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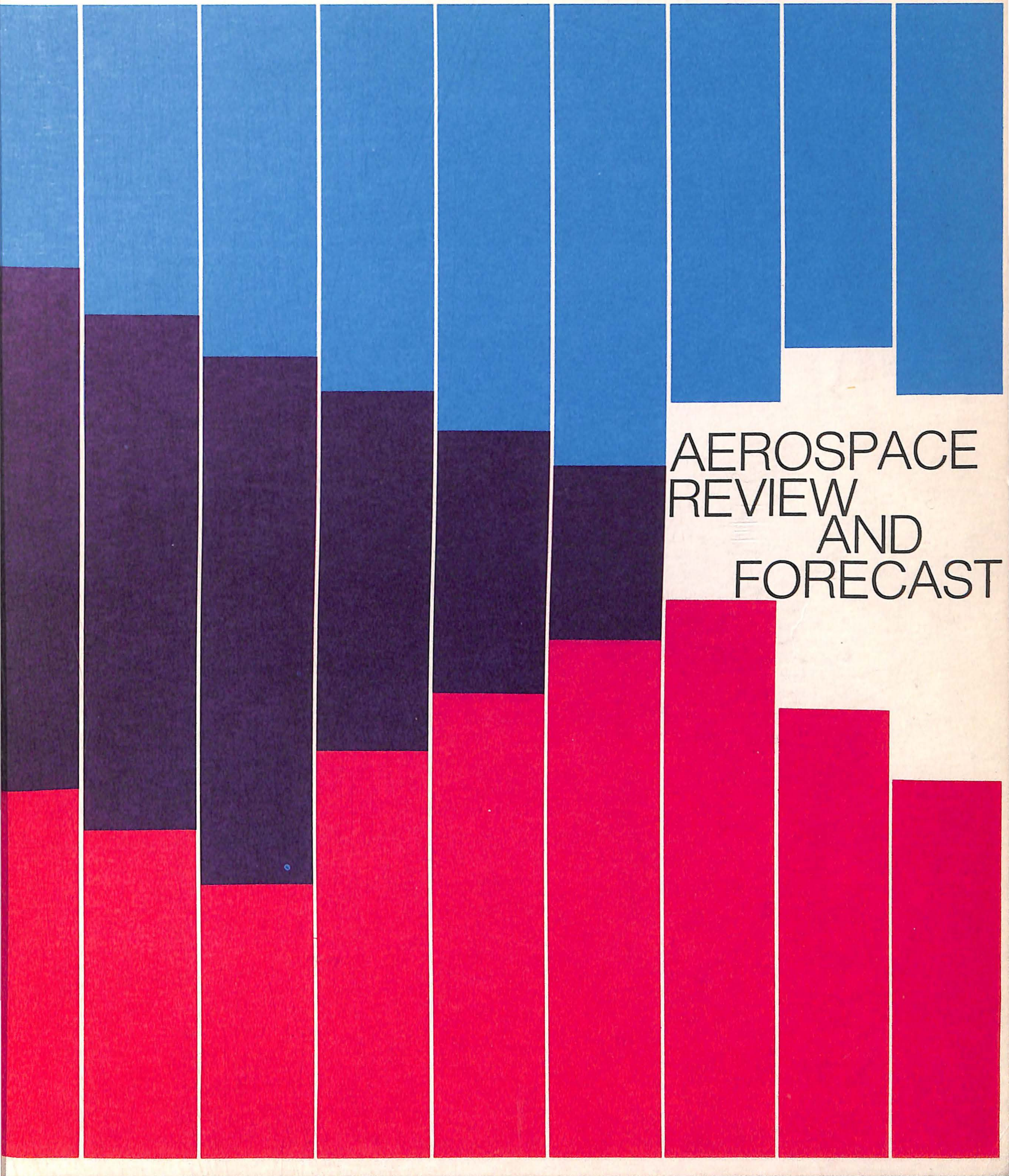

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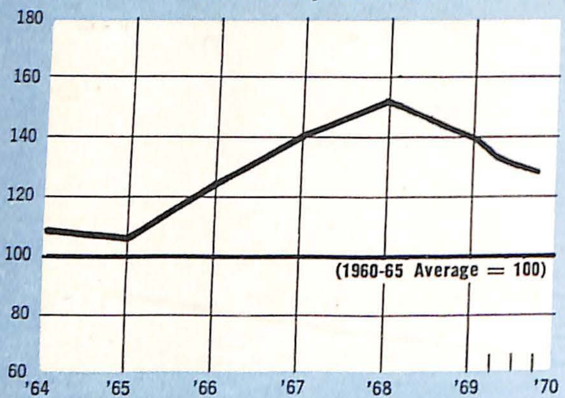
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales



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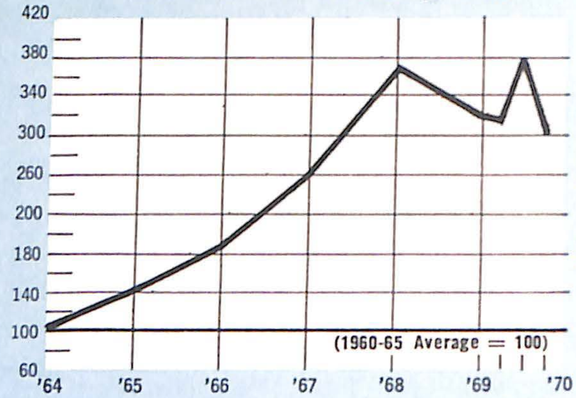
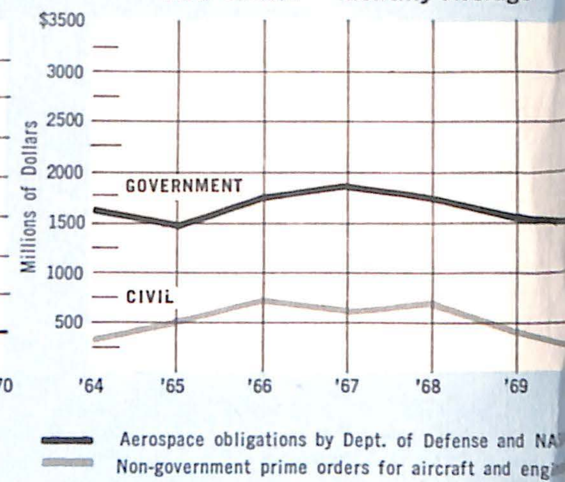


OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1960-65 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Sept 30 1970	27.7	25.6	25.0
	Billion $	Quarterly	4.8		6.5	6.5	6.0
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	Sept 1970	1,304	1,035	1,649
Aircraft	Million $	Monthly	601	Sept 1970	723	635	792
Missiles & Space	Million $	Monthly	550	Sept 1970	581	400	857
Aerospace outlays: Total	Million $	Monthly	1,067	Sept 1970	1,126	1,154	1,227
Aircraft	Million $	Monthly	561	Sept 1970	715	675	734
Missiles & Space	Million $	Monthly	506	Sept 1970	551	479	493
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920+	Sept 1970	1,298	1,226	1,040
Aircraft	Million $	Monthly	447	Sept 1970	689	602	473
Missiles & Space	Million $	Monthly	473	Sept 1970	409	624	567
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Nov 1970	147	230	152
Expenditures	Million $	Monthly	130	Nov 1970	194	249	208
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3#	Quarter Ending Sept 30 1970	29.3	25.2	25.6
U.S. Government	Billion $	Quarterly	11.6		15.1	12.6	13.7
Nongovernment	Billion $	Quarterly	3.7		14.2	12.6	11.9
EXPORTS							
Total (Including military)	Million $	Monthly	110	Sept 1970	157	188	177
New Commercial Transports	Million $	Monthly	24	Sept 1970	15	17	40
PROFITS							
Aerospace — Based on Sales	Percent	Quarterly	2.3	Quarter Ending Sept 30 1970	3.0	2.1	1.9
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		4.6	4.4	3.9
EMPLOYMENT: Total	Thousands	Monthly	1,132	Oct 1970	1,335	1,114	1,091
Aircraft	Thousands	Monthly	469	Oct 1970	591	488	475
Missiles & Space	Thousands	Monthly	496	Oct 1970	570	458	448
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Oct 1970	4.02	4.20	4.22

R Revised.
E Estimate.
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
\# Averages for 1961-65.
+ Averages for fiscal years 1960-65.

Source: Aerospace Industries Associati

PROFITS DILEMMA

The aerospace industry today faces a serious problem as we enter the decade of the Seventies. The problem: How does the industry achieve a level of profits that will enable it to meet the tough challenges of this decade?

Declining sales and sharply reduced profits — down to 2.0 percent of sales after taxes, the lowest level since 1961 — can effectively hobble the industry's capability to exploit new breakthroughs.

This profit level is less than half that of all manufacturing industries, despite the belief in a surprisingly large segment of public opinion that government aerospace programs generate a high level of profits.

A specific comparison of profit rates is astonishing. Over a recent ten-year period a leading cigarette manufacturer had sales of $16.0 billion and realized a profit of $2.8 billion, or 17 percent. During the same period a major aerospace company had sales of $18.6 billion, but made a profit of only $300 million, or 1.6 percent.

Primarily, low profits and/or severe losses stem from government procurement trends. These include:

- Increased use of fixed-price contracts too early in the procurement process when weapon system costs are virtually impossible to estimate.
- A growing pyramid of regulations, restrictions and controls which constrain innovation, hamper performance and preempt competitive ingenuity.
- A significant shift of risk to contractors without commensurate rewards for assuming those risks.

The factors are making government contracting less and less attractive to industry. A recent survey by the Opinion Research Corporation reveals this trend. For example, 83 percent of manufacturing executives interviewed said they were not interested in seeking additional defense contracts.

Similarly, 72 percent of the bank executives questioned during this same period stated that their institutions were not looking for increased involvement in financing defense work.

The general results tend to confirm the fact that defense contracting is relatively unprofitable compared with the commercial market and is becoming increasingly unattractive to industry.

AIA

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The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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Aerospac

Review And Forecast

AEROSPACE industry sales continued their anticipated decline in 1970 to $24.9 billion compared with $26.1 billion in 1969, a 4.6 percent decrease.

However, a 13.7 percent increase in commercial aerospace sales, primarily jet transports, was reported in 1970 from sales of $4,910 million, compared with $4,342 million in 1969. This increase reflects the first deliveries of a wide-bodied jet transport model.

Generally, all other areas of aerospace activity continued the decline which started in 1968 when record sales of $29.0 billion were reported.

Major aerospace sales areas include:

Total aerospace sales to the Department of Defense in 1970 were $14.4 billion compared with $15.8 billion in 1969.

Military aircraft sales declined to $8.8 billion in 1970 compared with $9.8 billion in 1969. These figures include both procurement and research and development funds.

Missile sales, which also include research and development, declined slightly from $5,058 million in 1969 to $4,955 million in 1970.

Space sales continued to decline in 1970 to a figure of $3,606 million, compared with $4,272 million in 1969. This is a result of the virtual completion of the hardware phase of the Apollo program, as well as a decline in military space expenditures.

Nonaerospace sales were nearly the same, with $2,659 million in 1970 compared with $2,699 million in 1969. These sales represent work by aerospace firms in such fields as urban transportation, pollution control, marine sciences and water desalination.

Utility and executive aircraft sales decreased from $578 million in 1969 to $301 million in 1970 and units delivered showed a corresponding drop of 39.5 percent.

Civilian helicopter sales decreased from $75 million in 1969 to $53 million in 1970.

1971 FORECAST

Aerospace industry sales in 1971 are expected to decline to $23.5 billion in 1971 from sales of $24.9 billion in 1970. The anticipated decline is in both government and commercial sales.

Department of Defense sales are estimated at $13.7 billion in 1971 compared with $14.4 billion in 1970.

Space sales will decline to $3,198 million in 1971 from $3,606 million in 1970.

Commercial aerospace sales are also expected to decline between 1970 and 1971, dropping from $4,910 million to $4,541 million. The decline is primarily due to the stretchout of production schedules for jet transport aircraft.

Nonaerospace sales in 1971 are estimated at $2,650 million, virtually the same as in 1970.

BACKLOG

Total aerospace backlog at the close of the first half of 1970 was $25.2 billion compared with $28.3 billion at the end of 1969. It is anticipated that the backlog at the end of 1970 will be $23.2 billion.

However, the backlog of commercial transport aircraft increased from $9.0 billion to $9.9 billion between June 30, 1969 and the same date in 1970. During this same period, the backlog of foreign orders for commercial transports rose from $2.8 billion to $3.4 billion.

