	.30	.96	6.79
1939	78.2	.43	1.05	9.30
1940	111.2	.66	1.26	13.04
1941	178.0	1.04	2.34	21.18
1942	264.0	2.12	8.21	36.73
1943	270.6	2.56	15.75	45.37
1944	340.5	2.58	17.83	54.46
1945	448.0	4.76	8.72	58.28
1946	1,100.6	8.16	15.09	133.25
*1947	1,660.0	12.31	26.62	204.93
*1948	2,171.0	16.10	38.10	271.30
*1949	2,640.0	19.58	51.90	335.48
*1950	3,128.0	23.20	63.20	399.20

Passenger-miles are converted to ton-miles on basis of 200 pounds per passenger (including excess baggage)

*Estimated

2. Seat-Mile and Ton-Mile Capacity Growth

The most significant aspect in the development of international seat-miles and ton-mile capacity is the impact of the war on this traffic leading to the introduction of DC-4 and Constellation type equipment which almost tripled the available seat-miles from 1945 to 1946. The further introduction of DC-6 and Boeing Stratocruiser equipment in the 1947-1950 period also illustrates the influence of larger and faster aircraft on available seat-mile and ton-mile capacity totals.

The growth of United States international and territorial seat-mile and ton-mile capacity is shown in Table V.

Table V
Seat-Miles and Ton-Mile Capacity International and Territorial Carriers
1939-1950

Year	Average Number of Aircraft in Operation	Available Seat-Miles (millions)	*Ton-Mile Capacity (millions)
1939	74	79.5	11.94
1940	82	195.3	29.32
1941	94	265.0	39.79
1942	75	315.0	47.30
1943	79	337.0	50.60
1944	79	425.0	63.81
1945	82	583.4	87.59
1946	134	1,551.3	211.8
**1947	233	3,300.0	441.9
**1948	187	3,748.0	495.9
**1949	186	4,616.0	593.4
**1950	180	5,720.0	697.0

*Ton-mile capacity estimated 1939-1945
**Estimated (See Plates VI, VII, VIII and IX)

C. Feeder Airlines

As of September 8, 1947 the Civil Aeronautics Board had issued temporary three-year certificates of public convenience and necessity to ten feederline operators and made route awards with the issuance of a certificate contingent upon a showing of airport adequacy to six other carriers totaling some 20,000 route miles as follows:

Carrier	Route Miles
Central Airlines	1,308
Challenger Airlines	1,613
Empire Airlines	694
Florida Airways	476
Iowa Airplane Company*	1,281
Monarch Airlines	1,550
Parks Air Transport*	2,315
Piedmont Aviation*	1,775
Pioneer Airlines	1,417
Roscoe Turner Aeronautical Corporation*	646
Southern Airways*	1,367
Southwest Airways	1,144
Trans-Texas Airways	1,824
West Coast Airlines	869
Wiggins Airways	657
Wisconsin Central Airlines*	1,489
Total	20,425

*Certificate subject to showing of adequate airports

Additional feeder routes will be awarded by the Civil Aeronautics Board on the completion of the Mississippi Valley Case, the New Mexico-Arizona Case and the Middle Atlantic Case which should increase the domestic feederline network to an approximate 25,000 miles.

Of the sixteen carriers listed above seven have actually commenced operation, namely, Challenger Airlines, Empire Airlines, Florida Airways, Monarch Airlines, Pioneer Airlines, Southwest Airways and West Coast Airlines.

Operating results of these seven carriers for the first six months of 1947 have not been too encouraging and prohibitive losses have been averted only by increased mail pay. Their net operating loss for the period amounted to $1,093,498 despite an average mail pay of 39.42¢ per revenue-mile or $21.46 per ton-mile.

From a route mileage standpoint the present market for a feederline airplane appears promising but on closer scrutiny must be discounted because of the following factors:

a. Temporary status of carriers;
b. Unstable financial position;
c. Availability of surplus equipment;
d. Abnormally high operating costs;
e. Inability of feederlines to agree on a standard type airplane;
f. Potential firm orders insufficient to sustain production program.

Just how far the Civil Aeronautics Board will go to sustain the feederline program with mail pay is a difficult question to answer. However, it is probable that the existing feederlines will continue to operate during the term of their temporary certificates with the equipment now on hand or economically available from the trunk carriers as the latter release surplus DC-3s and Lodestars. New feederline operators who have not as yet obtained equipment can be logically expected to follow the same procedure.

D. Non-Scheduled Cargo Carriers

The non-scheduled cargo carriers are a definite outgrowth of World War II and without exception have availed themselves of surplus transport aircraft to commence their operations.

Out of a somewhat confused situation existing during the latter part of 1945 and the first part of 1946 several strong non-scheduled cargo companies have emerged, and the record shows that their accomplishments for 1946 and the first six months of 1947 are outstanding in the field of air transport.

According to estimates recently released by the Department of Commerce in their National Air Cargo Survey, the non-certificated air freight lines carried 47 million ton-miles of freight in 1946 as compared to a combined total of 43 million ton-miles of express and freight handled by the existing certificated airlines.

For the first six months in 1947 the certificated carriers handled 26 million ton-miles of express and freight and assuming the same ratio as existed during 1946, the non-scheduled carriers' total would approximate 29 million ton-miles.

The future of the non-scheduled cargo operators depends upon what action the Civil Aeronautics Board will take in granting or denying them permanent certificates to operate as common carriers of air freight. This decision will be made either late in 1947 or early in 1948 and, if favorable, it will practically eliminate the status of domestic non-scheduled air freight carrier as it is now known, replacing it with certificated air freight operators as common carriers under a permanent authorization.

Conservative estimates of freight ton-miles that these presently termed non-scheduled cargo carriers will handle for the period 1947-1950 are included in the industry totals in Table I and Plate I.

E. Foreign Airlines

The development of foreign airlines is also a history of transportation achievement. In Europe the first commercial service was inaugurated in 1918 and local services in South America had been pioneered as early as 1919. By 1929 regular international air services were operating to Eastern Asia, Australia, South Africa and South America.

With the exception of Latin America, Russia and Canada the prewar foreign airlines were predominantly international in character, just the reverse of the situation existing in the United States. Furthermore, most of them were government owned or controlled and their development in some instances can be attributed to government subsidy motivated by political and military ambitions.

Statistics showing the development of foreign airlines are neither standardized nor complete. However, data compiled by the International Civil Aviation Organization indicate the growth of world air transport in the prewar period as follows.

In 1932 foreign airlines (excluding U.S.S.R.) flew 38 million aircraft miles, carrying 110 million passenger-miles. By 1938 these figures had increased to 111 million aircraft miles and 465 million passenger-miles.

Comparative statistics showing the postwar position of foreign airlines are not presently available as the world air traffic pattern is still in the process of transition from war to peace; however, general information available indicates their postwar growth has been phenomenal.

Estimates for foreign airline passenger-miles during the 1947-1950 period can be made from the available seat-miles based on a 60% load factor as shown in Plates VI, VII, VIII and IX.

Year	Passenger-Miles (millions)
1947	2,810.8
1948	4,216.3
1949	5,340.6
1950	6,986.4

F. Expansion of Services

Present local services appear adequate in most foreign countries with the exception of some African and South American nations. Present international services are well developed and in some sections, primarily the North Atlantic, overscheduled. With particular reference to the North Atlantic operations, experience of the past six to eight months indicates that while the demand has been high for transportation, such demand is more of a seasonable nature than an all year round requirement and the bulk is due to tourist travel.

New equipment now being delivered to the foreign operators is considerably more advanced technically speaking than the airport facilities, navigation and communication aids (including night flying) and the status of the training of flight and maintenance personnel. Consequently it is reasonable to assume that before services can be expanded, even though the traffic demand is present, these items must be further developed.

International travel has been stimulated by the dollar balances available in other countries. This condition has changed appreciably for commercial as well as holiday travelers, and with decreasing dollars available in foreign countries there should be a direct adverse effect upon travel.

Foreign operators in some sections have already developed cargo operations. However, in most countries cargo carrying has not advanced to the state it now occupies in the United States. Accordingly it is logical to assume that there should be considerable expansion and development in the carrying of cargo. It is reasonable that this will in time create a demand for cargo carrying aircraft; however, based upon the amount of equipment available on the surplus market it does not appear that the demand for new equipment of this type will be felt before the next two to three years. This applies to the foreign military cargo requirements as well as commercial.

Probably the most fertile field for domestic expansion is the all-cargo operation. However, all of these carriers, both certificated airlines and non-scheduled companies, are using converted war surplus equipment in their operations, and it will be several years before they will be in a position to make volume purchases of a new all-cargo design.

It appears that the nation's conventional airline network, with the exception of feederlines, is fairly well settled and for the most part additions in airline mileage will consist of present route extensions or modifications. Expansion, therefore, will come more as a result of increased service over the present network than from additional route mileage. Two major factors in connection with expansion of services are first, the competitive rate picture with the railroads and, secondly, all-weather flying and the improvement of the safety record.

FARE COMPETITION WITH THE RAILROADS

It has been the belief of many in the industry that the key to volume air transportation lies in the possibility of 3¢ passenger fares. Unfortunately, economic conditions have put the 3¢ fare beyond present day reach and have forced the airlines to increase their fares in an attempt to bolster their financial position. The Civil Aeronautics Board approved a 10% increase in airline fares, effective April 1, 1947, raising the level from 4.5¢ to 4.95¢ per passenger-mile. A further upward trend is evidenced by the recent action of Northwest Airlines in filing for an additional 10% fare increase. Other airlines on record as favoring this increase are Pennsylvania-Central, United and Braniff.

Rail fares are also being pushed upward as on May 20, 1947, the Interstate Commerce Commission granted increases to the Eastern railroads on passenger fares from 3.3¢ to 3.5¢ per mile in parlor and sleeping cars and from 2.2¢ to 2.5¢ per mile in coaches.

The Interstate Commerce Commission has also given the Pullman Company special permission to boost rates effective October 1, 1947. By increasing the minimum charge on standard lower berth rates the percentage of increase ranges from 48.9% where the present lower berth rate is $2.35 to 1% where the present rate is $17.35. No changes are made in rates of $17.70 and over.

The relation of airline fares to first-class rail plus pullman fares is shown in Table VI and on Plate III illustrating the improved position of the airlines in competition for high fare passenger transportation.

Table VI

Relation of Air Fares to First-Class Rail Fares

Year	Air Passenger Revenue per Passenger-Mile (cents)	1st Class Rail Passenger Revenue per Passenger-Mile[1] (cents)	Rail Fares Adjusted for Distance by 1.17 (cents)	Ratio Air Fares to Adjusted Rail Fares
1930	8.30	4.00	4.68	1.77
1931	6.70	3.83	4.48	1.50
1932	6.10	3.49	4.08	1.50
1933	6.10	3.14	3.67	1.66
1934	5.90	2.89	3.38	1.75
1935	5.73	2.90	3.39	1.69
1936	5.58	2.93	3.43	1.63
1937	5.36	3.00	3.51	1.53
1938	5.70	3.00	3.51	1.62
1939	5.15	3.02	3.53	1.46
1940	5.06	3.00	3.51	1.44
1941	5.03	2.88	3.37	1.49
1942	5.27	2.95	3.45	1.53
1943	5.35	2.94	3.44	1.56
1944	5.14	2.99	3.50	1.47
1945	4.95	2.95	3.45	1.43
1946	4.63	3.03	3.55	1.30
1947[2]	4.85	3.41	3.99	1.22

[1]Revenue per passenger-mile for sleeping and parlor cars plus pullman revenue per passenger-mile

[2]First 5 months

ACCIDENTS AND SAFETY AND ALL-WEATHER FLYING

Fear of flying has always been a deterrent to air travel, particularly among the people in the age bracket over fifty. To alleviate this condition the airlines, in conjunction with the Government, have adopted strict safety codes.

A large measure of credit for the increase in safety which has directly contributed to the development of air travel is owed to the Federal Government in providing radio range stations, weather stations and other safety devices. The constant improvement of these meteorological and navigation aids as well as the improvement in airborne radio and radar, ground control radar and the advent of high altitude, over-weather aircraft all contribute to increase in safety, increase in schedule performance and, hence, increased public acceptance of flying as a major portion of the transportation system.

Proof of the influence of these safety standards is contained in the record of passenger fatalities. In 1930 the passenger death rate per 100 million passenger-miles was 28.57 and in 1946 the rate was only 1.46.

Table VII shows the domestic airline safety record from 1936 through 1946. The passenger death rates per 100 million passenger-miles are slightly higher than those published by the Civil Aeronautics Board as the ratio shown is related to revenue passenger-miles and not total passenger-miles flown.

Table VII
Passenger Fatality Record U. S. Domestic Airlines
1936-1946

Year	Revenue Passenger-Miles	Passenger Fatalities	Rate/100,000,000 Miles
1936	388,242,000	44	11.51
1937	407,296,000	40	9.82
1938	476,400,000	25	5.25
1939	677,000,000	9	1.33
1940	1,041,200,000	36	3.46
1941	1,369,600,000	35	2.56
1942	1,398,000,000	55	3.94
1943	1,606,100,000	23	1.43
1944	2,246,900,000	48	2.14
1945	3,362,400,000	77	2.29
1946	5,947,000,000	81	1.36

One of the unfortunate aspects of airline accidents is the unwarranted front-page publicity immediately following each mishap which tends to create a negative reaction toward air travel.

Plate IV illustrates the number of revenue passengers by months for 1945 and 1946 and the first six months of 1947. Each accident during the period is spotted in to determine what effect, if any, it might have on air travel.

It appears from Plate IV that accidents had little bearing on air traffic through 1945 and most of 1946. However, the series of four accidents in October, November and December, 1946 and January, 1947 could well be construed as having a noticeable effect on air travel despite other contributing causes. The three accidents in May and June, 1947 appear to have had a marked effect on air travel in June, 1947 as this month showed a decline of some 50,000 passengers from May which is contrary to the normal seasonal flow.

II. OUTLOOK FOR FUTURE COMMERCIAL AIRCRAFT PRODUCTION

A. Equipment in Use and on Order

Plate V shows an estimate of the aircraft in use and on order as of September, 1947. The aircraft listed for U. S. domestic and American Flag operators are believed to be reasonably accurate; however, their grouping as to domestic or foreign operation represents an estimate based on present knowledge of foreign route patterns and traffic demands.

The equipment listed for foreign airlines is almost impossible to estimate accurately. The estimate is based primarily on reports of Douglas Field Service men who have contacted many of the foreign airlines. Reports of the Foreign Liquidation Commission and the War Assets Administration indicate that many more transport aircraft than those listed have been sold in foreign markets. However, it is believed that many of these sales were to foreign governments for non-commercial operation and to foreign airlines for the purpose of parts cannibalization.

B. Domestic Sales Prospects

1. Estimated Replacement Business

Unfortunately it is impossible to determine with any degree of accuracy the future market for any certain type or model of airplane. However, in Plates VI, VII, VIII and IX for the years 1947 through 1950, aircraft in service and on order are converted to terms of passenger seat-miles flown and ton-mile capacity. These figures, when compared to the estimate of passenger-miles and ton-miles carried, show remarkable consistency in following the normal estimated passenger-mile and ton-mile trend providing an operating load factor in the 60 to 70 per cent range for domestic operators.

During the four year period Lodestars, DC-3s and DC-4s have been gradually reduced in number on the assumption they will be finally replaced with newer, faster, larger and more economical designs. The practical disadvantage in the replacement of the older aircraft with more advanced designs, however, is that an increase in seat-miles flown and ton-miles available is obtained which meets the normal growth trends but at the expense of an actual decrease in airplane miles flown. This, in turn, produces a decrease in the frequency of service which is required to further build up the passenger and cargo traffic.

For this reason there is need for at least one more type of aircraft of advanced, more economical design but with smaller capacity to satisfy the immediate needs of both the domestic and foreign air transport industry. This aircraft has been introduced as a "DC-3 replacement" in the seat-miles and ton-miles flown plates in the years 1949 and 1950. Even with the assumed use of this new type it will probably be necessary for the airlines to retain a sizeable number of DC-3s and DC-4s as late as 1950 which is shown in Plate IX.

The bulk of the potential business during the four year period is in straight replacement of DC-3 and Lodestar types and some DC-4 replacements.

Analysis of the plates of seat-miles flown and ton-miles capacity in comparison with Plate V, Aircraft in Use and on Order, indicates a domestic market over and above present orders for approximately 25 4-engine passenger aircraft, 25 4-engine cargo aircraft and 275 2-engine aircraft.

C. Export Sales Prospects

1. Exports of the Past

Prewar exports of land planes from the United States by number and dollar value are shown in Table VIII for the years 1930-1941.

Table VIII
Exports of U. S. Land Planes
1930-1941

Year	Number Landplanes	Value in $
1930	321	4,819,669
1931	140	1,812,809
1932	280	4,358,967
1933	406	5,391,493
1934	490	8,195,484
1935	333	6,598,515
1936	503	10,076,353
1937	595	17,690,573
1938	861	37,370,294
1939	1,212	66,238,311
1940	3,424	191,279,378
1941	5,782	384,836,158

2. Surplus Sales of Commercial Transports

The following facts are evident from Plate X and XA of past U. S. plane exports when combined with the effect of surplus aircraft flooding the market. By extending the trend of prewar foreign aircraft purchases through the war years into the postwar period a cumulative market for U. S. produced aircraft of approximately 9,000 planes of all types (private, military and commercial) would have been available. Since the war this potential market was actually absorbed in the following manner:

Sales of American Aircraft

Surplus aircraft left in foreign countries sold by Government to date	6,150 airplanes
New aircraft sold by U. S. Manufacturers	2,600 airplanes
	8,750 airplanes

The sale of surplus aircraft by the Government represents 70% of all aircraft sold since the end of the war, leaving but 30% of the market available to U. S. manufacturers for the sale of new planes. By flooding the foreign market with American aircraft selling at low prices the Government has made it extremely difficult for U. S. aircraft manufacturers to generate new business.

Of the 6,150 commercial and personal type planes sold as surplus by the Government, 2,400 or approximately 40% of the total were originally built by the Douglas Aircraft Company. Two thousand, six hundred and seventy-eight (2,678) airplanes of the total surplus sold were suitable for commercial airline use and represent approximately 44% of the total.

3. Estimated Replacement Business

It is estimated that export demand for replacement airplanes will be approximately as follows:

DC-3, Lodestar (2-engine)	118	(Comparison of
DC-4, DC-6, Stratocruiser & Constellation (4-engine)	37	Plate V and Plate IX)

These airplanes are in addition to present orders for Convairs, Martin's, DC-6s, Constellations and Stratocruisers, and this estimate is based on the following factors:

a. In the DC-3, DC-4 field surplus equipment has satisfied the demand and saturated the market.
b. Due to the low price of surplus equipment some operators have over-purchased and are now equipment poor.
c. Numerous non-scheduled operators, operating with limited capital, were able to enter the field principally on the basis of the low initial purchase cost of surplus equipment. There will be a number of these operators who will be unable to survive and their equipment will re-enter the market.
d. The sale and trading of this excess surplus equipment will have an appreciable effect on the demand for new airplanes for a number of years to come.

The above comments regarding the DC-3 and DC-4 field are based on the fact that governmental regulation with regard to aircraft performance will not be altered, thus restricting the utilization of such type aircraft. In the DC-6, Constellation, Stratocruiser field experience on international routes to date indicates that equipment already delivered and on order should satisfy the requirments for the next two to three years.

4. Demand Supplied by Foreign Manufacturers and Probable Demand for U. S. Aircraft

It is estimated that the greatest demand will be for DC-3 and smaller type of aircraft. The only available source of supply of this type of aircraft other than the United States will be Great Britain, Sweden, France and, possibly, Russia.

Great Britain: The DeHavilland Dove, coming under the category of small airplanes, is apparently a good airplane and one which will supply most of the British market in that field. The Vickers Viking has not lived up to expectations and as a result should have a relatively limited market outside of the British Empire. In the larger classification of airplanes the British program on the Tudor has failed miserably to date. Intermediate types, such as the Hermes, are falling short of coming up to the standards set by the DC-6 and Constellation.

Sweden: The Swedish have developed a usable airplane in the SAAB, similar to the DC-3. To date they have been limited by their production facilities and economic backing.

France: The French, while developing many types, have not as yet progressed to a stage where they can be considered serious contenders in the world market.

Russia: It is known that the USSR is building versions of the DC-3 as well as four-engined transports; however, lack of information precludes estimating their potential.

Other countries, such as **Italy, the Netherlands** and **Czechoslovakia**, can be considered in the same class as the French at present time.

In addition to the industrial and technical consideration there is the economic factor to be considered in appraising foreign aircraft supply. For example, the offering for sale of British aircraft is simplified to the purchaser in that payment can be made in sterling as British requirements for imports, as contrasted to the United States' requirements, make it possible for other countries to establish favorable credit with the British whereas the U. S. trade structure is less flexible.

The above presents some of the intangible factors in estimating the demand which can be supplied by foreign manufacturers and that which can be supplied by U. S. manufacturers. However, in general, it can be expected that the British will supply the demand for the bulk of the British market as well as a fair portion of the Empire market. It appears that the balance of the world market will be supplied primarily by U. S. manufacturers, provided present financing problems can be alleviated.

D. The World Market for Commercial Aircraft Production

Accumulating the U. S. domestic and exports sales prospects results in a total estimated world market for:

80 to 90 — 4-engine aircraft
380 to 400 — 2-engine aircraft

over and above existing orders.

This amount of new production would represent a very large and welcome order for any manufacturer in the hard-pressed postwar aircraft industry. But it must be divided into a time period of four to six years and among five to eight major manufacturers.

Since the war the air transport field has grown to a point where more specialized types of equipment are needed. For example, aircraft of the Boeing Stratocruiser, the DC-6 and Constellation types will be used for over-ocean runs and major transcontinental runs. Upon intermediate hauls Consolidated 240, Martin 202s and 303s will be used. There is also a place for smaller type aircraft in short haul operations of the domestic trunk lines, feederlines and foreign lines.