EXPORTS AND IMPORTS

Aerospace exports continued to increase as they have since 1964. They rose from $3,151 million in 1969 to $3,466 million in 1970, a 10 percent increase. Major reason for the increase was transport aircraft exports which gained from $940 million in 1969 to $1,578 million in 1970, a rise of 67.9 percent. Military aerospace exports declined 36.3 percent from $1,145 million to $730 million in the same period.

Imports of aerospace products in 1970 were valued at $294 million, a 4.2 percent decline from $307 million in 1969. This decline is expected to be reversed in 1971 because of the imports of jet engines for a new transport aircraft model.

Exports of aerospace products underpin the generally favorable balance of trade for the U.S.

PROFITS

Aerospace industry profits (as a percentage of sales after taxes) are expected to drop from 2.5 percent in 1969 to 2.0 percent in 1970.

EMPLOYMENT

The aerospace industry remains the nation's largest manufacturing employer with more than 1,000,000 workers. Employment in the aerospace industry declined from an average of 1,347,000 workers in December, 1969 to 1,067,000 in December, 1970.

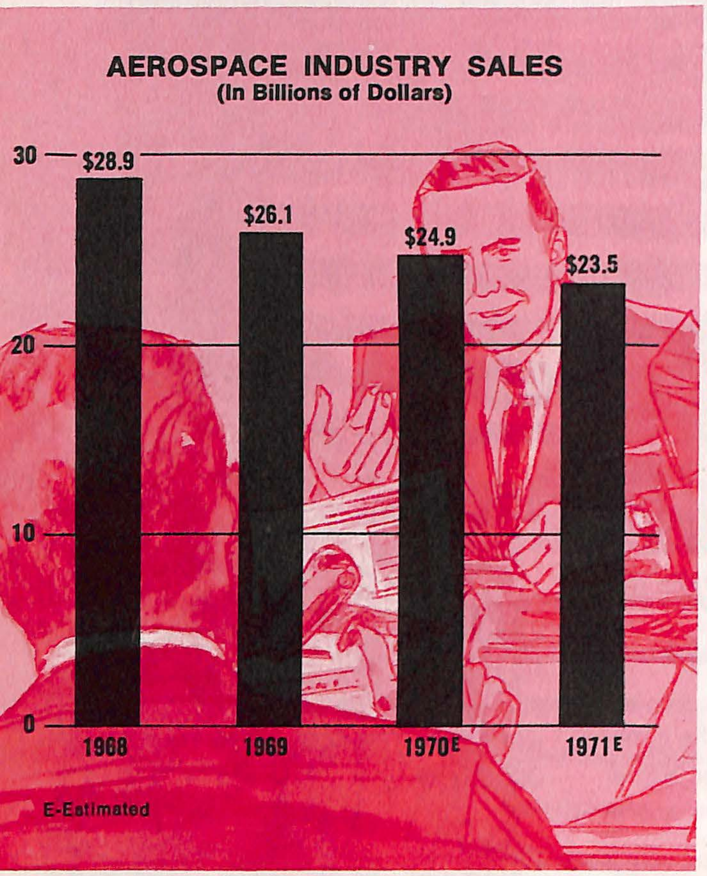
Production workers in the aerospace industry dropped from 696,000 in December, 1969 to 515,000 in December, 1970, a 26 percent decrease. Employment of scientists and engineers is expected to continue to decline from the peak of 235,000 in June, 1967. It is estimated that employment in this category will be reduced to 175,000 by March, 1971.

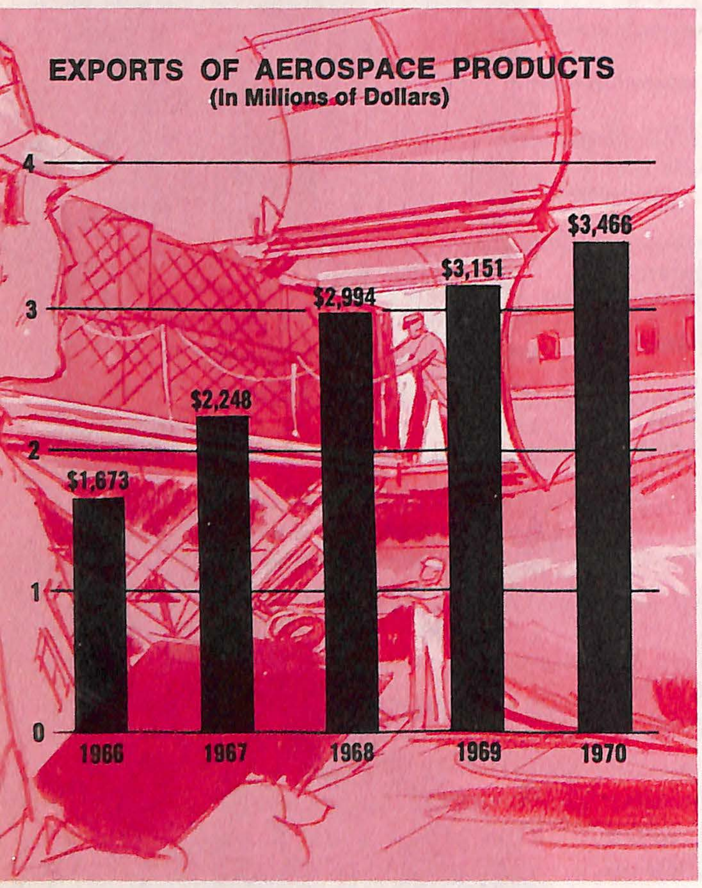
During 1970 production workers made up 48 percent of total employment, scientists and engineers accounted for 17 percent, technicians 6 percent, and the remainder was in white collar categories.

Employment in the aerospace industry is expected to decline by 6.3 percent between December, 1970 and December, 1971 from 1,067,000 to 1,000,000.

EARNINGS AND PAYROLL

Weekly earnings of production workers in the aerospace industry rose from $164.48 to $172.00 between 1969 and 1970 as average hourly earnings increased from $3.92 to $4.15 in the same period. Total industry payroll declined from $14 billion to $11.9 billion because of the decrease in employment.





Karl G. Harr, Jr., president of the Aerospace Industries Association, in a speech before the Aviation/Space Writers Association's Mid-East Region, analyzed last year's economic record of the industry (see page 2), providing reasons for the decline in 1970 and the optimistic prospects for the future.

Many major industries are down somewhat in this period of economic softness. Industries have to be able to weather such cycles. Obviously an industry such as ours has done so before and will do so now. We're basically in strong shape as a whole and look for an upswing in 1972.

That we, like many other industries, are going through a relatively severe downward cycle is not the point. The point is that our industry, perhaps more than any other, is affected by governmental decisions as to fundamental national policy. The reason for my concern lies not so much with the current economic situation, but with the fact that the dialogue leading up to such national policy decisions has become increasingly irrational and irresponsible. I see in this something approaching a national malaise.

The incredible goings on concerning the supersonic transport are but a symptom of the malaise. I cannot remember when so much nonsense has been raised to a level of such dignity in the course of legislative deliberation . . . and all the signs are that this kind of thing will continue.

I suggest if we do not soon recover our rationality and restore our traditional respect for the need to face facts as they are and deal with them squarely, however difficult that may be, we stand in serious danger of doing irreparable damage to our nation's future. . . .

There seems at present to exist a predominant national willingness to accept myth over fact if the myth accords with an emotionally predetermined bias. But above all there seems to be a widely prevalent neurosis approaching a death wish, leading to total inability or perhaps total refusal to see problems as they are. . . .

Such failure to understand the problems and honestly accept their implications is not confined to problems dealing with aerospace and defense or technological advance. It is as broad as the range of major national problems embracing crime control, environmental improvement, and the like. In each instance a desperate search by some for quick and painless solutions has lead to sloganeering, the perpetuation of patent mythology and heavy doses of hypocrisy.

. . . by virtue of this emotional malaise, leading to a total lack of appreciation of the vital role of research and development, we as a nation are in serious jeopardy of not being able to fulfill our needs for advanced technology, particularly in the crucial defense area, not very far down the road. You can't neglect research and development and then all of a sudden when you are in dire need of advanced technology, perhaps for your survival, just pick it off the shelf. And once this capability is lost it can take decades to restore it.

Like every other major national problem — crime control, environmental improvement, upgrading of education and housing, or whatever — keeping up technology takes hard long-range thinking, systematic planning, and then patient dedication to the task. Quick and painless solutions are as phony as the people who advance them and the latter unmistakably stamp themselves as being more interested in headlines or political advantage than in solutions.

It is perhaps unnecessary . . . to recall once again that without technological advance we will not have the capability to address ourselves effectively to the solution of our other national problems . . . Perhaps the most pernicious myth abroad in the land today is the one that suggests an either/or choice between investing in technological advance and investing in solutions to social problems. While the latter goes well beyond technological advance it depends so heavily on such overall advance not only for its supply of innovative options but also for a healthy growing economic base, that rather than having a choice we really can't have the latter without the former. How enthusiastically the panderers of the quick fix have labored to obscure this simple truth.

. . . zealously merchandised mythology has hurt our national efforts to apply the obviously enormous potential for good across the full range of our national interest that is embodied in the revolutionary technological breakthroughs of recent years.

The massively purveyed mythology about profits in that part of the nation's industrial base which supplies the government's needs has had its effect. We are in the process of driving away many companies essential to the fulfillment of our national requirements.

The profit rate on sales after taxes is two percent — much less than half the national average for manufacturing industries and far below what is required to keep an industry viable much less innovative.

Fortunately, there are more than a few straws in the wind that portend a more rational future.

First, there is increasing concern in the executive branch and in the minds of many influential members of Congress over the erosion of the national level of research and development. I believe the downward trend will be reversed, perhaps beginning with fiscal year 1972 Federal Budget.

Second, Secretary Laird has announced that the new national security policy will place greater emphasis on the modernization of our weapons, in lieu of maintaining a high military manpower level.

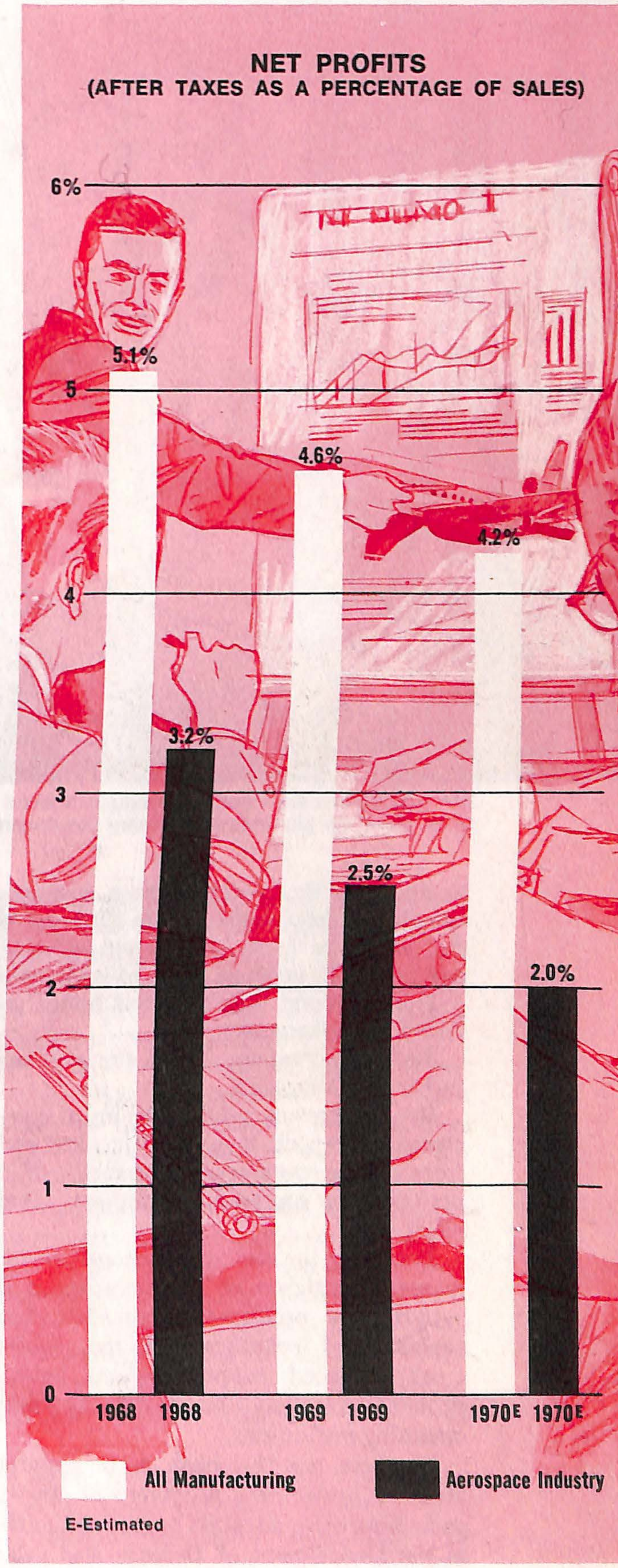
Third, the approval of the space shuttle and space station and the continuing emphasis on near earth benefits from space portend an increase, in my estimation, of funding for NASA in the near future.