This specialization results in the use of many more types of aircraft than there were in the past and the unit cost of each type will necessarily be higher. This cost would undoubtedly be an additional burden to the airlines and may have a serious effect on their financial picture since airline passenger-mile rates have decreased during a period of increasing costs along with mail pay reduction. The replacement program with newer, specialized aircraft may well be a greater financial problem to the airlines than is generally believed.

III. PROBLEMS INVOLVED IN DEVELOPING, MANUFACTURING AND SELLING NEW COMMERCIAL AIRCRAFT

A. Cost of Development

1. Original Development of Prototype

Development costs are commonly believed to be synonymous with experimental costs in aircraft parlance. However, experience has repeatedly taught that no single experimental airplane or dozen experimental airplanes are a sufficient number to eliminate the major bugs in the design and manufacture of new commercial aircraft or aircraft of any advanced type. In the case of the DC-6, despite great similarity to the Army's C-54, and despite expenditures of approximately $6,900,000 on prototype airplane YC-112A, $6,500,000 on DC-6s numbers 1 and 1A, the Douglas Company is continuing to spend vast sums to improve the airplane after approximately eighty of them have been delivered.

In the broad sense development costs never cease, only diminish as production continues during the lifetime of an airplane model. It is impossible to segregate the costs of these improvements although were a model completely frozen in design a radically lower cost of production would be experienced.

Lack of actual experience in segregating development costs after initial experimental airplanes leaves it a matter for conjecture and forces relying upon experimental development costs in the more narrow sense of the word.

2. Production Warranty and Development Costs

Following the initial cost of developing the prototype it is necessary to spend large sums in eliminating the inevitable "bugs" inherent in any new design. Engineering and experimental and service man-hours constantly pile up throughout the whole manufacturing period in the design and development of improvements and changes necessary to the operator for increased safety, convenience and economy of operation. Experience has indicated that non-reimbursed warranty and production development costs may be equivalent to more than 75% of the original development costs.

B. Cost of Manufacturing

1. Working Capital Requirements

Development costs, although high, are not as great as the investment required to put a new airplane into quantity production. The capital tied up in material inventories and work-in-process far exceeds the return from advance and progress payments during the first year or two of production.

For example, in the case of the DC-6 the Douglas Company has spent $42,000,000 more than it has received from DC-6 sales to date. The costs of experimental DC-6s #1 and 1A amount to approximately $6,500,000. The experimental phase of DC-6 development was a minor financial difficulty in comparison to the overall cost of getting it into production. Financing requirements of this magnitude are formidable obstacles to the release of new models.

2. Advantage of Quantity in Reduction of Manufacturing Costs

The competitive commercial airplane market creates an intense incentive to price a new airplane as low as possible. If this is not done, sales prospects are nil.

Assuming that it requires $5,000,000 to build a prototype DC-3 replacement and the cost of the first 100 airplanes averages $275,000 per airplane, each of the 100 must be saddled with $50,000 worth of development cost which brings the price to a level too high to sell. From recent experience no new postwar commercial air transport model has sold in quantities higher than 178 (Consolidated-Vultee Model 240). Assuming 200 as today's maximum sales potential for a new model, spread of a DC-3 replacement airplane development costs would amount to $25,000 per airplane. This is still enough to severely restrict DC-3 replacement sales. Not until sales approach 500 or 1,000 airplanes does the spread of $5,000,000 diminish to a tolerable portion of the total cost, i.e., $10,000 or $5,000 per airplane. How the aircraft manufacturers and the airlines can boost a 200 airplane potential to a 500 or 1,000 potential is a major problem which, perhaps, only the Government can solve.

C. Financing Aircraft Sales

1. Domestic Airlines

a. Financial Record

Earnings Record: The scheduled airlines of the United States incurred an aggregate operating deficit during 1946 of $15 million; after allowance for $5.5 million of tax carryback credits the net deficit amounted to $9.5 million (see Plate XI). In contrast, the same airlines showed a net income of almost $24 million during the preceding year and averaged $19 million of net income each year during the war. Reports for four of the airlines showing earnings were for fiscal years ended June 30, 1946; since the bulk of the 1946 losses were incurred last fall, the actual aggregate deficit last year was even greater. Last year's sharp downtrend in operations has been further accentuated this year. Results for the first five months of 1947, the most recent period for which reasonably complete financial data are available, show an aggregate operating loss of $17 million, more than ten times the loss for the same period a year ago. While the recent reports for individual months from some of the airlines indicate more favorable comparisons with 1946, it is scarcely conceivable that income gains through the balance of this year, assuming they occur, will be sufficient to prevent the overall 1947 deficit from exceeding last year's by a significant margin.

Working Capital and Net Worth: The aggregate working capital of the airlines dropped $21 million during 1946 (see Plate XII) with four of the airlines showing excesses of current liabilities over current assets of from several hundred thousand dollars to more than four million dollars. This depletion of working funds occurred, first, because of the large operating losses and, secondly, as a consequence of large scale acquisitions of equipment and property. Although the bulk of new equipment deliveries are occuring subsequent to the 1946 fiscal year-end, the property, equipment, and other non-current assets of the airlines increased by $141 million during 1946, from $205 million at the beginning to over $346 million at the fiscal year close. This increase of 70% in property in one year, a development probably unequalled in any other major industry, was financed primarily by $134 million of new capital issues of debentures and stocks during the companies' 1946 fiscal years. Since $45 million of the new funds were obtained from common and preferred stocks, the airlines' aggregate net worth was increased by $30 million during the year, after allowance for the $9.5 million of operating losses and some $5.5 million of dividends paid by the few airlines who were operating in the black. While only a very few interim 1946 balance sheets are available, it would seem evident that, with the large operating losses incurred thus far and the accelerating rate of equipment deliveries, working capital has been further depleted, the property accounts have risen to new peaks, and net worth has continued downward.

b. Capital Expansion

Reference has already been made to the securing of some $134 million of new capital during 1946. Of this total, $40 million was represented by preferred stocks and only $6 million by common stocks with the balance of $88 million consisting of indebtedness secured for the most part by liens on the equipment being acquired. This 1946 total was 80% larger than the amount of new capital raised during the companies' 1945 fiscal years. In 1945, however, more than two-thirds of the total consisted of common stocks issues. It should be observed that financing by three of the sixteen airlines accounted for 94% of the total new capital acquired last year and half of the airlines acquired none; this same concentration was observed during 1945.

c. Long-term Credits, Bank Loans, Liens on Equipment

Airline financing since the war, as seen above, does not appear to have been on a consistent or uniform basis. In contrast to the prevalence of common and preferred stock issues during 1945, such equity financing during the past year has been in the minority, with the result, as indicated in a recent study by the C.A.B., that less than one-third of the airlines are free of indebtedness and in some instances from 30% to 70% of their capitalization consists of fixed obligations. A major reason for this virtual cessation of new capital financing by stock issues has been the sharp downtrend in air transport stock prices since 1945.

From their postwar peak during the closing months of 1945, average airline stock prices have dropped nearly 60%. In no other major industry, including aircraft manufacturing itself, has public investment opinion, the acid test of which is the stock market, deteriorated so drastically in the past two years. It is not surprising, therefore, that the airlines have been forced to turn elsewhere than common and preferred stocks for their financing.

As a further resort, to which they have turned for financial assistance, a number of airlines have entered into short and medium term credit agreements with groups of participating banks, insurance companies and others, both for equipment financing and general working capital needs. The exact volume of such financing is not easily ascertainable and was, therefore, not included in the foregoing totals but it could conceivably approach the proportions of the outstanding longer term issues. In addition to being generally of much shorter maturity than the economic life of the equipment purchased, however, another questionable aspect of these commercial credits is that they are frequently dependent upon the maintenance of working capital above certain minimum levels. Continued losses by the airlines of recent and current proportions would have the effect of voiding such sources of financing, where working capital minimums are required, possibly even prior to their present maturities. More than one airline has already been reported to have encountered real difficulties because of inability to meet the conditions of its short term credits. In other words, the heavy operating losses of the great majority of the airlines since the war have prevented them, in many instances, from security necessary capital in a form and on terms that are best suited to their equipment and other operational requirements.

2. Foreign Airlines

a. Availability of Dollar Exchange

The aircraft manufacturing industry is foremost among those in which the rapidly deteriorating ability of foreign buyers to secure the means of payment has become a severely limiting factor in export sales. The extent and causes of the dollar shortages throughout the world are too well known to be reiterated. Most unfortunately the countries of Western Europe and the British Empire, areas in which the ability to purchase in this country has declined most rapidly, are those with the largest and longest-established airline operations and are, therefore, the major potential markets for our commercial aircraft.

b. Foreign Credits

A limited amount of dollar exchange assistance has been obtained since the war by certain aircraft manufacturers from the Export-Import Bank. Preliminary discussions with the International Bank are understood to have held forth some promise, however, at least in the sense that purchases of commercial aircraft are included among the purposes for which such loans might be made. In respect to both of these lending institutions the guarantee or other endorsement by the borrower's government is generally required, and properly so, but the basic difficulty appears to be that the problems of international economic and financial reconstruction are so overwhelming and grave that initiating or conclusive actions by foreign governments in applying for loans have not been forthcoming to any appreciable extent. In our experience, even preliminary steps to avail themselves of the facilities of the Export-Import or International Bank have been considered only by a few of the smaller countries, none of which include any of the larger foreign airlines. Our contacts with the officials of the Export-Import and International Bank have been highly satisfactory, but the missing element appears to be the inclination or ability of the foreign countries, apparently in view of the rapid succession of unfavorable developments in the overall international scene, to enter into the necessary commitments. The commercial and investment bankers in this country also feel they cannot actively enter into the financing of aircraft exports in view of the uncertain conditions abroad.

c. Airplane as a Generator of Dollar Exchange

In contrast to electrical installations, manufacturing facilities or other transportation equipment for export, airplanes would appear to have a unique advantage to foreign countries, particularly those short of foreign exchange, in that they represent a means of generating such exchange. To a far greater extent than in this country, the foreign airlines are engaged in international operations, in the transportation of passengers and merchandise of foreign origin, the revenues from which are received in the exchange of other countries. Moreover, although we do not have comprehensive data on this subject, it is common observation that on many of the foreign airlines, American citizens and cargo paying for their passage in dollars are the dominant traffic. More than 30% of the foreign airline traffic through New York City during the past year was of dollar origin. The International Economic Division of the Department of Commerce has estimated that from routes touching at United States points alone, some $13 million in dollar exchange was obtained by the foreign airlines in 1946, the 1947 total is estimated to approach $20 million, and that in 1948 to increase by another 40%. Dollar exchange from American traffic originating and terminating wholly outside this country undoubtedly adds further to these totals. It might be expected that a greater realization of this dollar-generating ability of the aircraft, together with an easing of other international obstacles, would lead to some revival in the present virtually void foreign market for American aircraft but to date there has been little or no indication in this direction.

D. Market Limited by Costs

Although a sizable market exists for U. S. produced commercial aircraft, it is definitely limited in scope by the ability of the airlines to purchase additional airplanes of existing design or to pay development costs on new models.

1. Needs of the Manufacturer

a. Development Aid

In time of emergency it is most important to the national safety to have available a strong and well-equipped commercial air transport industry. Even in time of peace air transport operators must be backed by a strong and well staffed manufacturing industry. This combined commercial industry can immediately convert its existing equipment into a sizable military air lift and provide for continuing production of military transports. For these reasons and to reduce the ultimate cost in time and money, the Goverment can easily afford to participate financially in development contracts for new commercial air transport aircraft.

b. High Production

Since a new aircraft is still unproved and its true utilization can never be obtained until it is put into service in reasonable quantity, the manufacturer also needs production contracts from the Government as well as from commercial customers in order to spread his development, warranty, tooling and production costs over a greater number of airplanes.

Aside from the amortization of these costs the actual direct manufacturing costs decrease with quantity. From actual experience the cost of the 10th unit is approximately 34% of the first; the 100th, 16%; the 200th, 13%; the 500th, 10%; and the 1,000th, 8%. These reductions represent the learning curve of both management and workers directed toward a better production effort.

c. Continuity of Production

Probably the most important need of the aircraft manufacturer is continuity of production as it will allow for retention of personnel whose job knowledge and special techniques are indispensable to efficiency and economy.

Discontinuity in the postwar DC-4 production at the Santa Monica Plant (three months elapsed between airplane number 60, the last military C-54G converted to commercial type, and airplane number 61, the first commercial DC-4 on order) jumped the assembly hours of some components as much as 80% when no design changes whatever were present. Plate XIII illustrates the increase in production man-hours per pound on several DC-4 components directly attributable to this three-month lapse. For maximum benefit additional releases of the same model must reach production before the "know-how" is liquidated.

The continuity of this "know-how" when carried from model to model or even on re-orders of the same model is the largest single factor in the reduction of manufacturing costs when a reasonable design similarity exists.

IV. MILITARY SIGNIFICANCE OF NEW COMMERCIAL AIRCRAFT

A. Commercial Transport Conversion to Military Use

The value to the nation of a well-equipped and smooth-running commercial air transportation network in wartime emergency was demonstrated after the entry of the United States into World War II. At this point the Army Air Forces had but a few transport airplanes, most of them of the DC-3 type. All of the DC-3s then on order by the airlines were taken over by the Army and during the course of the war some 12,000 DC-3 type aircraft were produced. They also took over production of the DC-4 type airplane. The DC-4 became the Army C-54 and the Navy R5D and approximately 1,500 aircraft of this type were produced.

It is a logical conclusion that every commercial air transport should be of great interest to the Armed Services as their supply of transports, other than those on hand, must come from the civil airlines or from the air manufacturer then in production on transport models.

B. Government Participation in Development and Production

Under present day conditions the extremely high costs of development of new airplanes tend to discourage development of new commercial equipment. The manufacturer is in no better position than the airline to singly undertake the development of a new model. Pooling of resources by interested parties for new commercial development appears to offer the only practical means of providing the funds required. The interdependence of commercial and military air transport as evidenced in the last war emphasizes the inalienable interest of the Armed Forces in new commercial aircraft development. Some measure of military value will reside in most new commercial models. In some cases the potential military need will exceed the commercial; in other cases the reverse will be true. Wherever military need exists it should be frankly admitted by the Armed Services and financial support should be provided commensurate with its potential interest.

Financial participation by the Armed Services should not be made contingent upon strict compliance with military specifications. The industry should have full freedom to establish requirements for the new airplane which it considers essential for commercial operation and omit incompatible military requirements without threat of loss of reasonable support from the Armed Services. The Air Coordinating Committee, or some similar body, should attempt to bring about the greatest possible agreement between the airlines and the military on specifications prior to the start of a new project and should attempt to get agreement on the extent of the financial interest of each group in the project.

A sufficiently liberal policy should be adopted by the Government to assure the growth of a financially strong aircraft industry capable of underwriting periodic development of advanced commercial equipment.

In the interest of national security the Armed Forces should carry on a program of continuous development of cargo transport and essential components and accessories applying the most advanced techniques of the art to future military needs independent of the necessarily conservative consideration of commercial requirements. Development of new design applications which could not reasonably be undertaken by the air transport industry should, through this program, assure maintenance of a leading world position for American military transport equipment and coincidentally provide additional indirect assistance to the air transport industry.

MEMORANDUM

In the belief that additional suggestions on this subject may be of help to the Commission, I am taking the liberty of attaching to the exhibits accompanying my report a memorandum on legal obstacles in secured aircraft financing, with special emphasis on the relation of these obstacles to development of civil aviation aircraft markets at home and abroad.

Legal Obstacles in Secured Aircraft Financing

In addition to the operating deficits and other financial deterrents, there are several major legal difficulties cited by financial institutions as obstacles to aircraft financing by means of secured liens. First, a conditional seller, equipment trust trustee, or chattel mortgagee might be held liable as owner of the aircraft. A suitable amendment of the Civil Aeronautics Act could effectively remove this liability. Second, difficulty arises from doubt as to the status of the property in event of bankruptcy. The secured creditor could not be properly protected unless he is able to repossess the operating equipment, and the right of repossession should be added to the Bankruptcy Act on corporate reorganizations. And, third, there is at present no system for recording interests in engines or in spare parts generally, although the latter may run as high as 25% of the airplane cost. Appropriate amendments to the Civil Aeronautics Act providing for such recording would permit the use of spares as security. The aircraft industry and various financing institutions are preparing legislation on these points for submission to Congress. The foreign field presents even greater difficulties, inasmuch as there is presently no means for the international recording of financial interests in aircraft. At the present time the ICAO is considering a draft convention on the recognition of rights in aircraft. Without such a convention, it becomes increasingly difficult both for United States international carriers to obtain funds for new equipment as well as funds for the purchase of American equipment by foreign operators.

PLATE I

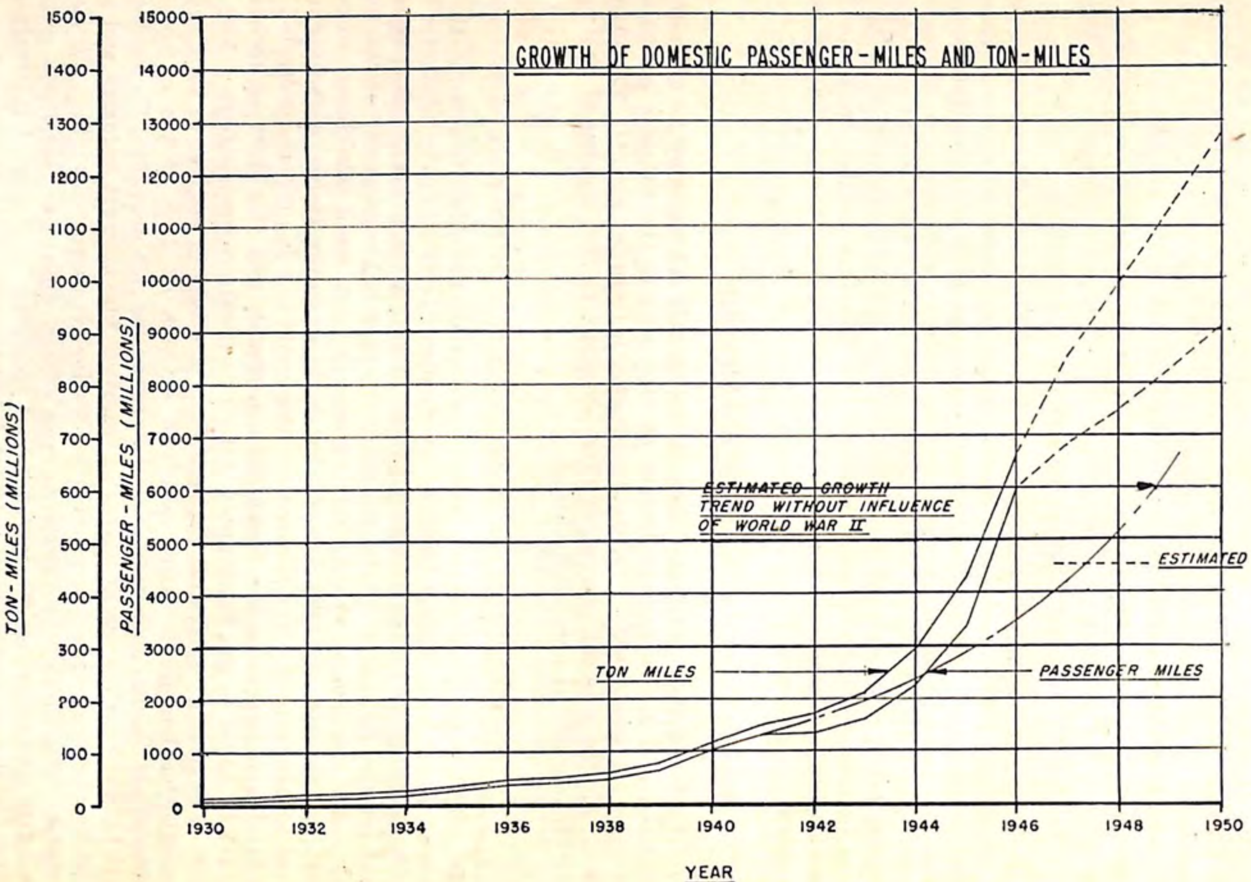

GROWTH OF DOMESTIC PASSENGER-MILES AND TON-MILES
TON-MILES (MILLIONS)
PASSENGER-MILES (MILLIONS)
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1930
1932
1934
1936
1938
1940
1942
1944
1946
1948
1950
YEAR
ESTIMATED GROWTH TREND WITHOUT INFLUENCE OF WORLD WAR II
ESTIMATED
TON MILES
PASSENGER MILES