Fourth, the recovery of the economy and consequent expansion in the Gross National Product will relieve some of the pressures that have caused the airlines such heavy losses this year and will provide added financial resources for solving some of our pressing domestic problems.

Fifth, foreign sales of U.S. aerospace products again set a new record in 1970 primarily resulting from exports of new jet transport aircraft which rose from $940 million in 1969 to nearly $1.6 billion in 1970, more than offsetting the decline of some $400 million in military aerospace exports. Equally encouraging is continuing orders for these aircraft from foreign airlines.

At present, U.S. aerospace exports are measured in billions of dollars, while imports are in the million dollar category — $293.0 in 1970 — a condition, incidentally, that will be tragically reversed if we fail to proceed with the U.S. Supersonic Transport program.

Sixth, I believe that the initial steps have been taken by the government to establish a true marketplace where industry can go to sell its solutions to our many societal and environmental problems. The aerospace industry is this nation's largest reservoir of scientific imagination, technical expertise and program management experience that can be applied to such major national problems as mass transportation, adequate housing, pollution control and resource protection.



AIA committees and councils conduct detailed studies and then provide government agencies with recommendations to improve the government/industry relationship in such important areas as the weapon system acquisition process.

Nowhere in the world is there a more sophisticated, complex or successful system than the one devised by this nation to meet its national security requirements and sustain its position of world leadership.

During World War II it was hailed proudly as "The Arsenal of Democracy."

Today its detractors attack the system as a "Military/Industrial Complex."

But the system is infinitely more than a simple two-element complex. It reaches into and seeks cooperation from nearly every important sector of our society. Its performance represents a unique advance in human effort.

Ironically, the system's successes have contributed to increased criticism of its performance. Heightened demands have produced unprecedented strains. Highly sophisticated technology and the requirement for ever more advanced weapon systems have multiplied the problem areas and taxed the capabilities of the co-operating institutions.

Nowhere has this been more apparent than in the area of Government procurement. In its conscientious and competitive attempts to respond to the requirements of the Department of Defense and other Agencies of the Government, industry often has found itself embarrassed as to cost estimates, schedule forecasts and capability to deliver complex and previously non-existent weapon systems.

BACKGROUND

Technology and science can reduce to tolerant limits the trial and error involved in the process of invention, but they cannot eliminate it.

Both the Department of Defense and the aerospace industry have been acutely aware of the problems involved in the procurement process and have worked intensively to improve the system by identifying its inherent problems and developing acceptable solutions.

From the first "identification of need" throughout the succeeding development steps industry and Government organizations interact in a complex pattern to accomplish the mission of building and deploying a weapon system.

For a number of years there has been widespread concern among members of the Aerospace Industries Association that Department of Defense procurement policies did not adequately take into consideration the inherent technical uncertainties in the development of advanced major weapon systems of high technical content.

Technical uncertainty can be defined briefly as the total number of technical problems which must be solved if a new weapon system, such as an airplane or missile, is to be completed. Eliminating technical uncertainty is an evolutionary process that converts unknown factors to known factors over a period of time through the application of the scientific and engineering

For the Common Defense

A report on a major industry effort to resolve weapon system acquisition problems – for the benefit of Government, industry and the taxpayer

manpower assigned to the program. Eliminating technical uncertainty is essential to success in meeting cost and schedule requirements in programs calling for complex weapon systems that involve the ultimate in the technical know-how of a given period.

Necessarily, technical uncertainty is a major factor in determining the bid a contractor submits as his best estimate of the cost of building a weapon system. Certain unknowns, or "unks" as they have been called, can be anticipated, and the cost of resolving them accounted for by conservative scheduling, allocation of manpower and skill reserves, and other measures. Others, classified as "unknown unknowns" or "unk-unks," cannot be anticipated, and therefore cannot be taken into account in preparing a bid on the system. Examples of this second category are environmental factors, stress factors and the discovery of new and more effective technology.

Industry has found that Department of Defense contractual policies and regulations do not adequately allow for the effect of this technical uncertainty on the successful completion of a contract. Cost growth, performance deficiencies, schedule delays and major capital difficulties often have been the result.

Thus, against this background, early in 1968 the Aerospace Industries Association undertook a detailed study of the "Essential Technical Steps and Related Uncertainties in Department of Defense Weapon Systems Procurement."

The Project Group assembled to study this problem was composed of senior technical, administrative, financial and legal managers from AIA member companies. The Project Group's research and study thus far has covered four phases of the DoD acquisition process. Each phase has resulted in a report.

To date each of the four phases of the study has resulted in a report that presented recommendations designed to improve the Department of Defense weapon systems acquisition process. Phases I and II of the study were completed in 1968 and Phase III was completed in 1969. Phase IV was completed in December 1970. Reference to these dates is important because of the many changes in the development and procurement policies and practices that have taken place during these three years. This has meant that each new phase of the study has had a changing baseline to consider. Therefore, any information concerning each phase should be read with reference to the time frame in which it was developed.

What follows is a summary of the findings of the four study phases that analyzed the problems facing both Government and industry and made recommendations designed to increase efficiency, economy and performance. The Aerospace Industries Association is publishing these findings in order to encourage general awareness of the problems involved and the efforts being made to solve them.

PHASES I AND II

Phase I analyzed the essential technical steps and related uncertainties in weapon systems development and established a fundamental model of the existing development and acquisition process. Phase II then had as its primary objective the development of recommendations for improving the Department of Defense development process and contractual patterns. The resulting recommendations, based on an analysis of actual policy and practice in comparison with the fundamental model established during Phase I, included:

(1) *DoD should revise policy to recognize technical uncertainties;* (2) *DoD should establish a standing board for review of contracting methods*; *and* (3) *The Office of the Secretary of Defense (OSD) should establish a working interface with industry.*

Deputy Secretary of Defense Packard's May 28, 1970, departmental memorandum providing policy guidance on major weapon systems acquisition embodies the spirit of the first of these recommendations, and cancellation of DoD Directive 3200.9 (Initiation of Engineering & Operational Systems Development) during the fall of 1970, unless it is replaced by a more severe document, represents progress. Establishment of the Defense Systems Acquisition Review Council (DSARC) meets the need expressed in the second proposal. These positive actions indicate an easing of the communication problem reflected in the third recommendation.

PHASE III

Phase III determined what information is necessary and reliably available for decision-making within the weapon system development and procurement process. It recommended that:

(1) *Guidelines should be issued for DoD Directive 3200.9 (now cancelled, as noted above) to provide greater program flexibility;* (2) *DoD Directive 4105.62 (Proposal Evaluation of Source Selection) should be supplemented so as to obtain industry suggestions on Requests for Proposals (RFP's), including statements of work desired;* (3) *More use of prototypes should be considered early in development;* (4) *Policy should require thorough and objective DoD/industry application of risk assessment; and* (5) *Procurement practices should be changed to benefit the competitive environment.*

As with Phase II, there were indications following Phase III that progress was being made. Implementation of the May 28 memorandum, implementation of the Validation Phase with its attendant flexibility, and the cancellation of DoD Directive 3200.9 should help. There appears to be an awareness in DoD of problems created by Requests for Proposals. The Advanced Manned Strategic Aircraft (B-1), Airborne Warning and Control System (AWACS), Advanced Air Force Attack Aircraft (AX) and other programs point to greater use of prototypes to reduce uncertainties in early development and there is now additional awareness of technical uncertainty and risk. The fifth recommendation, on the competitive environment, concerns a recognized problem area and is dealt with in Phase IV.

Radar is housed atop long-range jet aircraft in artist's concept from The Boeing Co., prime contractor for the USAF's Airborne Warning and Control System (AWACS), which will conduct surveillance and command-and-control of tactical and air defense forces.

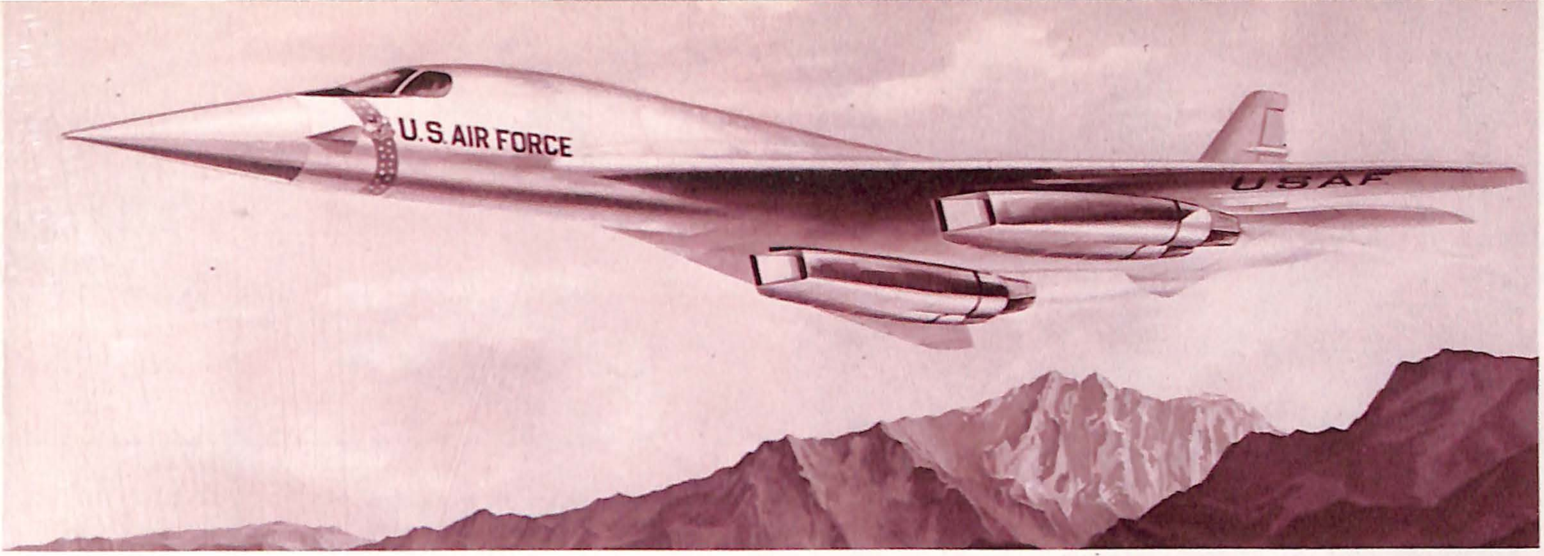
PHASE IV

Phase IV addressed source selection and it centered on the basic concern that many of the technical, cost and schedule problems which arise in major Department of Defense development programs with high technical content are created prior to and at the time that a source is selected to go into full scale development. This phase of the study resulted in recommendations for changes in the present acquistion process that would improve credibility and equity and would result in providing a method of proposal evaluation and source selection aimed at accounting for the effect of technical uncertainty on proposed schedules and cost for programs of high technical content. "Probable development cost" estimates would be used for government funding, budgeting and evaluation purposes. (Cost as used in this report is cost to the Government, and includes a fee or profit.)

Phase IV recommendations are as follows:

INDEPENDENT PROGRAM ESTIMATES

The government (Congress, OSD, and Military Departments) and competing companies should give additional recognition to and make greater use of independent program cost estimates. This includes various estimates throughout the early part of the life cycle, such as first program estimates that are developed from tradeoffs and estimates for Technical Development Plans or their equivalent, Development Concept Papers (DCP's), Five-Year Defense Plans (FYDP's), funding, budgeting, proposals, proposal evaluation and source selection, and negotiation. More specifically, *a capability must be developed utilizing parametric and comparative analysis techniques* to prepare more realistic program estimates early in the conceptual phase of the program. Furthermore, *this capability must be organizationally located within the government and competing companies where it can be objective in developing cost estimates.* For added value, independent estimates should continue throughout the balance of the life cycle of the weapon



Artist's conception of B-1 advanced manned aircraft under development by North American Rockwell Corp. to replace USAF's existing strategic bomber fleet.

system. Finally, planning and development estimates should provide for changes in operational requirements, economic changes, and modifications to production schedules.

EVALUATION AND SELECTION CRITERIA

DoD Directive 4105.62 (Proposal Evaluation and Source election) and related Military Department documents should be revised to make a clear distinction between proposal evaluation criteria and source selection criteria and identify who has the responsibility for each function. These same documents should clearly require publication of the proposal evaluation criteria with relative weightings and source selection criteria with relative weightings in the Request for Proposal (RFP).