PLATE II

GROWTH OF INTERNATIONAL AND TERRITORIAL PASSENGER-MILES AND TON-MILES 1936 — 1950

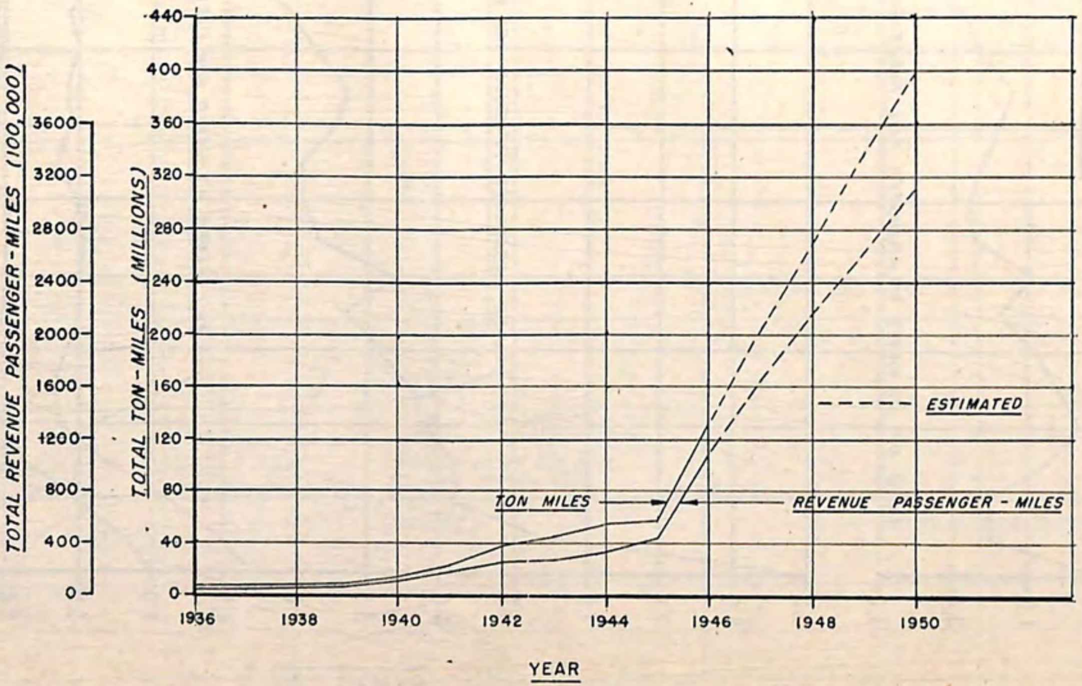
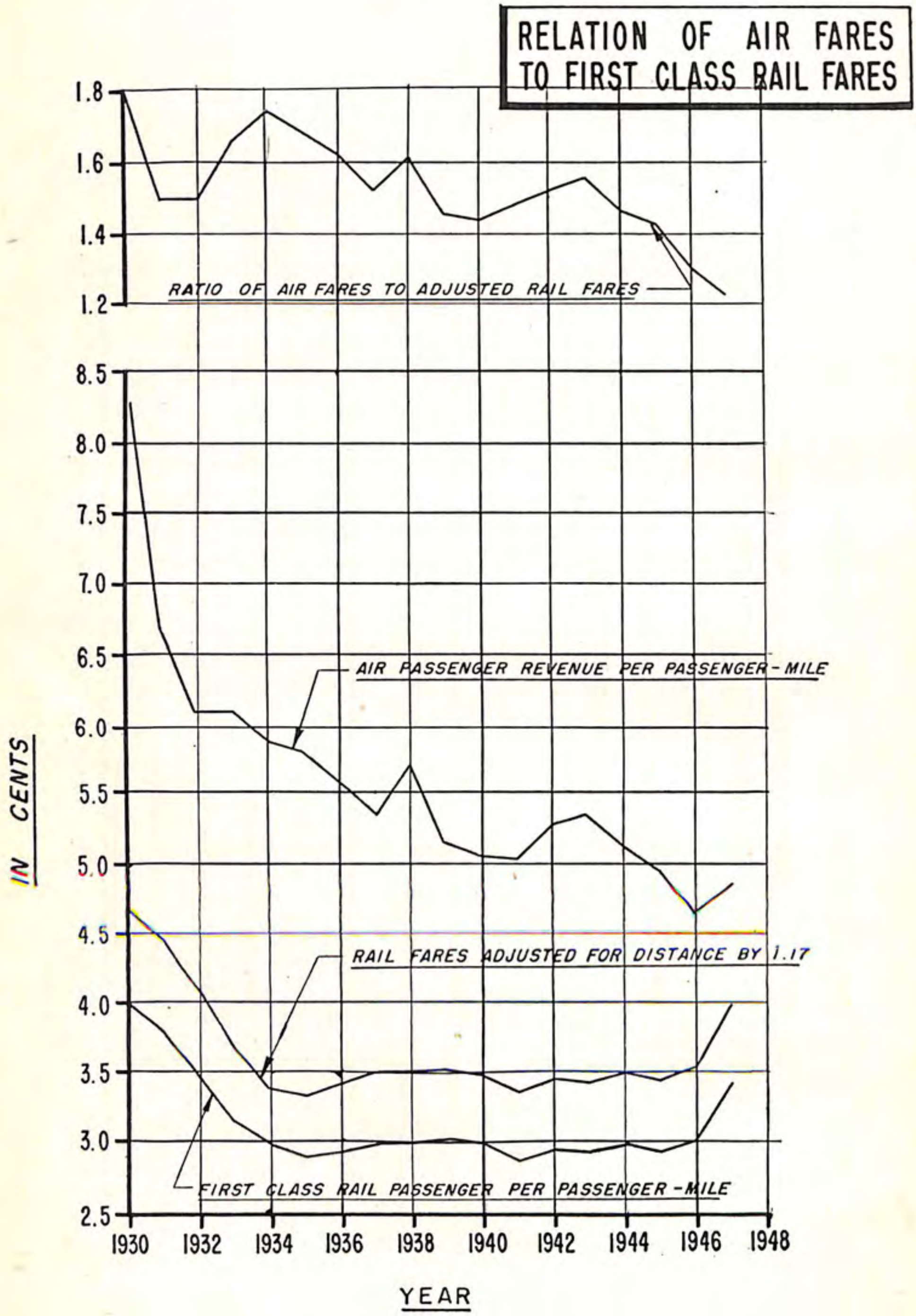


PLATE III


RELATION OF AIR FARES TO FIRST CLASS RAIL FARES
1.8
1.6
1.4
1.2
RATIO OF AIR FARES TO ADJUSTED RAIL FARES
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
IN CENTS
AIR PASSENGER REVENUE PER PASSENGER-MILE
RAIL FARES ADJUSTED FOR DISTANCE BY 1.17
FIRST CLASS RAIL PASSENGER PER PASSENGER-MILE
1930
1932
1934
1936
1938
1940
1942
1944
1946
1948
YEAR

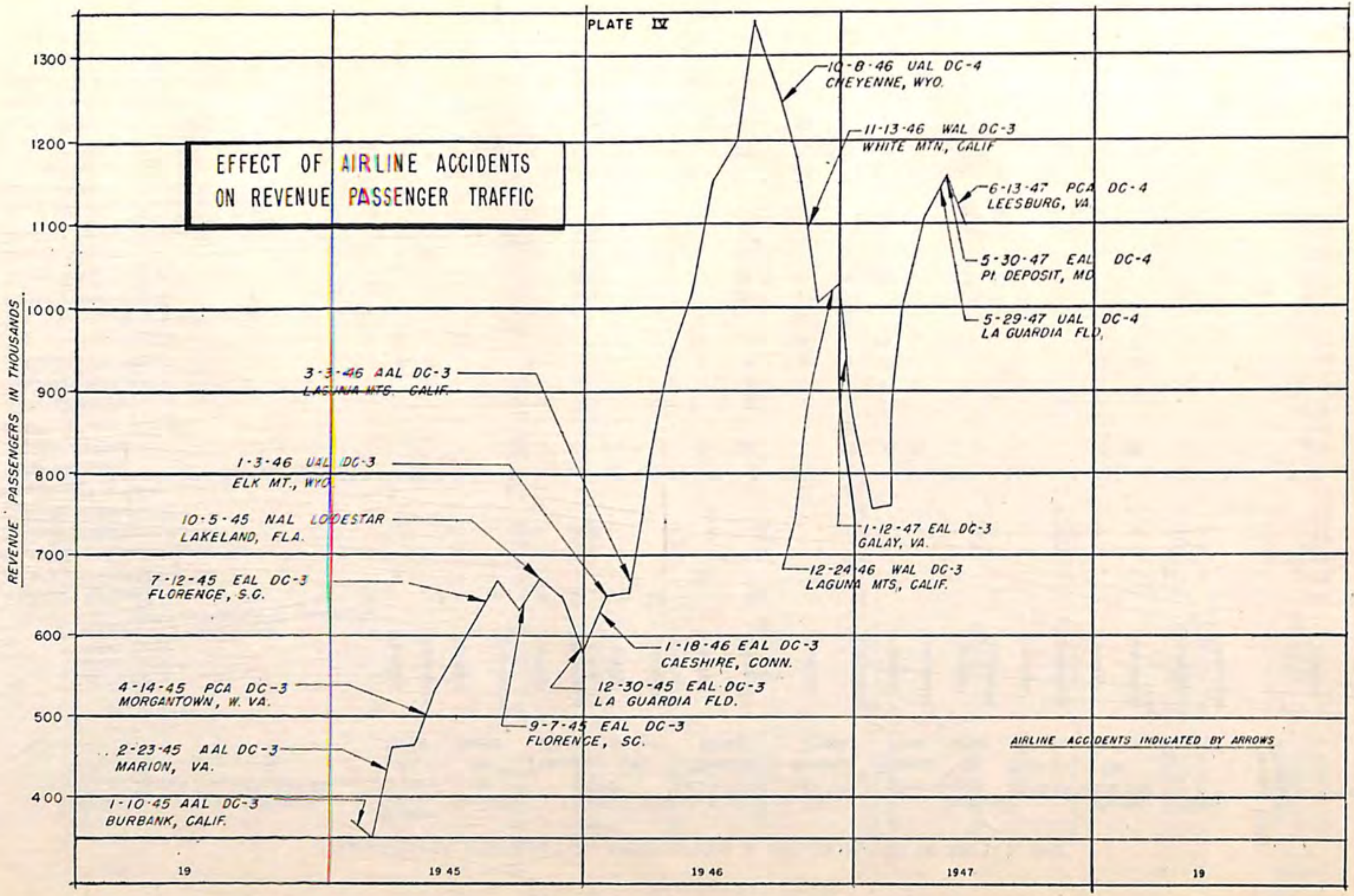


PLATE IV
EFFECT OF AIRLINE ACCIDENTS
ON REVENUE PASSENGER TRAFFIC
REVENUE PASSENGERS IN THOUSANDS
1300
1200
1100
1000
900
800
700
600
500
400
10-8-46 UAL DC-4
CHEYENNE, WYO.
11-13-46 WAL DC-3
WHITE MTN, CALIF.
6-13-47 PCA DC-4
LEESBURG, VA.
5-30-47 EAL DC-4
Pt. DEPOSIT, MD.
5-29-47 UAL DC-4
LA GUARDIA FLD.
3-3-46 AAL DC-3
LAGUNA MTS. CALIF.
1-3-46 UAL DC-3
ELK MT., WYO.
10-5-45 NAL LODESTAR
LAKELAND, FLA.
1-12-47 EAL DC-3
GALAY, VA.
12-24-46 WAL DC-3
LAGUNA MTS., CALIF.
7-12-45 EAL DC-3
FLORENCE, S.C.
1-18-46 EAL DC-3
CAESHIRE, CONN.
12-30-45 EAL DC-3
LA GUARDIA FLD.
4-14-45 PCA DC-3
MORGANTOWN, W. VA.
9-7-45 EAL DC-3
FLORENCE, SC.
2-23-45 AAL DC-3
MARION, VA.
1-10-45 AAL DC-3
BURBANK, CALIF.
AIRLINE ACCIDENTS INDICATED BY ARROWS
19
1945
1946
1947
19

PLATE V

COMMERCIAL AIRCRAFT IN OPERATION & ON ORDER AS OF SEPT. 1, 1947

AMERICAN, FLAG, TRUNK, AND INTERNATIONAL LINES	Boeing Strato-Cruiser On Order		Convair 240 On Order		Douglas Aircraft Company, Inc. DC-6 Present Fleet		DC-6 On Order		DC-4-C-54 Present Fleet		DC-3 Present Fleet		Lockheed Constellation Present Fleet		Constellation On Order		12-14-18 Present Fleet		Martin 202 & 303 On Order		Other Present		Foreign Built Transports	Totals	
	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic		Present	On Order
American Airlines	..	.	..	100	6	25	2	17	..	45	..	74	..	..	..	.	..	..	..	..	..	..	..	150	119
American Overseas Airlines	8	.	..	..	..	..	..	..	11	..	1	..	7	..	..	.	..	..	..	..	..	..	..	19	8
Braniff International Airlines	..	.	..	..	..	1	4	1	..	10	..	18	..	..	..	.	..	..	..	..	..	..	..	29	5
Chicago & Southern Airlines	..	.	..	..	..	..	..	..	2	2	..	13	..	..	..	.	..	..	..	..	..	..	..	17	..
Colonial Airlines	..	.	..	..	..	..	..	..	3	..	..	12	..	..	..	.	..	..	..	..	..	..	..	15	..
Continental Airlines	..	.	..	5	..	..	..	..	..	..	..	12	..	..	..	.	..	..	..	..	..	..	..	12	5
Delta Airlines	..	.	..	..	..	..	..	..	..	7	..	17	..	..	..	.	..	..	..	..	..	..	..	24	..
Eastern Airlines	..	.	..	..	..	..	..	..	2	10	..	53	..	13	..	1	..	..	..	25	..	...	..	78	26
Mid-Continent Airlines	..	.	..	..	..	..	..	..	..	..	..	15	..	..	..	.	..	..	..	..	..	..	..	15	..
National Airlines	..	.	..	..	..	2	..	2	3	4	..	..	..	..	..	.	..	12	..	..	..	..	..	21	2
Northeast Airlines	..	.	..	..	..	..	..	..	..	3	..	11	..	..	..	.	..	..	..	..	..	..	..	14	..
Northwest Airlines	6	4	..	..	..	..	..	..	8	8	2	22	..	..	..	.	..	..	..	25	..	..	..	40	35
Pan American Airways	20	.	20	..	..	..	..	..	73	..	26	..	20	..	2	.	..	..	..	..	..	..	..	119	42
Pan American-Grace Airways	..	.	..	..	3	..	2	..	5	..	14	..	..	..	..	.	..	..	..	..	..	..	..	22	2
Penn-Central Airlines	..	.	..	..	..	..	..	..	..	22	..	29	..	..	..	.	..	..	..	..	..	..	..	51	..
Trans World Airlines	..	.	..	..	..	..	..	..	..	12	..	69	13	14	..	.	..	..	..	..	..	5	..	113	..
United Airlines	4	3	..	..	10	16	5	4	..	30	..	76	..	..	..	.	..	..	..	..	..	..	..	136	16
Western Inland Airlines	..	.	..	10	..	..	..	..	..	11	..	13	..	..	..	.	..	..	..	..	..	..	..	24	10
Total American Flag Trunk and International Lines Airplanes:																									
Foreign	38	.	20	..	19	..	13	..	107	..	43	..	40	..	2	.	..	..	..	..	..	..	..	209	73
Domestic	..	7	..	115	..	44	..	24	..	168	..	434	..	27	..	1	..	12	..	50	..	5	..	691	197
Total Airplanes Territorial Carriers	..	.	..	..	..	..	..	..	2	..	11	..	..	..	..	.	..	..	..	..	1	..	..	14	..
Feeders Lines Airplanes	..	.	..	..	..	..	..	..	..	..	..	26	..	..	..	.	..	..	..	..	..	16	..	42	..
Grand Total American Flag Lines	38	7	20	115	19	44	13	24	109	168	54	460	40	27	2	1	..	12	..	50	1	21	..	956	270
(Estimated) All Scheduled Foreign Airlines	10	.	42	..	1	..	35	..	222	..	1300	..	42	..	10	.	180	..	50	..	225	..	250	2220	147
Total World	48	7	62	115	20	44	48	24	331	168	1354	460	82	27	12	1	180	12	50	50	226	21	250	3176	417
TOTAL AIRPLANES	55		177		136				499		1814		122				192		100		247		250	3593	

PLATE VI

ESTIMATE OF AIRPLANES, PASSENGER SEAT-MILES FLOWN AND TON-MILES AVAILABLE—1947
ANNUAL

Airline Grouping: *Airplane Model*	1 Avg. No. Aps. in Service	2 Avg. No. of Days In Serv.	3 Avg. Ap. Utiliz. Hrs./Day	4 Avg. Bl. Speed (MPH)	5 Annual Ap. Miles Flown (1)x(2)x(3)x(4) (millions)	6 Avg. No. Seats Available	7 Avg. Tons Wt. Payload Available	8 Annual Seat-Miles Flown (5)x(6) (millions)	9 Annual Ton-Miles Avail. (5)x(7) (millions)
U. S. Domestic Scheduled Airlines									
Boeing Model 307	5	340	8	180	2.4	30	4.0	72.0	9.6
Constellation L-49 & L-649	20	300	5	250	7.5	50	7.0	375.0	52.5
Douglas DC-3	430	340	10	150	219.0	20	2.5	4,385.0	548.0
Douglas DC-4	160	320	9	190	87.7	46	6.0	4,030.0	526.0
Douglas DC-6	30	300	6	250	13.5	52	7.0	702.0	94.5
Lodestar	12	320	8	160	4.9	17	2.0	83.3	9.8
TOTAL	657				335.0			9,647.3	1,240.4
U. S. All Cargo Services									
Curtiss-Wright C-46	14	300	8	180	6.1	..	5.0	....	30.5
Douglas DC-3	33	150	5	150	3.7	..	3.0	....	11.1
Douglas DC-4	10	300	6	190	3.4	..	9.0	....	30.6
TOTAL	57				13.2				72.2
TOTAL U. S. DOMESTIC TON-MILES AVAILABLE									1,312.6
U. S. Feeder Airlines									
Douglas DC-3	26	280	5	140	5.1	20	2.5	102.0	12.7
Other Small Transports	16	280	5	130	2.9	10	1.7	29.0	4.9
TOTAL	42				8.0			131.0	17.6
U. S. Amer. Flag International & Territorial									
Constellation L-49 & L-649	40	300	5	250	15.0	45	6.0	675.0	90.0
Douglas DC-3	75	250	8	150	22.5	20	2.5	450.0	56.3
Douglas DC-4	100	300	8	190	45.6	44	6.0	2,005.0	273.5
Douglas DC-6	18	150	5	250	3.4	50	6.5	170.0	22.1
TOTAL	233				86.5			3,300.0	441.9
All Foreign Airlines									
Constellation L-49 & L-649	42	180	4	250	7.5	45	6.0	337.7	45.0
Douglas DC-3	1,300	200	3	150	117.0	20	2.5	2,340.0	292.5
Douglas DC-4	222	200	4	190	33.7	44	6.0	1,482.0	202.0
Lockheed 12-14 & 18	180	200	3	160	17.3	14	1.8	242.0	31.1
Other Small Transports	225	180	3	120	14.6	5	.7	73.0	10.2
Foreign Built Transports	250	200	3	140	21.0	10	1.8	210.0	37.8
TOTAL	2,219				211.1			4,684.7	618.6

Plate VI

PLATE VII

ESTIMATE OF AIRPLANES, PASSENGER SEAT-MILES FLOWN AND TON-MILES AVAILABLE—1948

ANNUAL

Airline Grouping: Airplane Model	1 Avg. No. Aps. in Service	2 Avg. No. of Days in Serv.	3 Avg. Ap. Utiliz. Hrs./Day	4 Avg. Bl. Speed (MPH)	5 Annual Ap. Miles Flown (1)x(2)x(3)x(4) (millions)	6 Avg. No. Seats Available	7 Avg. Tons Wt. Payload Available	8 Annual Seat-Miles Flown (5)x(6) (millions)	9 Annual Ton-Miles Avail. (5)x(7) (millions)
U. S. Domestic Scheduled Airlines									
Boeing Model 307	5	150	8	180	1.1	30	4.0	33.0	4.4
Boeing Model 377	4	150	5	270	.8	66	8.0	52.8	6.4
Constellation L-49 & L-649	28	340	6	250	14.2	50	7.0	710.0	99.4
Douglas DC-3	370	340	10	150	188.7	20	2.5	3,777.0	471.5
Douglas DC-4	150	340	10	190	96.9	46	6.0	4,460.0	581.0
Douglas DC-6	69	300	7	250	36.2	54	7.0	1,953.0	253.2
Convair 240	30	150	4	230	4.1	40	4.5	164.0	18.4
Martin 202 & 303	10	200	4	230	1.8	40	4.0	72.0	7.2
TOTAL	666				343.8			11,221.8	1,441.5
U. S. All Cargo Services									
Curtiss-Wright C-46	12	340	8	180	5.9	..	5.0	....	29.5
Douglas DC-3	20	200	7	150	4.2	..	3.0	....	12.6
Douglas DC-4	20	340	8	190	10.3	..	9.0	....	92.7
New 4-Engine Cargo Plane	4	200	6	260	1.2	..	14.0	....	16.8
TOTAL	56				21.6				151.6
TOTAL U. S. DOMESTIC TON-MILES AVAILABLE									1,593.1
U. S. Feeder Airlines									
Douglas DC-3	46	280	5	140	9.0	20	2.5	180.0	22.5
Other Small Transports	20	280	5	130	3.6	10	1.7	36.0	6.1
TOTAL	66				12.6			216.0	28.6
U. S. Amer. Flag International & Territorial									
Boeing Model 377	15	150	5	270	3.0	66	8.0	198.0	24.0
Constellation L-49 & L-649	40	340	7	250	23.8	45	6.0	1,070.0	142.8
Douglas DC-3	10	340	10	150	5.1	20	2.5	102.0	12.7
Douglas DC-4	80	340	6	190	31.0	44	6.0	1,362.0	186.0
Douglas DC-6	32	300	8	250	19.2	50	6.5	960.0	124.8
Convair 240	10	150	4	230	1.4	40	4.0	56.0	5.6
TOTAL	187				83.5			3,748.0	495.9
All Foreign Airlines									
Boeing Model 377	5	100	5	270	.7	66	8.0	46.2	5.6
Convair 240	10	150	3	230	1.0	40	4.0	40.0	4.0
Douglas DC-3	1,000	300	3	150	135.0	20	2.5	2,700.0	337.5
Douglas DC-4	250	300	4	190	57.0	44	6.0	2,508.0	342.0
Douglas DC-6	20	180	6	250	5.4	48	6.0	259.2	32.4
Lockheed 12-14 & 18	120	200	3	160	11.5	14	1.8	161.0	20.7
Lockheed Constellation	50	250	6	250	18.7	45	6.0	841.0	112.2
Martin 202 & 303	10	150	3	230	1.0	40	4.0	40.0	4.0
Other Small Transports	200	200	3	120	14.4	5	.7	72.0	10.1
Foreign Built Transports	200	250	3	140	21.0	10	1.8	210.0	37.8
TOTAL	1,865				265.7			6,877.2	906.3