ASSESSMENT OF TECHNICAL UNCERTAINTY

DoD Directive 4105.62 and the replacement for 3200.9 (Initiation of Engineering and Operational Systems Development) and related Military Department documents should be revised to require that Source Selection Plans provide for the "assessment of technical uncertainty" as a discrete and weighted element of evaluation. The proposal evaluation criteria and source selection criteria should clearly reflect this element. Further, the RFP for the Validation Phase should be structured to motivate both industry and the Military Departments to provide a full and frank discussion of known unknown "technical uncertainties" as the program evolves and moves into Full Scale Development. It should be recognized that known unknowns still represent a smaller portion of the uncertainties and that the unknown unknowns, which cannot be discussed because they are truly unknown, are still a major uncertainty item.

MOST PROBABLE COST VERSUS BID COST

An independent cost estimate should be made for each proposal to determine each proposal's most probable cost. Then, as a basis to evaluate costs, a comparison of the most probable costs of successfully performing on a program, as well as a comparison with bid costs, should be used by the Source Selection Evaluation Board, Advisory Council and Authority. Any contractor whose proposal contains an unrealistically low bid cost in relationship to the most probable cost may be requested to provide clarification or justification, but not revision. *The evaluation of each cost proposal would be downgraded to the degree the bid cost is determined to be unrealistically low which may result in elimination from competition.* ASPR, DoD Directive 4105.62, and related Military Department documents should be revised to require evaluation of costs in this manner.

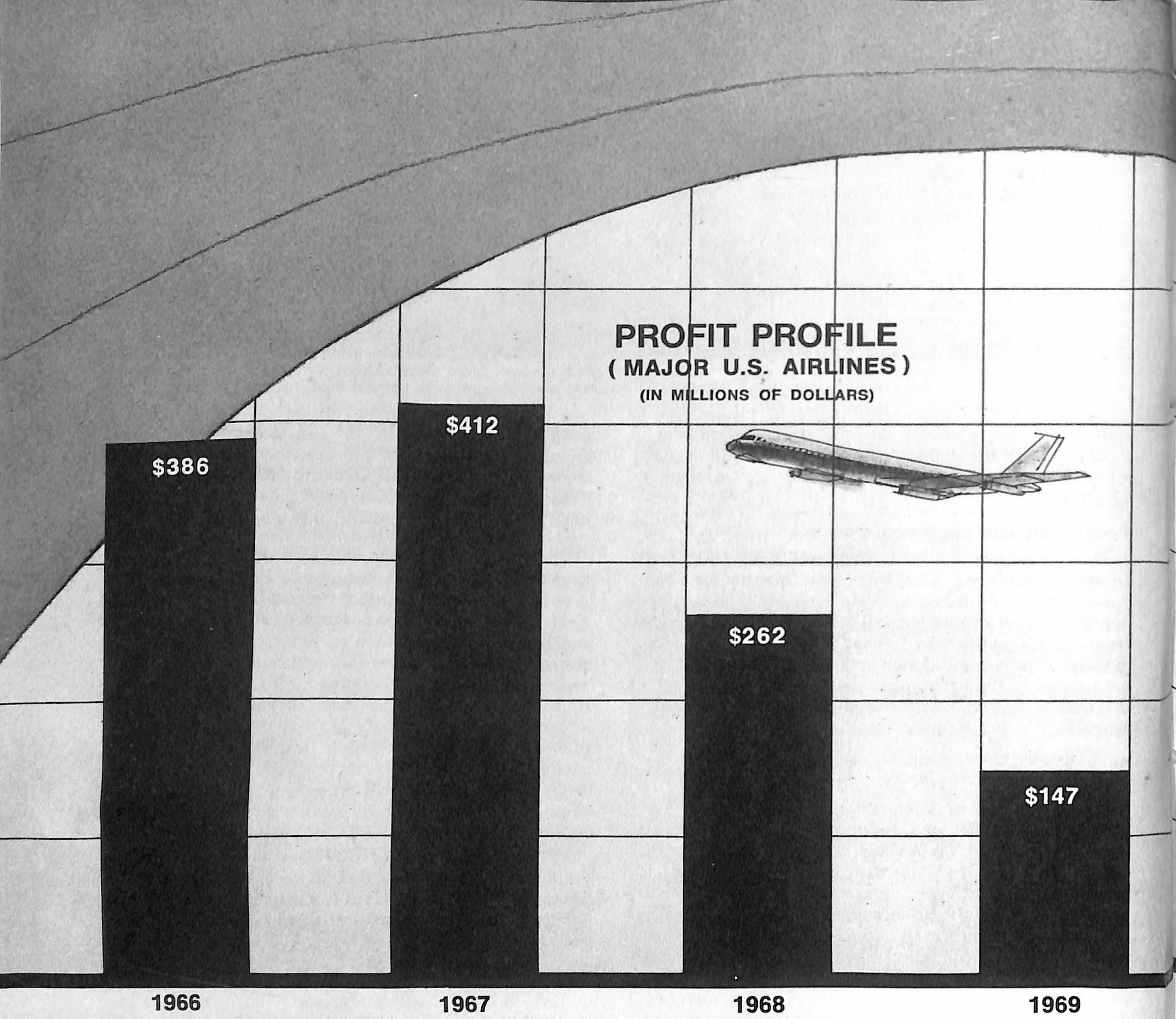
TECHNICAL TRANSFUSION AND LEVELING

DoD policies and practices should be revised to eliminate technical leveling and technical transfusion prior to final contractor selection. Further, DoD policies and practices should also be revised to assure that source selection and notification take place as a specific event prior to commencing contract negotiation. After one final contractor has been selected and notified of his selection, technical transfusion can then properly take place during final negotiation. Implementation of this recommendation limits the requirement for oral and written discussion to clarification and substantiation and prohibits upgrading the proposal. More specifically, this policy should be clearly stated in DoD Directives 4105.62 and the replacement for 3200.9, and related Military Department documents. Procurement and project managers should also be trained to eliminate the practice of inappropriate and premature technical transfusion, and merging selection and negotiation.

CONCLUSION

The recommendations detailed above represent industry's position on improving the methods this nation employs to acquire the weapon systems needed for defense. It is important to note that industry is proud of its record of working with the Department of Defense to meet America's military commitments. Accordingly, it views the improvement of the methods integral to that relationship as a mutual task rather than adversary issue.

In fact, much has been done in recent years toward dealing with technical uncertainty in defense contracting. The establishment of the Defense Systems Acquisition Review Council (DSARC) and the Commission on Government Procurement, increased use of prototypes, and the discontinuation of total-package procurement contracts on programs involving a high degree of technical uncertainty all represent forward steps in improving the process. Much still remains to be done, however, if public confidence in the defense industry and the Government is to be sustained.



The outlook for the air transport industry is bleak.

Stuart G. Tipton, president of the Air Transport Association, recently estimated that the major U. S. air carriers will show losses of $123 million in 1970, $192 million in 1971 and $279 million in 1972, despite significant cost reduction steps. These estimates are made on the basis of the current fare charges.

The deterioration of airline earnings can only lead to a sharp reduction in one of the nation's prime business growth assets — air transportation.

Earnings of major air carriers in recent years show a profit of $386 million in 1966, a rise to $412 million in 1967, a drop to $262 million in 1968 and a further drop to $147 million in 1969.

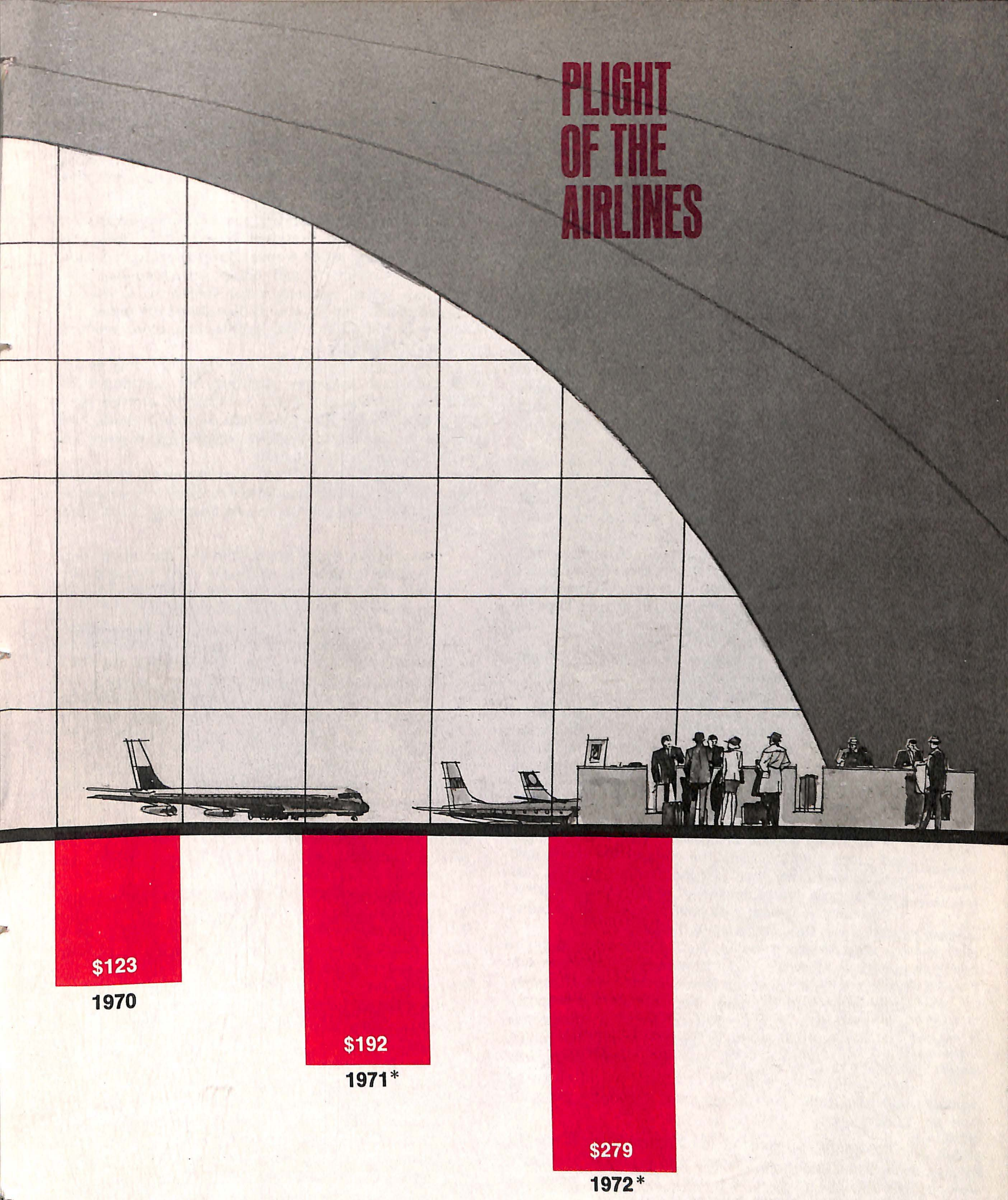
ATA states that this drop from peak profits to a near loss within three years can be attributed to four major factors:

- The productivity benefit of replacing propeller aircraft with jet aircraft was essentially completed in 1967.
- Since 1967, the rapid rise in inflation in the national economy struck the airlines particularly hard and in 1969 inflation in the airline industry was almost double the U.S. rate.
- The depressed national economic performance has completely eliminated domestic traffic growth in the airline industry in the face of rising capacity.
- The pricing system in the airline industry has lagged well behind the impact of productivity runout and heavy inflation.

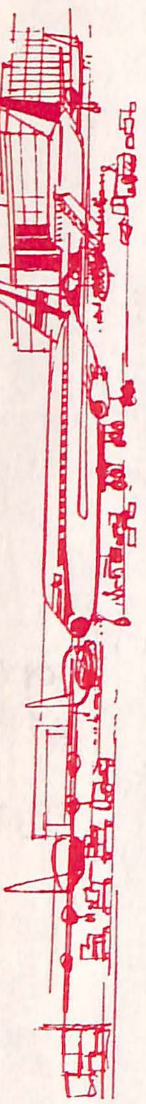
Recently, representatives of the air carriers and the transport aircraft manufacturers met with the officials of the Department of Transportation to present their

(continued on page 12)

PLIGHT OF THE AIRLINES



* Estimates for losses in 1971 and 1972 are based on the current fare structure.



(continued from page 10)

views on the future of air transportation and to make recommendations to improve prospects.