Plate VII

PLATE VIII

ESTIMATE OF AIRPLANES, PASSENGER SEAT-MILES FLOWN AND TON-MILES AVAILABLE—1949

ANNUAL

Airline Grouping: *Airplane Model*	1 Avg. No. Aps. in Service	2 Avg. No. of Days in Serv.	3 Avg. Ap. Utiliz. Hrs./Day	4 Avg. Bl. Speed (MPH)	5 Annual Ap. Miles Flown (1)x(2)x(3)x(4) (millions)	6 Avg. No. Seats Available	7 Avg. Tons Wt. Payload Available	8 Annual Seat-Miles Flown (5)x(6) (millions)	9 Annual Ton-Miles Avail. (5)x(7) (millions)
U. S. Domestic Scheduled Airlines									
Boeing Model 377	8	300	6	270	3.9	66	8.0	257.5	31.2
Constellation L-49 & L-649	30	340	8	250	20.4	50	7.0	1,020.0	142.7
Douglas DC-3	170	340	10	150	86.6	20	2.5	1,730.0	216.3
Douglas DC-4	110	340	9	190	63.8	46	6.0	2,935.0	383.0
Douglas DC-6	75	300	8	250	45.0	54	7.0	2,430.0	315.0
Convair 240	115	320	9	230	76.2	40	4.5	3,047.0	343.0
Martin 202 & 303	50	320	8	230	29.4	40	4.0	1,175.0	117.5
New DC-3 Replacement	75	200	6	210	18.9	28	3.7	529.0	79.0
TOTAL	638				344.2			13,123.5	1,627.7
U. S. All Cargo Services									
Curtiss-Wright C-46	10	340	8	180	4.9	..	5.0	....	24.5
Douglas DC-3	10	200	7	150	2.1	..	3.0	....	6.3
Douglas DC-4	30	340	8	190	15.5	..	9.0	....	139.5
New 4-Engine Cargo Plane	10	250	8	260	5.2	..	14.0	....	72.8
TOTAL	60				27.7				243.1
TOTAL U. S. DOMESTIC TON-MILES AVAILABLE									1,870.8
U. S. Feeder Lines									
Douglas DC-3	50	300	6	140	12.6	20	2.5	252.0	31.5
Other Small Transports	24	300	6	130	5.6	10	1.7	56.0	9.5
TOTAL	74				28.2			308.0	41.0
U. S. Amer. Flag International & Territorial									
Boeing Model 377	30	300	6	270	14.6	66	8.0	964.0	116.8
Constellation L-49 & L-649	42	340	8	250	28.6	45	6.0	1,286.0	171.5
Douglas DC-4	55	340	6	190	21.3	44	6.0	936.0	127.5
Douglas DC-6	34	340	8	250	23.1	50	6.5	1,154.0	150.0
Convair 240 Martin 202 & 303	25	200	6	230	6.9	40	4.0	276.0	27.6
TOTAL	186				94.5			4,616.0	593.4
All Foreign Airlines									
Boeing Model 377	10	250	6	270	4.0	66	8.0	264.0	32.0
Convair 240 Martin 202 & 303	70	250	5	230	20.1	40	4.0	804.0	80.4
Douglas DC-3	600	340	4	150	122.3	20	2.5	2,445.0	305.8
Douglas DC-4	280	300	4	190	63.8	44	6.0	2,807.0	382.7
Douglas DC-6 Lockheed Connie	90	300	6	250	40.5	46	6.0	1,862.0	243.0
Lockheed 12-14 & 18	50	250	3	160	6.0	14	1.8	84.0	10.8
Other Small Transports	100	250	3	120	9.0	5	.7	45.0	6.3
Foreign Built Transports	250	200	4	150	30.0	15	2.0	450.0	60.0
New DC-3 Replacement	40	150	4	210	5.0	28	3.7	140.0	18.5
TOTAL	1,490				300.7			8,901.0	1,139.5

Plate VIII

PLATE IX

ESTIMATE OP AIRPLANES, PASSENGER SEAT-MILES FLOWN AND TON-MILES AVAILABLE—1950

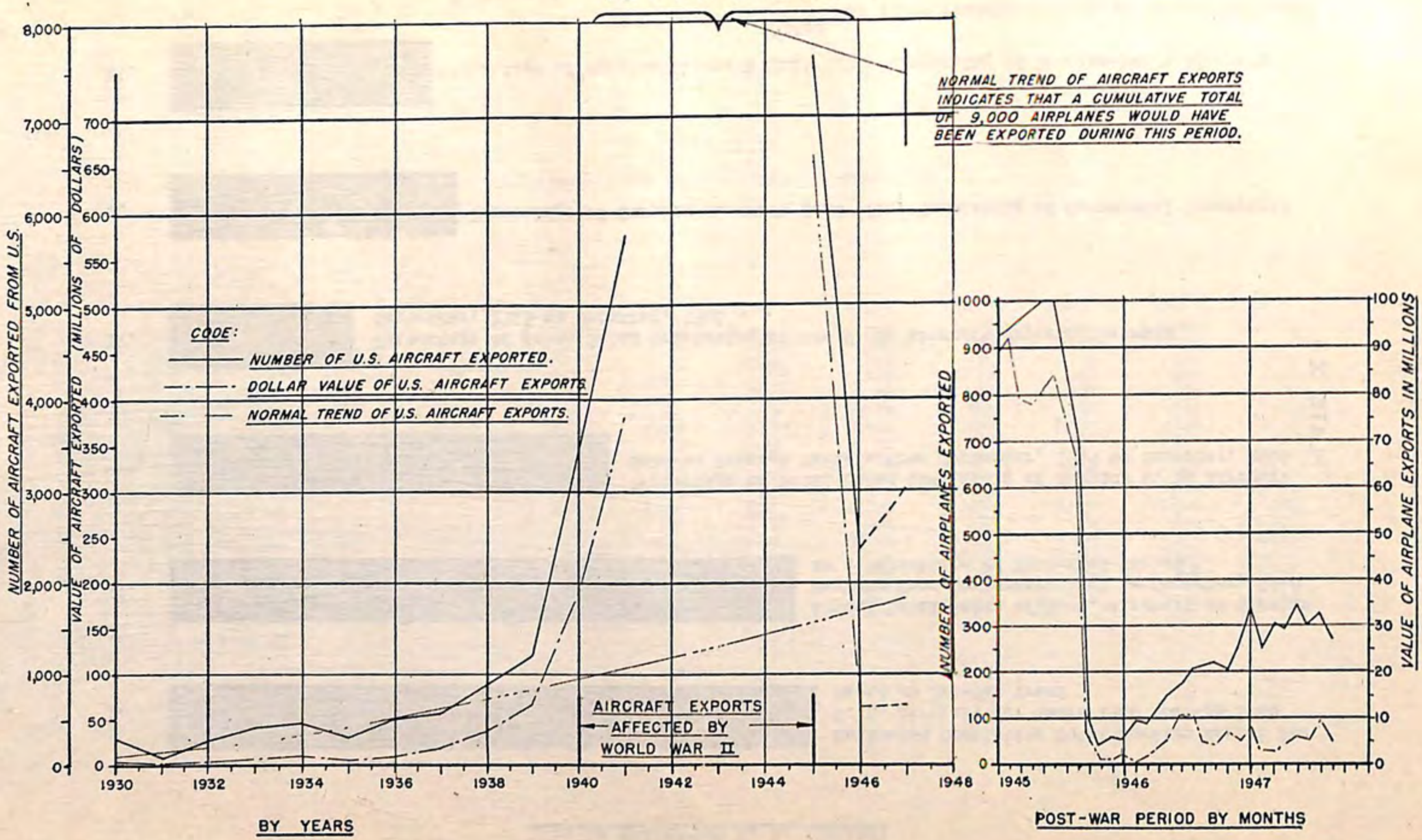
ANNUAL

Airline Grouping: *Airplane Model*	1 Avg. No. Aps. in Service	2 Avg. No. of Days In Serv.	3 Avg. Ap. Utiliz. Hrs./Day	4 Avg. Bl. Speed (MPH)	5 Annual Ap. Miles Flown (1)x(2)x(3)x(4) (millions)	6 Avg. No. Seats Available	7 Avg. Tons Wt. Payload Available	8 Annual Seat-Miles Flown (5)x(6) (millions)	9 Annual Ton-Miles Avail. (5)x(7) (millions)
U. S. Domestic Scheduled Airlines									
Boeing Model 377	10	320	8	270	6.9	66	8.0	455.0	55.2
Constellation L-49 & L-649 / Douglas DC-6	110	340	8	250	74.7	52	7.0	3,880.0	522.0
Douglas DC-3	100	340	10	150	51.0	20	2.5	1,020.0	127.4
Douglas DC-4	80	340	10	190	51.6	46	6.0	2,375.0	309.5
Convair 240 / Martin 202 & 303	180	320	9	230	119.1	40	4.0	4,760.0	476.0
New DC-3 Replacement	250	220	8	210	92.4	28	3.7	2,588.0	342.0
TOTAL	730				395.7			15,078.0	1,832.1
U. S. All Cargo Services									
Curtiss-Wright C-46	10	340	8	180	4.9	..	5.0	....	24.5
Douglas DC-4	50	340	8	190	25.8	..	9.0	....	232.0
New 4-Engine Cargo Plane	25	300	8	260	15.6	..	14.0	....	218.4
TOTAL	85				46.3				474.9
TOTAL U. S. DOMESTIC TON-MILES AVAILABLE									2,307.0
U. S. Feeder Lines									
Douglas DC-3	50	340	8	140	19.0	20	2.5	380.0	47.5
Other Small Transports	24	340	8	130	8.5	10	1.7	85.0	14.4
Helicopter Transports	30	250	4	90	2.7	4	.8	10.8	2.2
TOTAL	104				30.2			475.8	64.1
U. S. Amer. Flag International & Territorial									
Boeing Model 377	40	340	8	270	29.4	66	8.0	1,940.0	235.0
Constellation / Douglas DC-6	80	340	8	250	54.4	48	6.0	2,610.0	326.4
Douglas DC-4	30	340	6	190	11.6	44	6.0	510.0	69.6
Convair 240 / Martin 202 & 303	30	300	8	230	16.5	40	4.0	660.0	66.0
TOTAL	180				111.9			5,720.0	697.0
All Foreign Airlines									
Boeing Model 377	15	300	6	270	7.3	66	8.0	481.0	59.4
Convair 240 / Martin 202 & 303	100	300	6	230	41.4	40	4.0	1,658.0	165.8
Douglas DC-3	400	340	4	150	81.6	20	2.5	1,630.0	203.8
Douglas DC-4	180	340	6	190	69.6	44	6.0	3,060.0	417.0
Douglas DC-6 / Lockheed Constellation	120	300	6	250	54.0	46	6.0	2,482.0	324.0
Other Small Transports	100	300	3	120	9.0	5	.7	45.0	6.3
Foreign Built Transports	100	250	6	220	33.0	40	5.5	1,320.0	181.5
New DC-3 Replacement	110	250	6	210	34.6	28	3.7	968.0	128.0
TOTAL	1,125				330.5			11,644.0	1,485.8