Recommendations by the manufacturers included:

- Continue to stimulate the economy in general so that airline revenues will in turn be stimulated.
- Speed up government processes on rate review cases and grant fare increases, on an interim basis, to the point that profitability (up to the recently established 11 percent ceiling) can be realized. This will help restore a reasonable value to the price of airlines' stock on the open market, enhance their ability to borrow money for purchases of new aircraft, and make it possible for them to attract new equity investment from the public.
- Increase subsidy to the local service carriers and others, as necessary to maintain profitable service to those localities which the Congress feels should have air service even though they cannot commercially support it. Alternately, airlines should be allowed to suspend service to unprofitable points.
- Resolve airline requests for reductions in the number of competitive flights and permit airlines to work together and negotiate capacity problems on marginal routes so that load factors may be improved when airlines are mutually in agreement. The government should move away from the present interim (6 months) approach to these changes and support them over a period of at least 12 months or longer. The short cycle prevents airlines from making longer term changes in capacity and merely provides savings in crew and fuel costs through temporary reductions in hours flown.
- Impose strong jawboning to restrain the rapidly rising labor and other operating costs.
- Reinstate the investment tax credit or permit more rapid depreciation of business machinery and equipment, including aircraft. In the short term, the airlines would be unable to utilize such credits or write-offs due to lack of profits. However, lessors (regardless of the term of the lease) could utilize the benefits and large amounts of equity capital would become available for the purpose of aircraft financing.
- Speed up government processes on airline mergers and adopt a policy permitting mergers for sound business reasons other than just the "failing business doctrine." Merged companies should be permitted to exercise independent judgment with respect to personnel reductions to gain the economies of the merger.
- Sustain strong support for the national program on airport and airways modernization including more substantial federal funds for matching with local communities rather than less funds. For example, the proposed use of the user taxes for Federal Aviation Administration operating expenses is to the detriment of the capital investment program. This assistance helps defray the tremendous costs of airport facilities brought about by both the traffic growth and most especially the wide bodied jets.
- Support and assist in the modernization of the air instrument approach systems and collision avoidance systems that would have a direct benefit on increasing utilization and on-time departures and arrivals.
- Increase federal budgets needed to improve and expand air traffic control activity.
- Work to prevent passage of higher tariffs in pending foreign trade bill which could adversely affect American manufacturers selling aircraft abroad.

The transport manufacturers at the same time offered recommendations that would be helpful to the aerospace industry. These include:

- Reinstate the investment tax credit or adopt the recommendations of President Nixon's task force on business taxation, which would allow faster depreciation of business machinery and equipment, including aircraft. This would not only assist customers in buying new equipment, but it would also materially assist the industry in purchasing and maintaining more modern production facilities.
- Protect and enhance the exporting capability of the U.S. aerospace industry, including the avoidance of tariff barriers. Successful past commercial aircraft programs have been highly dependent on foreign sales, and success in the future requires continuing capture of the foreign commercial market.
- The Export-Import Bank is doing an excellent job with relatively limited resources but should be strengthened and provided with increased financing capabilities as follows:

  Remove the ExIm Bank from the unified budget, liberalize its lending authority, and increase the funds available, permitting substantial tax and gold flow benefits from enhanced foreign sales.

  Allow the ExIm Bank to make the commitment value of the loan to the foreign airline available to the U.S. manufacturer to help finance airplane manufacture at the same interest rate as given the airline. At time of airplane delivery, the ExIm loan to the U.S. manufacturer would cease, and the loan of the same amount to the foreign airline would go into effect.
- Strong jawboning by the Administration should be made to discourage excessive wage increases which are inflationary in nature.
- Revise the present government procedures in the rental of government owned facilities; remove the 25 percent limitation on commercial use and reduce the commercial rental rates.
- Strongly support the efforts of the Aviation Advisory Commission recently appointed by the President. This commission will be in a position to recommend a future policy approach to the full spectrum of current commercial aviation issues and could significantly influence the future as the Morrow and Finletter advisory boards influenced national policy with respect to military and commercial aviation in the 1920's and 1940's, respectively.
- Provide a national research and development base sufficient to insure the continuing competitive position of U.S. aerospace technology, including the following:

  Continue the Civil Aircraft Research & Development (CARD) policy study, and implement the recommendation; finance the development of quiet engines; and finance new aircraft demonstrator programs through industry contracts.

The Leadership Forum

Aviation Week & Space Technology in recent issues opened its pages to leaders in the aerospace, air transport, business and labor fields to express their views on the aerospace industry's role and contributions to our national economic and social strength. These views eloquently describe the aerospace industry as an innovative national resource with great potential for the future. *Aerospace Magazine* is pleased to carry a selection of these views.

Russell D. O'Neal
President
Aerospace-Electronics
The Bendix Corporation

The aerospace industry, as the prime producer and user of American science and technology and the developer of major system management techniques has contributed mightily to the national power of the United States.

However, the momentum of the aerospace industry is slowing down as the necessary investment to keep it progressing is being substantially reduced. The point has been reached where it is necessary to consider the implications of this slowdown to the national power of the United States.

The national power of a nation usually refers to its ability to deal with other nations. Classically, national power consists of economic power, military power, political power and the power over world opinion.

Particularly since the advent of the atomic age, a country's economy and military forces have depended to an unprecedented degree on science and technology for the maintenance of national power. Even the political power of a nation to some degree has been determined by the opinion of citizens around the world about the progress the nation is making in science and technology. Space achievements during the 1960s are a good example. National prestige has been lost and achieved on the basis of achievements in space activities.

Therefore, it seems to me an appropriate investment by our nation in a vigorous scientific and technological base is absolutely essential not only to our national power but to our national survival. Let us take a lesson from history and not follow the pattern of many previous great powers who allowed their national power to deteriorate.

W. P. Gwinn
Chairman
United Aircraft Corporation

Ever since its beginning, the aerospace industry has steadily expanded the boundaries of our nation's technology — even beyond our own planet — and has become the most dynamic and vibrant industry in the United States.

Historically, technology has preceded the social and material changes that have improved America's standard of living. What we take for granted today — rapid communications, jet travel, television, central heating, frozen foods, even indoor plumbing — came only after technological progress made them possible.

The winds of change are blowing ever harder. The strength of our free enterprise system is social justice, and the success of our nation's social improvement programs rests ultimately on the ability of our free enterprise system to generate the funds needed in the social fields.

Growth has always been the hallmark of the aerospace industry, so even as we deal with pressing social challenges, we must seek to broaden our technical horizons. The primary goal of any industry is survival in order to serve; and this is the motivating force that spurs us on to provide jobs, accomplish technical objectives, and make profits so that our entire society can move on to new and proud achievements.

The Leadership Forum

L. J. Evans
President
Grumman Corporation

The ascendance of nations to greatness has not come without strong will and high purpose. Nor have great nations remained great without constant nurturing of the resources and energies which made them great. The annals of history are replete with chapter and verse which should provide clear heed lest we choose to relinquish our position of greatness and wallow in the wake of those who chose to subjugate national perspective and will to popular expedient. The aerospace industry is a vital national resource. It has been the thrust of our national momentum; the energizer of our national economy, albeit there are those who choose now to ignore history and challenge its dedication and purpose. It must not be shelved for it will surely stagnate and deplete as it is a resource which tends to feed upon itself. As our nation faces each critical juncture, it must concurrently make decisions which will unalterably chart its heritage. To those who must make these decisions, pay close heed to history for to ignore history by attacking and dividing our technological base can only lead to emasculation of our heritage, and to national obsolescence.

Forbes Mann
President
LTV Aerospace Corporation

Aerospace technology has been an inherent part of America's defense for over fifty years. The results of this vigorous and demanding technology are many and varied. Primary, of course, is the guarantee provided by our armed forces that America and the rest of the free world have the time and opportunity to seek solutions basd on individual human dignity. That guarantee comes from strength — not weakness.

This same technology will be in the forefront, too, in solving the economic and environmental domestic problems that concern us all today. These problems can and must be solved — and they will be — if this technology is skillfully utilized and properly supported.

As in all dynamic situations, the decision process is perpetual. We can advance, stagnate, or retreat. Retreat is possible, but to most, unthinkable; stagnation is impractical. Advancement is inevitable. The direction and speed of this advance are determined by the strength of our research and development. If we fail to recognize this now — and act on it — all of our efforts later may be futile.

John B. Lawson
Executive Vice President
Aerospace and
Defense Systems Operations
Philco-Ford Corporation
A subsidiary of Ford Motor Company

Our nation must maintain a capable defensive position in the world's military climate of today. Ford Motor Company traditionally has responded to the military needs of the nation in times of crisis since World War I. We as a company continue to maintain what we consider a justifiable pride in our work in providing the technological knowledge and products which are necessary to help insure the freedom of this nation and other countries in the Free World.

There are continuing threats both to our allies and to the continental United States which we must recognize. A number of advanced systems and products must be developed and produced for our nation during the 1970's to insure U.S. strategic offensive and defensive force requirements. A U.S. "balance of weapons" is critical in today's troubled world.

During the 1970's the Department of Defense and other U.S. Government agencies will impose an increasing stress on cost reduction on weapons and other programs. This places an increasing demand for cost consciousness on all contractors. Technological developments and advances must still be continued if we are to keep pace with the progress of other nations, but within the parameters of even more stringent economic considerations. But rather than consider this emphasis on cost consciousness and cost reduction a hindrance, we at Ford willingly accept it as a necessary business challenge in carrying out our obligations to the U.S. Government and the people of this nation.

J. W. Crosby
Chairman of the Executive Committee
Thiokol Chemical Corporation

Recently, there has been widespread criticism of space and defense spending. Proponents argue that such spending should be drastically curtailed, contending that these funds might better be used to solve our socio-economic problems.

No one questions the urgency or the need to improve the lot of the underprivileged, to wage war on crime, or to clean up our air and water. But to suggest that we must, or should, do so at the expense of a weakened aerospace industry is utter folly. The many problems of our society will not be solved by rhetoric. They can best be alleviated by prompt and concerted application of the abundant technologies that are, in large measure, products of the aerospace industry.

The legion of scientific, technical, and managerial talent within the aerospace industry enables it to respond with alacrity to national needs in pollution control, medical science, transportation, marine science, water desalinization, and training the hard core unemployed.

A viable aerospace industry is an absolute essential if our great nation is to remain free — free to choose its own destiny, and free to help create a better world for all of mankind.

T. A. Wilson
President
The Boeing Company

The aerospace industry has had some truly outstanding accomplishments in the period of my experience — successfully provisioning our nation in a major air war between the powers, equipping a world-wide jet transport system, building a strategic nuclear deterrent force and landing men on the moon. The importance of this type of capability to the nation does not fade with a period of slackening business and the current struggle over high developmental costs. It is a resource as basic to our present stage of national growth as earlier "Yankee ingenuity" was to a previous stage of our country's history.

New requirements call as strongly as ever for this capability. The growth of air transportation will continue with the expansion of populations and of the world economy. Automated reliability systems surpassing those needed to get to the moon will necessarily become an integral part of this higher density transportation system. The whole field of vertical and short take off from multiple points remains largely to be developed. The time-saving and economic gain of supersonic speeds across oceans can help to build a more cohesive world community.

In defense, the industry must offer the technical means to national security while we seek greater progress in international understanding. In space, the rewards of discovery and application of scientific knowledge have only begun to be felt and will undoubtedly multiply.

While the aerospace industry undergoes its current belt-tightening and honing down process, it is important that government and public alike recognize the contribution which this industry has made and must continue to make. The aersopace industry must come out of the present period with the strength to do justice to the challenges of the future. I am confident that it will do just this.

Mark Morton
Vice President and Group Executive
Aerospace Group
General Electric Company

Spearheaded by our aerospace programs, America's technology moved rapidly forward during the past decade. This advance has provided a solid foundation for abundant current and future benefits in medicine, communication, education, housing, environment, international peace — all of which will richly contribute to the improvement of the total quality of man's life.

Technology, however, cannot be turned on or off, like a faucet, depending on world crises or domestic problems. Real solutions to the latter, in fact, can best be achieved through strong technological advances. And aerospace, as before, can be the spearhead.

Currently the nation is dangerously reducing its research and development efforts. To ignore this critical priority is to repeat the historical decay of other countries in other centuries. If we are to maintain a healthy economy, keep our world trade position, solve our social ills, and build a better life, we must exhibit the vision and the courage to maintain a vigorous national commitment to the continuous and aggressive advancement of science and technology.

James B. Taylor
Vice-President
Cessna Aircraft Company

Imagine industry without airplanes.

Imagine management without communications, production lines without transportation. Imagine the nuclear age geared to steam engines or waterways.

The dominant position of American air transportation now results from decades of painstaking research and development in private industry, universities and government laboratories.

Business aircraft — those essential tools of modern management — have grown from this strong base. Aerospace technology, employed in the development of efficient, safe business aircraft, has added new mobility to management.

As an expanding economy looks to new industrial sites, the business aircraft becomes even more essential. The smaller town, long neglected by other forms of transportation, can offer the advantages of a metropolis to businesses using their own aircraft.

And as effective and safe as today's business aircraft are, they can become even more efficient. Using tomorrow's technology, business aircraft will be able to takeoff and land in even shorter distances, cruise faster, carry more payload. They'll be quieter and cleaner. But without new technology . . .

Imagine industry without airplanes.

F. D. Hall
Chairman and Chief Executive Officer
Eastern Air Lines

In this time when there are so many grave questions concerning the order of national priorities, the maintenance of a strong and vigorous aerospace capacity merits a position near the top of the list.

It is not necessary to stress the importance to our national defense of the research, development, and production programs undertaken for NASA and for the Armed Forces. In the international arena, leadership in space programs influences our role as a leader of the Free World. Sputnik brought this fact home to us, just as Apollo did for our ideological adversaries.

But equally important, though perhaps not so obvious, are the wide range of peripheral benefits which the nation derives from a healthy aerospace program. The aerospace industry directly employs more than a million people and indirectly supports hundreds of thousands more. Its benefits are long-term as well as short-term. Today's jet aircraft, which offer the traveling public the highest degree of comfort and convenience in history, owe much to military and civilian aerospace efforts of the past. The life support systems developed for astronauts are already paving the way for medical advances that will benefit all mankind. And I am certain that out of the efforts of a continued, strong aerospace program will come the technology that will help improve our daily lives in ways we have not yet conceived of, and perhaps on worlds we have not yet dreamt of.

The Leadership Forum

George Meany
President
American Federation of Labor and
Congress of Industrial Organizations

The world pre-eminence of American aviation should be a cause of great satisfaction to all Americans. Here is success that can be traced directly to the ingenuity of American management and the skills of American workers, the two working together under the American system of free collective bargaining.

The American aerospace industry has created great national wealth for the United States and at the same time provided jobs for hundreds of thousands of Americans. The industry's technological advances have had useful applications in many other industries.

The aerospace industry has provided American military forces with the air superiority needed to protect freedom. Yet, it also enables the peoples of the world to become better acquainted and carry on more business with one another, essential ingredients for eventual world peace.

In our opinion, a strong, economically healthy aerospace industry, manned by skilled, capable workers, is essential to a strong, healthy America.

Najeeb E. Halaby
President and Chairman of the Board
Pan American World Airways, Inc.

Airlines have been among the most conspicuous beneficiaries of aerospace research. The airlines have inherited the inertial navigation system, satellite communications, weather satellites, and digital communications, among other things, from the space program. But the airlines have been only one industry to benefit. Systems management procedures devised for the space program have helped cope with urban problems; medical research has improved health on a wide scale.

These are specific applications of space research that have advanced particular fields. But in a larger sense, advanced research is even more vital. This world of multiplying population, commensurate consumption, vanishing resources, and stockpiling pollution demands more desperately each day the best that our minds and our talents can produce to sustain life on the planet. We cannot feed, house, and clothe the multiplying population and satisfy its aspirations by cutting back on our production. The only way to cope is by assigning a rightful high priority to the research that is our only hope of survival.

This, after all, is the function of technology: to sustain man. This function was never more needed.

Irving K. Kessler
Executive Vice President
Government and Commercial Systems
RCA Corporation

Aerospace is the one U.S. industry that deals directly with 20th Century man's greatest frontiers — air and the vastness of space above it. In two important respects, these are not unlike the frontiers we've known in our past. They present openings for potential aggressors, and therefore must be defended. They hold forth the promise of vast new opportunities for all of mankind, and therefore must be explored.

No nation can afford to ignore such challenges to both its survival and its progress. Nor is there anything incompatible in providing for a viable aerospace industry, and in attacking such serious national problems as poverty, urban blight, deficiencies in mass transport, and pollution of air and water. On the contrary, it is unlikely that we will ever really solve these problems if we lack the economic muscle and technological leadership a healthy aerospace industry confers upon us. For it is the most sophisticated of all U.S. industries, a proving ground for many of our most promising scientific concepts, the high water mark of our technology.

To defend ourselves against aggression, to help solve many of our pressing domestic problems, to venture forth into new worlds — these are urgent and primary reasons why a vigorously growing aerospace industry is in the best interests of our nation and of mankind.

Paul Thayer
President and Chairman of the Board
Ling-Temco-Vought Inc.

America — and the world — is now urgently addressing itself to solutions of man's ecological problems — current and future. These problems can only be solved by technology — new and applied. The aerospace industry has always been — through necessity — on the "cutting edge" of American technological progress. There is no doubt in my mind that it will continue to be. The honor of leading, however, carries with it at once, risk and responsibility — the risk of finding oneself in blind alleys and laboriously retracing one's steps to start again and again, and the responsibility of seeing to it that all are served. In my opinion, the industry's decisions on its research and development have led it into relatively few blind alleys. And America's place as a world leader in its standard of living and its position — undebatable — of being the anchor of the defense of the free world give testimony to its service. The thrust and vitality of the aerospace industry in the next twenty-five years, its ability to take the risks and live with the results, and its continuing struggle with the complex problems of modern society may very well determine whether man survives on this planet.

H. J. Haynes
President
Standard Oil Company of California

In weighing our national priorities for the 1970's, we should keep in mind that the achievements of the aerospace industry have made a significant contribution to our economic life and to the strength of our country.

Government, corporations and our entire citizenry have benefited from the computer technologies, management innovations, communication improvements, and earth satellite data derived from aerospace research.

The petroleum industry and its customers have shared in many ways in these benefits. To cite just a few — research on hydraulic fluids for supersonic military aircraft has led to improved fire-resistant fluids for commercial aircraft; earth satellites offer great promise in providing better geological data, and in statistical forecasting of sea and ice conditions for safer exploration, production and transport of petroleum; subsea exploration and producing systems, leading to improved development of vital offshore resources, are now being evolved in cooperation with aerospace engineers.

It is a rare enterprise in this country which cannot name more than one advance made possible by our pioneering conquests in space.

As an oilman I know it is folly to reduce exploration for crude oil if proved reserves are only adequate for immediate needs. It would be equally unwise for this nation to reduce aerospace activities so drastically as to lose our unsurpassed reserves of skilled manpower as well as threaten our leadership in space science and technology with all it can contribute to our economic well being in the years ahead.

C. H. Dolson
Chairman of the Board and
Chief Executive Officer
Delta Air Lines, Inc.

Three thousand years elapsed in the innovative process of man's first flight from the inventiveness of Daedalus on through the 18th Century theoreticians to the flight of the Wright Brothers. In this time frame, there was no order in the processing of knowledge, material, and techniques. We have closed this innovative process which interlocks research, development and application.

The stimulative impact of air transportation upon the transactions of business and government, personal travel, and interregional development will increase as technology advances. Airline service, integral in all economic sectors, is dependent upon a viable aerospace capability if we are to continue to reduce the relative cost and simultaneously improve the quality of products and services.

The future economic and social well-being and the security of our nation depend upon an efficient and well-balanced innovative process — a technological balance sheet which on the one hand maintains and identifies our assets of research, development, and industry application, and on the other, the cooperative effort and funding which permit the people of our great country to redeem their equity in the national investment.

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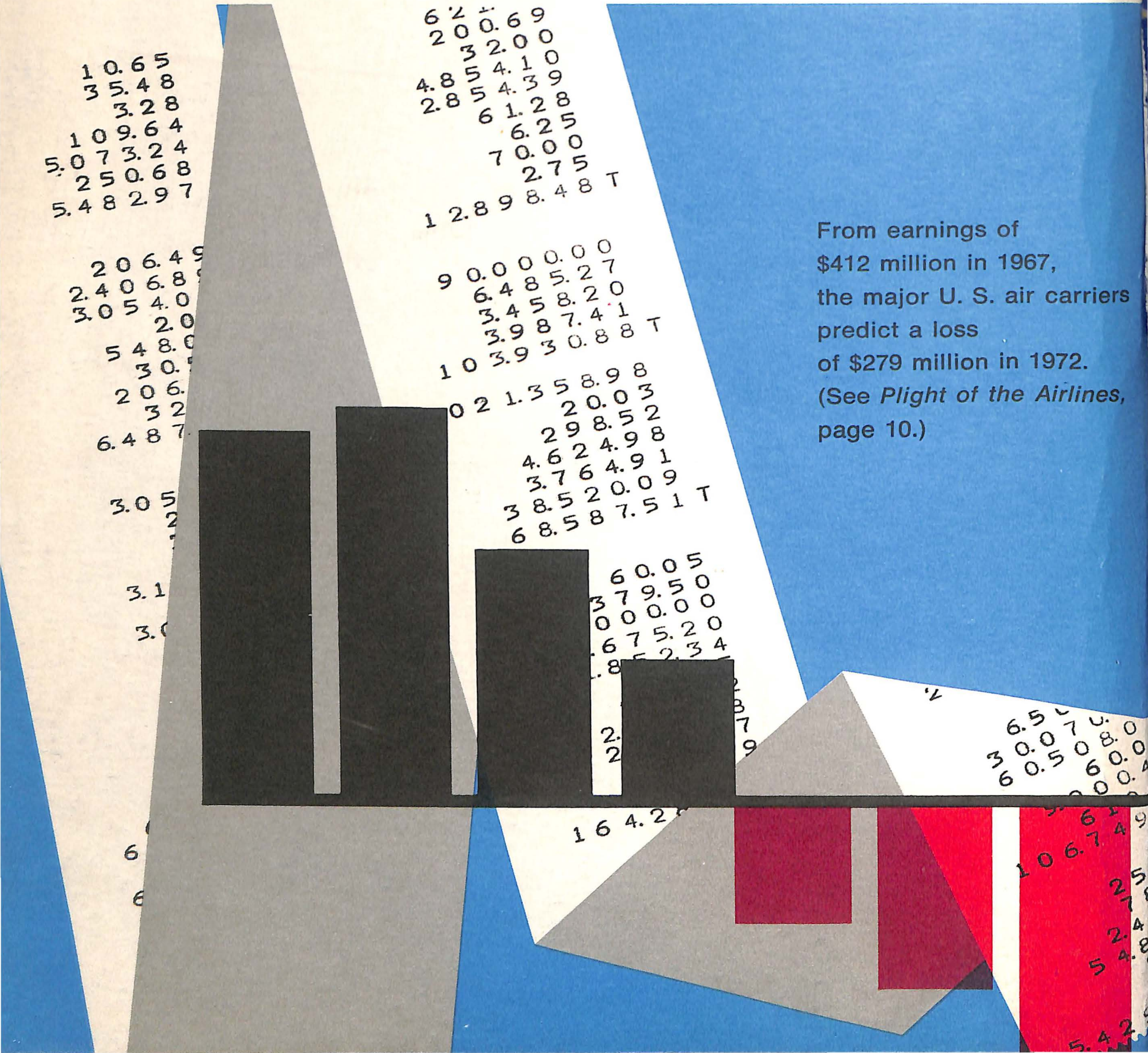


From earnings of
$412 million in 1967,
the major U. S. air carriers
predict a loss
of $279 million in 1972.
(See *Plight of the Airlines,*
page 10.)