Plate IX

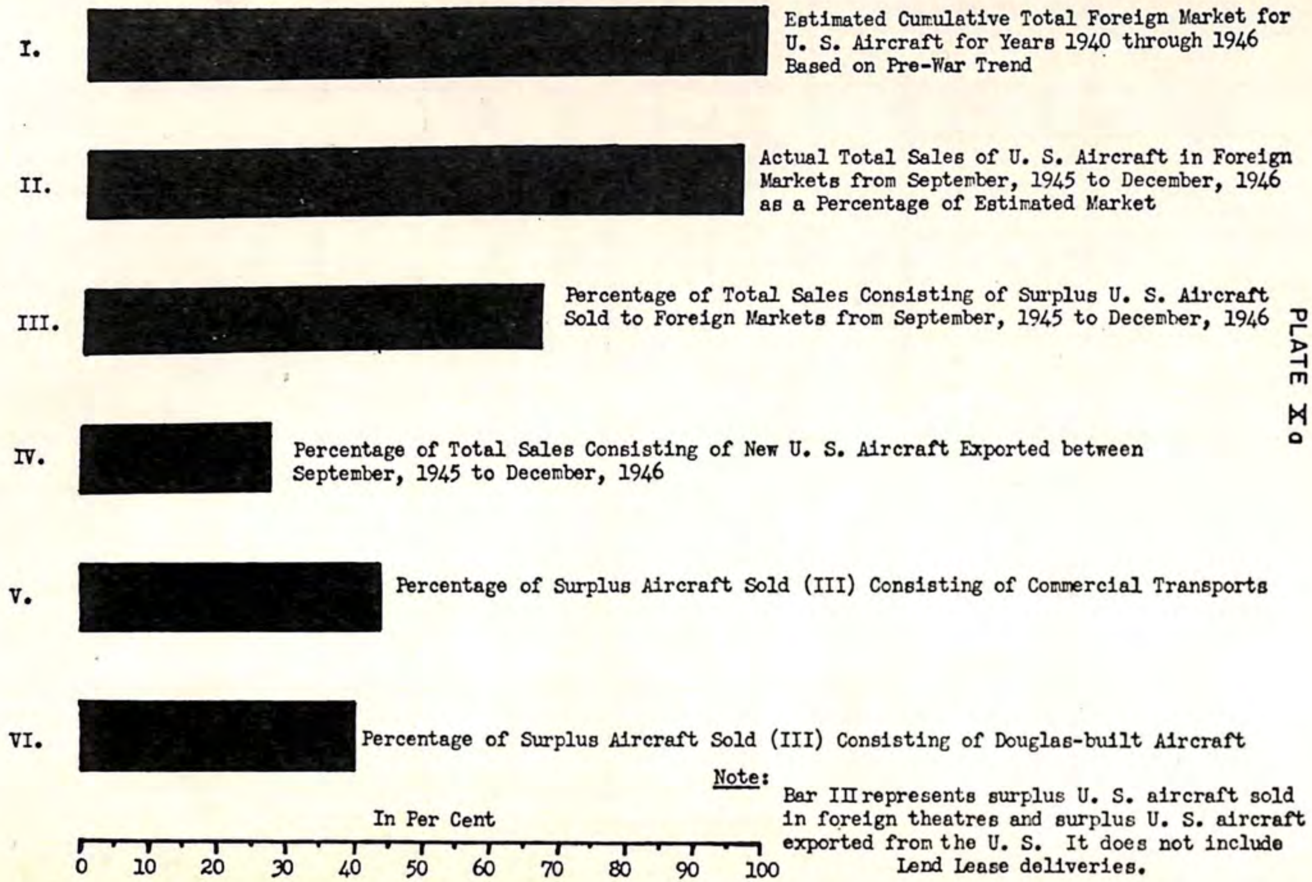
PLATE X

U.S. AIRPLANE EXPORTS



DONALD W. DOUGLAS

FOREIGN MARKET FOR U. S. AIRCRAFT



Note: Bar III represents surplus U. S. aircraft sold in foreign theatres and surplus U. S. aircraft exported from the U. S. It does not include Lend Lease deliveries.

PLATE X a

PLATE XI

NET INCOME OF UNITED STATES AIRLINES

(000 omitted)

	1939	1940	1941	1942	1943	1944	1945	1946	Tax Carry-back Credits in 1946
American Airlines, Inc.	$ 1,468	$ 1,859	$ 2,473	$ 3,852	$ 3,193	$ 4,396	$ 4,399	$ (252)	$ 1,280
Braniff Airways, Inc.	44	75	(84)	635	958	774	850	34	...
Chicago & Southern Air Lines, Inc.	70	30	(112)	129	128	128	169	(1,006)	237
Colonial Airlines, Inc.	(1)	(21)	53	108	16	(29)	109	(375)	65
Continental Air Lines, Inc.*	20	37	(35)	56	281	199	344	312	...
Delta Air Lines, Inc.*	52	60	(86)	359	404	429	551	362	...
Eastern Air Lines, Inc.	884	1,575	1,610	1,886	1,427	1,499	2,126	3,505	...
Mid-Continent Airlines, Inc.	(27)	46	(159)	69	171	139	171	263	...
National Airlines, Inc.*	2	29	10	170	193	3	170	227	...
Northeast Airlines, Inc.	6	10	(56)	(51)	(97)	(77)	(166)	191	...
Northwest Airlines, Inc.*	(123)	296	327	430	300	518	728	989	...
Pan American Airways Corp.	1,984	2,256	3,361	3,780	1,930	1,619	7,566	2,983	...
Pennsylvania-Central Airlines Corp.	53	143	127	408	280	405	441	(2,550)	581
Transcontinental & Western Air, Inc.	107	(98)	(488)	2,176	2,051	2,753	1,814	(14,348)	3,106
United Air Lines, Inc.	777	453	598	3,134	4,203	6,615	4,204	1,087	...
Western Air Lines, Inc.	75	140	6	694	90	136	208	(943)	278
TOTAL	$ 5,379	$ 6,890	$ 7,545	$17,835	$15,528	$19,507	$23,684	$(9,521)	$ 5,547

*Fiscal years ended June 30.
( ) Deficit.

Plate XI

PLATE XII

CHANGES IN AIRLINE FINANCIAL CONDITION.

NEW FINANCING, 1945-1946
(000 omitted)

	Property, Fixed Assets		Working Capital		Net Worth		New Financing, Fiscal Years	
	1945	1946	1945	1946	1945	1946	1945	1946
American Airlines, Inc.	$ 15,438	$ 72,714	$ 13,884	$ 35,079	$ 26,143	$ 65,133	$ ...	$ 80,000
Braniff Airways, Inc.	2,396	7,988	5,016	(932)	7,411	7,055	...	...
Chicago & Southern Air Lines, Inc.	1,663	3,564	401	1,861	1,937	4,120	188	4,482
Colonial Airlines, Inc.	1,257	2,116	194	391	766	2,162	208	1,814
Continental Air Lines, Inc.*	774	1,664	622	34	2,693	3,340	...	...
Delta Air Lines, Inc.*	965	4,269	3,170	1,126	4,086	4,221	2,388	...
Eastern Air Lines, Inc.	4,478	10,911	14,810	12,092	19,050	21,404	211	...
Mid-Continent Airlines, Inc.	1,031	1,054	647	840	1,296	1,527	181	...
National Airlines, Inc.*	1,040	3,897	1,519	1,012	2,466	2,692	...	1,875
Northeast Airlines, Inc.	1,319	2,527	542	(609)	1,703	1,892	120	...
Northwest Airlines, Inc.*	2,955	9,625	6,546	428	9,287	9,774	4,039	90
Pan American Airways Corp.	111,165	129,496	19,370	19,816	83,730	83,833	43,869	18,000
Pennsylvania-Central Airlines Corp.	10,812	12,424	3,823	(360)	4,635	2,171	10,000	...
Transcontinental & Western Air, Inc.	25,558	39,808	7,801	5,728	18,527	4,204	11,651	26,957
United Air Lines, Inc.	21,348	35,619	16,595	2,092	37,943	37,320	485	...
Western Air Lines, Inc.	2,839	8,833	764	(4,557)	2,009	3,321	1,248	1,137
TOTAL	$205,038	$346,509	$ 95,704	$ 74,041	$223,682	$254,169	$ 74,588**	$134,355**

*Fiscal years ended June 30.
**Short term borrowings carried as current liabilities are excluded.
( ) Deficit.

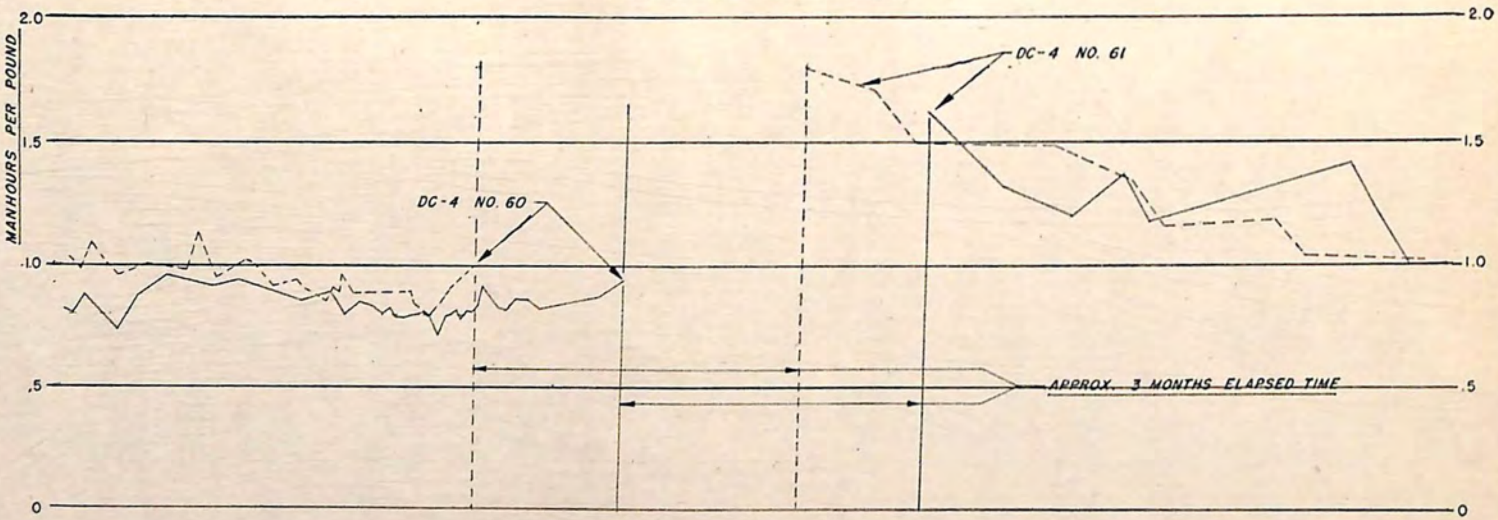
Plate XII

PLATE XIII

EFFECT OF PRODUCTION DISCONTINUITY
DC-4 AIRPLANE

CENTER WING STRUCTURE ————

FUS. CENTER SECTION STRUCTURE - - - - - - - -



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