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • SPRING 1971

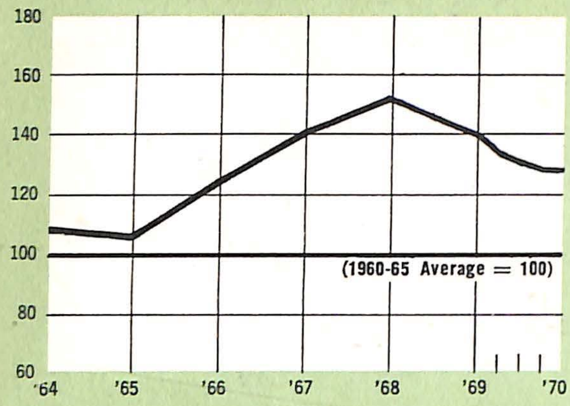
SOCIETY and AEROSPACE TECHNOLOGY

- Doubts About Technology: Are They Valid?
- Question: Can Aerospace Technology Serve Nonaerospace Needs?
- Fact: Transfer of Aerospace Technology Is Under Way

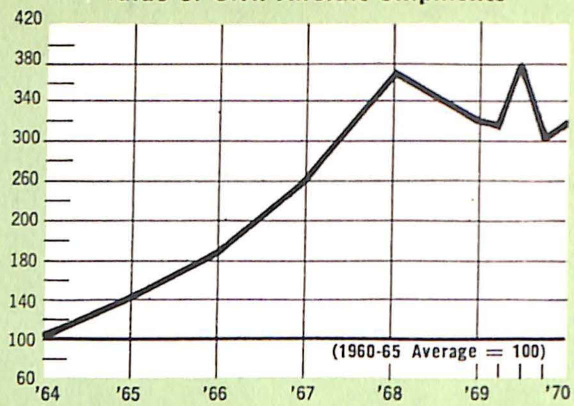
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

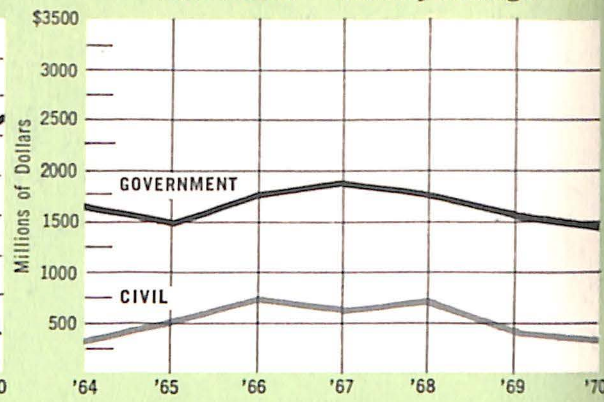


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1960-65 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Dec. 31 1970	26.9	25.1	24.8
	Billion $	Quarterly	4.8		6.6	6.0	6.5
DEPARTMENT OF DEFENSE							
Aerospace Obligations: Total	Mililon $	Monthly	1,151	12/70	1,440	1,315	1,570
Aircraft	Million $	Monthly	601	12/70	605	674	729
Missiles & Space	Million $	Monthly	550	12/70	835	641	841
Aerospace Outlays: Total	Million $	Monthly	1,067	12/70	1,307	1,136	1,345
Aircraft	Million $	Monthly	561	12/70	790	693	856
Missiles & Space	Million $	Monthly	506	12/70	517	443	489
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920✢	12/70	999	614	1,255
Aircraft	Million $	Monthly	447	12/70	526	392	533
Missiles & Space	Million $	Monthly	473	12/70	473	222	722
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	3/71	188	201	206
Expenditures	Million $	Monthly	130	3/71	273	236	263
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3#	Quarter Ending Dec. 31 1970	28.3	25.5	24.8
U.S. Government	Billion $	Quarterly	11.6		14.3	13.6	13.1
Nongovernment	Billion $	Quarterly	3.7		14.0	11.9	11.7
EXPORTS							
Total (Including military)	Million $	Monthly	110	1/71	302	277	292
New Commercial Transports	Million $	Monthly	24	1/71	139	91	79
PROFITS				Quarter Ending Dec. 31 1970			
Aerospace — Based on Sales	Percent	Quarterly	2.3		2.5	1.9	1.6
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		4.6	3.9	3.7
EMPLOYMENT: Total	Thousands	Monthly	1,132	1/71	1,282	1,069	1,052
Aircraft	Thousands	Monthly	469	1/71	562	465	456
Missiles & Space	Thousands	Monthly	496	1/71	548	438	430
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	1/71	4.08	4.30	4.29

R Revised.
E Estimate.
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
\# Averages for 1961-65.
✢ Averages for fiscal years 1960-65.

Source: Aerospace Industries Association

BY KARL G. HARR, JR.
President,
Aerospace Industries Association

A debate that has been sputtering for the past decade is today fast becoming a central issue with perhaps a decisive effect on the determination of national goals and priorities for the balance of the 20th Century.

The arena of debate is so large it is difficult to state the question both simply and adequately. In its broadest sense it revolves around the point of whether science and technology is a major force for national progress or a genie that has escaped and is becoming counter-productive to true progress and individual well-being.

On a deeper level, there exist strong concerns that the opponents of national technological advance are really attacking the pursuit of knowledge itself. Reluctance to push forward and experiment on the frontiers of knowledge, derived from loss of faith in our national ability to manage the implications of new discoveries, threatens the traditional cornerstone of our national well being and security — i.e., the fearless pursuit of knowledge.

This issue of *Aerospace Magazine* is an effort to place into greater perspective the true relationship between our society and technological advance. The aerospace industry is synonymous with advanced technology; in fact, it has been the principal well-spring of meaningful technological advances since the end of World War II. We hope the discussion of doubts, questions and facts concerning aerospace technology will be useful as the debate intensifies.

AIA

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The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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Doubts About Technology: Are They Valid?

Doubt has become the primary product of today's social revolution.

Few U.S. institutions have escaped being shaken by the scattershot bombardment of questions and doubt laid down by those who see themselves as the shock troops of the Age of Aquarius, or Age of the Youth Rebellion, or the Age of the Greening of America, or simply as mourners of the "good old days."

Education, the legal system, corporate business, and the family have been among the targets of one or more groups of champions of a quick overhaul of society.

One target, however, has borne the brunt of the attack. One target is constantly cast up to doubt, and represented as a fundamental dehumanizing danger to modern man.

Technology is that central target.

Technology, according to its critics, is the major peril because its side effects are inescapably adverse. The pace of technology change is called too fast for man to sort out the good from the bad, or for man's socio-political organizations to accommodate. And technology is said to be producing such an infinite variety of innovations that the burden of choice has become so great that individuals, corporations and governments inevitably will foul the quality of life.

The critics overlook such benefits as better nutrition, longer life expectancy, speedier travel and communications, and broadened opportunities in culture and recreation.

The solution, say the most obdurate opponents of technology, is to turn our backs and bring technical progress to a halt.

While it is unlikely that the majority of Americans would ever accept such unreasoning views, they already have had a deep influence on U.S. policy. Enough doubts have been raised in the past three years to bring on a substantial reduction in activity in science and technology.

In time, this inevitably will weaken development of new products and services for the civil market, which has become the main source of U.S. economic prosperity.

Acceptance of this fact, that technical innovation is the primary source of economic growth in a mature industrial society, is at last becoming widespread among economic theorists after decades of rejection. Some members of the Council of Economic Advisors for example, now attribute over half of the nation's annual real economic growth to new technology. The remainder comes from capital accumulation, education, more efficient use of labor and the other factors which traditionally have sparked growth in less-developed economies.

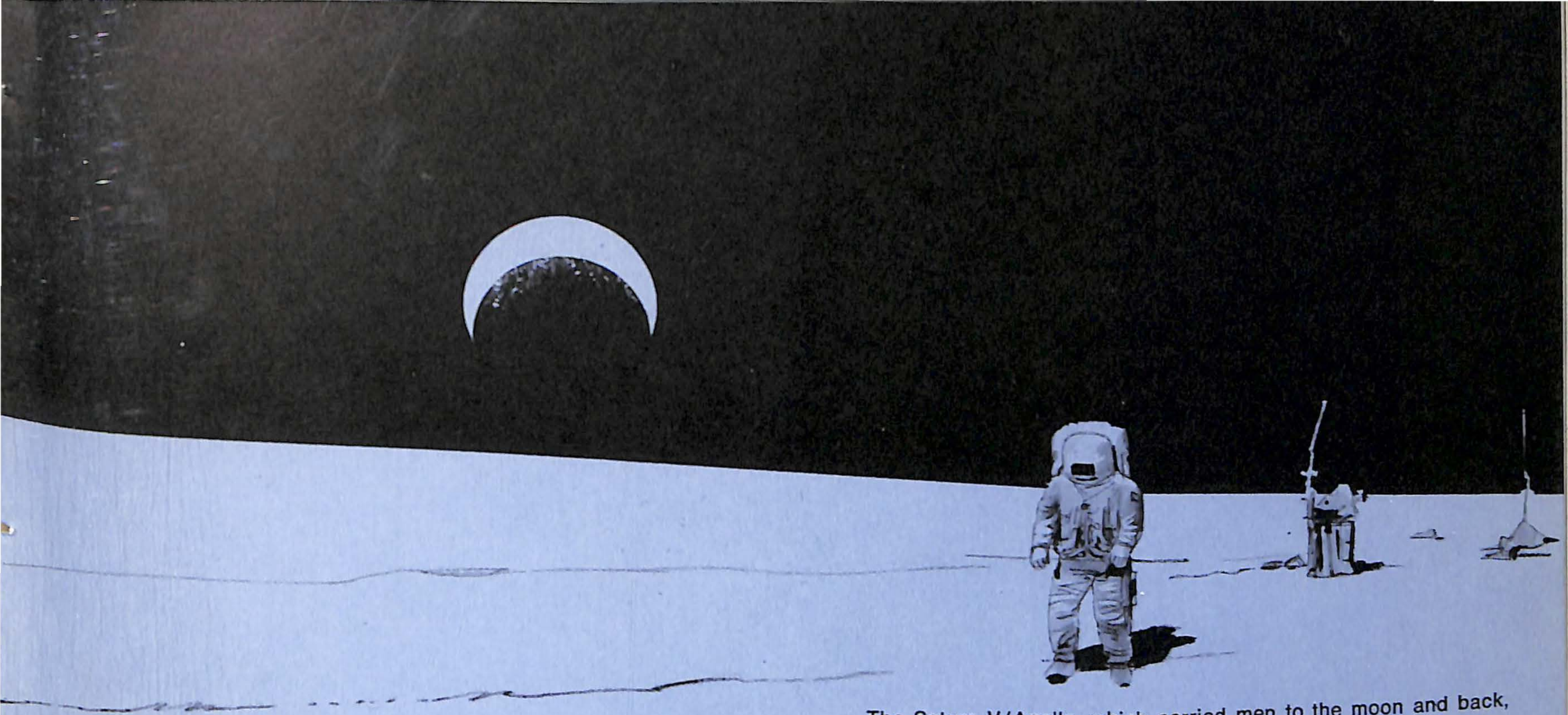
One final misconception about the chain of technological strength still remains. Somehow it has come to be expected that each link, each step in the chain, should produce a spill-over of hardware that is immediately useful in the next step. Some persons, for example, apparently won't accept the usefulness of space technology to commercial industry unless they see satellites being sold in supermarkets.

A significant amount of technology transfer does occur in the form of hardware, or slightly modified hardware, as documented in subsequent pages of *Aerospace Magazine*. But the most important spill-over, by far, is new techniques and new knowledge.

One doesn't have to work in industry to know that big changes have taken place in the past 20 years. Any company that tried to operate a 1950-style factory today would be hopelessly outclassed. Better products and more efficient factory operations are possible now because of new metal alloys, new high-strength plastics, more accurate methods of measurement, more automatic and more accurate methods of manufacture, greater knowledge of mechanical design, more rapid and more accurate techniques for quality control. The list is virtually endless.

Commercial industry did not start from scratch in the development of all of these new materials, techniques and machines. The vast majority of these improvements were built on the experience of aerospace contractors who first worked with these advanced ideas, usually under government-sponsored defense and space contracts.

The point of most concern, however, is that today's factory will be no



The Saturn V/Apollo, which carried men to the moon and back, is probably the most complex and reliable system ever built.

match for the 1990-style factory. More technical changes can be expected in the next 20 years than have occurred in the past 20.

Economic power at the end of the century will reside with the nation with the strongest technology, just as it does today. In the face of this certainty, it is not comforting to see the the U.S. weakening its science and technology, or to realize that major segments of the public and public officials still do not understand the fundamentals underlying our technological strength.

Present confusion is clearly illuminated by a recent study conducted by the Library of Congress at the behest of Congressional committees. The study asked the "salient question" for the United States today: "Are the processes and results of technological innovation generally a social good that should be continued into the indefinite future?"

The study's answer was that "further technological progress is indispensable," even if the objective is to achieve some sort of stability in which the pace of technical development is slowed or stopped.

The study also quotes from a National Academy of Sciences report on this general question which said the problem is not for society "to conceive ways to curb or restrain or otherwise 'fix' technology but rather to discover and repair the deficiencies in the process by which society puts the tools of science and technology to work."

It is something of a phenomenon that every American does not accept these views of technology's importance. This nation has only 6 per cent of the world's population and less than 15 per cent of its natural resources, yet we are the strongest commercial nation.

Our strength is technology. Technology is what makes us unique today. But leadership in technology is not inalienable. It is not guaranteed. It can only be earned through constant effort.

Consequently, the present disruption in science and technology must be regarded with deep concern.

Over the 1968-1971 period, basic research experienced a drop in support for the first time in 25 years, and in some vital sciences — physics, for example — reductions in federal support have ranged as high as 40 per cent. Advanced education in physics, the training associated with master's and PhD degrees, has been reduced in the same proportion. The American Physical Society says the situation has reached the "disaster" point.

Basic research's role in creating technological strength often is misunderstood because it isn't directed at any particular new machine or system, or at any specific need of mankind. Sometimes it has been derided as "what a scientists does when he doesn't know what he's doing," or simply as the collection of knowledge for knowledge's sake.

But basic research is the source of raw material, the new information from which engineers design improved equipment and advanced systems. It is certain that technical progress would cease if basic research ceased.

Second link in the technological chain, applied research and exploratory development, concerns the first attempts to put new knowledge to use in the building of better machines. It has been more seriously weakened than basic research. The aerospace industry's ability to maintain its lead in this type of work is in question.

During the slowdown in building of advanced defense and space systems, the industry has been forced to lay off more than 59,000 scientists and engineers. This is a reduction of about 26 per cent in the total force of 226,000 aerospace scientists and engineers employed three years ago. Such reduction in employment among highly skilled professionals is unprecedented in world history.

Misunderstandings about the nature of the applied research and exploratory development performed by the aerospace industry and its value to the military and economic health of the nation are even more prevalent than the misunderstandings about basic research.

The industry's contribution begins with the construction of experimental components and subsystems which

Modern manufacturing techniques, such as this profiler, were developed to meet aerospace requirements.

range from bearings, valves and measuring instruments, to sections of computers, hydraulic power units, sheet metal structures, guidance equipment, automatic manufacturing tools and jet engines. Under normal circumstances this sort of experimental construction and testing should go forward on a steady basis.

Then, on occasion, the experimental subsystems are put together to form a complete experimental system, most often an aircraft, missile or spacecraft.

Sometimes these new systems are successful and go on to the operational stage and are employed by the military forces or by the National Aeronautics and Space Administration in space flights.

But, even when aerospace systems become operational they are, in the strict sense, a part of applied research in the chain of U.S. technological strength. That is, the aerospace industry's operational systems feed information and experience to the rest of U.S. industry.

A prime example is the Saturn V/Apollo vehicle which carries astronaut crews to the moon. It is one of the largest and most complex electro-mechanical systems ever constructed. Still it is by far the most reliable large machine ever built by man.

A new order of design, manufacturing and management skill had to be developed to achieve the Saturn V/Apollo reliability. This new skill will be important in commercial activities for another decade at least.

Somehow this crucial point has been obscured by doubt. Some serious analysts contend there is little spill-over from military and space projects into commercial technology.

The error in this view is that it looks at complete systems, rather than the knowledge and technology from which the systems evolved. These critics usually point to the jet engine as one of the few examples of military technology having a commercial value. They then rate the rocket engine as having little or no value.

This ignores the fact that rocket engines are especially difficult technical problems because they must operate at unusually high temperature, they must pump corrosive fluids at very high rates, and they must have electro-mechanical control systems which can sequence a complex series of events with an error measured in microseconds. The knowledge gained in mastering these problems does have a commercial value, even if at the moment the rocket itself does not.

If one accepted the premise that civil and military technology are not closely related, one also would have to accept the idea that there are two separate worlds of engineering — one for weapons and one for commerce. This, of course, is nonsense.

The primary goals of all engineering, briefly, are:

- Lowering costs.
- Improving the efficiency of motors, generators and all types of energy conversion devices and processes, which includes improving the efficiency of all transportation systems.
- Improving design through use of new materials which reduce the weight and increase the strength of all machines. Designing the machine to operate under a wider variety of conditions is part of the goal.
- Improving the accuracies to which a machine can be controlled, and its capacity for work.
- Improving reliability.
- Improving communications between man and machines and between machines.

The relative importance of each goal varies depending upon the needs of the customer. In the past the military usually has had to be more interested in increasing the performance of machines than in the cost.

Today, cost is of more concern both to the military and to the government agencies working on the problems of the cities, such as waste treatment and mass ground transportation.

Such a rearrangement of priorities is not unusual. It is typical of the engineering business.

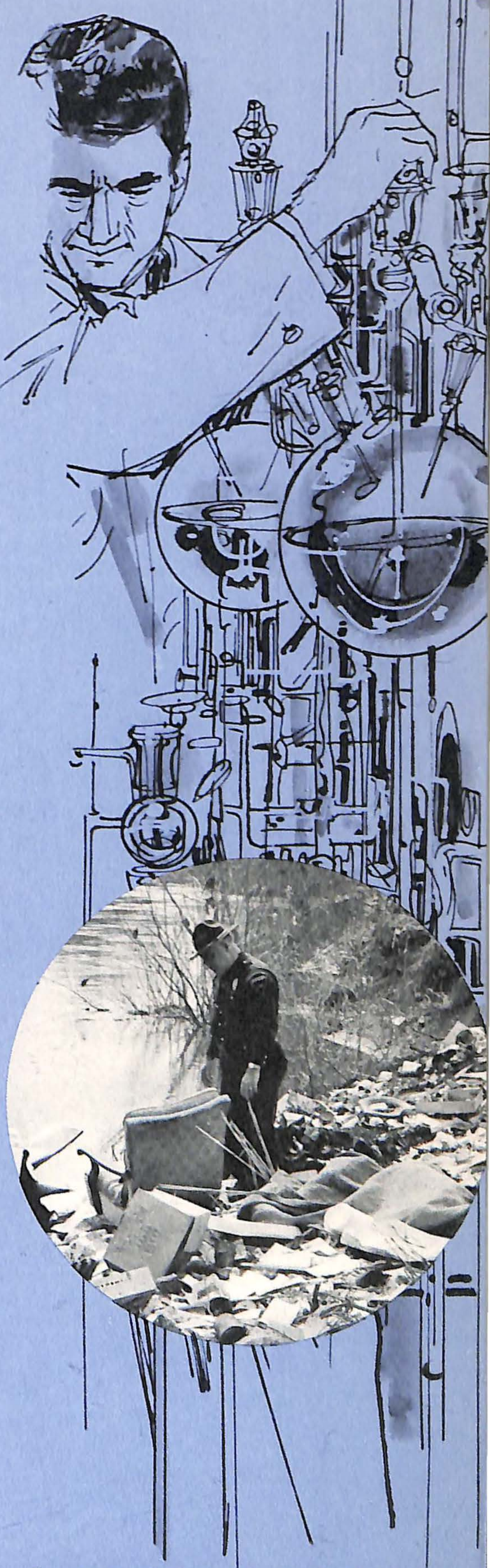
Engineers, in simplest terms, are problem-solvers. And it is not surprising that engineers are rated the world over by the difficulty of the problems they have solved.

This is the reason for the U.S. aerospace industry's worldwide reputation for excellence. The industry has an unparalleled record for solving difficult problems, for pushing forward the frontiers of technology and for turning the extraordinary into the commonplace.

Difficult problems are the industry's specialty. It makes no difference whether the priorities are shaped by the cities or the military. Advanced technology is needed in both areas, and the preponderance of experience with advanced technology lies with the U.S. aerospace industry.

In light of the curtailment in science and technology, and the slowness with which advanced technology is being applied to the problems of the cities, this question can be posed: Is the U.S. dismantling the chain of technological strength before its importance to the economic as well as the military strength of the nation is completely understood?

Question: Can Aerospace Technology Serve Nonaerospace Needs?



Aerospace firms are deeply involved in seeking solutions to control pollution.

This question pre-dates the current debate about the relevance of technology to society's goals. Interest in the question, however, has been heightened recently by the current economic problems of aerospace. Rejection of the supersonic transport program by Congress and its attendant effect upon aerospace professional and blue collar employment has accelerated the dialogue.

Over the last several years, the debate has been characterized by extremes of opinion outside the industry. Some accuse the industry of outright disinterest in solving social problems. Others claim that aerospace capability has been overrated and, besides, the industry does not know how to market its capability in new areas. Still others proclaim that aerospace technology is the greatest resource yet unmined for the greater common good.

For the record, the industry itself has long devoted close attention to the question. It rejects all extremes of thought on the one hand and, on the other hand, views with alarm approaches which assume that conversion of aerospace to other endeavor is a simple process. Industry's posture is based upon real-life experience and considerable study.

Late in 1964 and early 1965 the State of California awarded four study contracts which involved the use of the aerospace industry's managerial and technological talents to solve pressing problems in social areas. These studies included specifications for solving basic transportation problems, techniques for prevention and control of crime and delinquency, and the suitability of the use of systems analysis to handle waste management problems.

The studies attracted nationwide publicity, and for the first time focused major attention on the idea that the advanced techniques pioneered by the aerospace industry for defense and space projects could be used to solve massive social problems. For the magnitude of the problems, the study contract costs were modest: $100,000 each.

The idea has been debated, thoroughly and inconclusively, since then. Senator Gaylord Nelson in 1965 held hearings on a bill that would "mobilize and utilize the scientific and engineering manpower of the Nation to employ systems analysis and systems engineering to help to fully employ the Nation's manpower resources to solve national problems."

No action was taken on the bill by the 89th Congress, and Senator Nelson introduced the bill again in the 90th Congress, again held hearings; again, no action was taken.

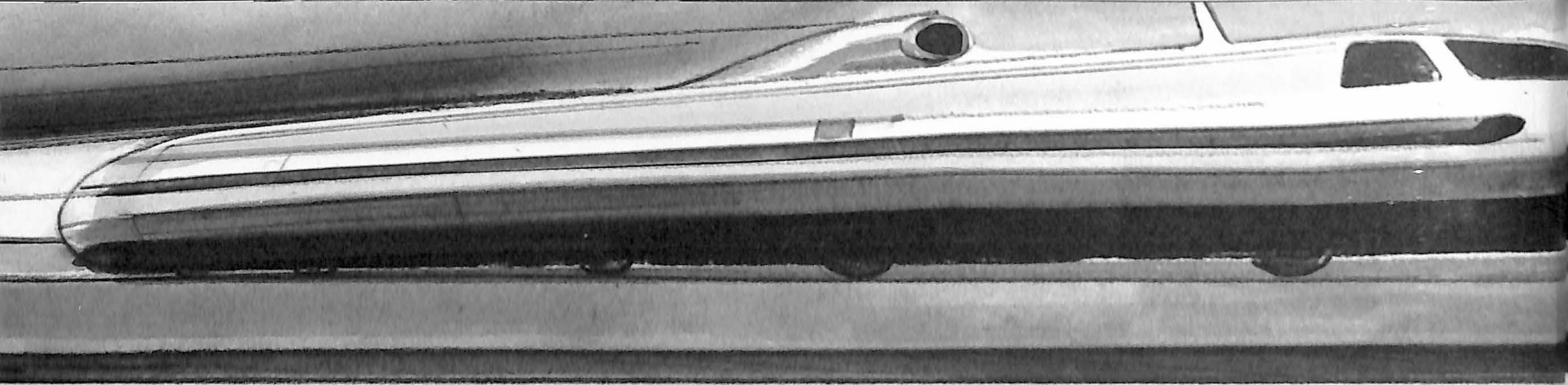
In 1969, Senator Abraham Ribicoff, as Chairman of the Subcommittee on Executive Reorganization and Government Research, asked a broad section of American industry for information regarding legislation that would have established a National Economic Conversion Commission, aimed at finding ways to convert industries from "defense-aerospace production and research to civilian projects. . . ." No legislation was produced.

Rep. Henry S. Reuss (D.-Wis.), chairman of the House Conservation and Natural Resources Committee, in late 1970 held hearings concerning the use of aerospace and industry technology to improve pollution control.

Mr. Reuss' opening statement posed the question:

"If we can go to the moon, why can't we clean up our environment? The question has become a cliché. The easy answer is just as obvious — have the same people who got us to the moon go to work cleaning up pollution.

"Space and defense contracts are being cut back. Aerospace industry PhD's are driving cabs, and engineers



Equipment for high speed ground transportation is being designed and manufactured by aerospace companies.

are slinging hash. Why not use their skills to get dirt out of our air, crud out of our water, and beer bottles off beaches?"

Since these hearings, which also have not produced any legislation, a spate of bills have been introduced in both houses of Congress aimed at retraining engineers employed in the aerospace industry to produce solutions to the clamoring social problems of the nation.

All of this seems to indicate that aerospace companies could solve many of our urgent problems if some way could be found to turn their energies in these directions.

The experience of the aerospace industry with major programs of a very high technology content has been with the Department of Defense and the National Aeronautics and Space Administration. These customers are technologically sophisticated, well-organized to recognize future needs, capable of procuring and assessing the research and development of systems to fulfill their requirements, and of financing the deployment and operations of new systems. This capability results in a well-defined task with the criteria for success of the final product clearly identified. The intercontinental ballistic missile and Apollo programs are examples of systems developed and delivered to government by a network of companies—large and small—supplemented by university and federal laboratories.

These comprehensive criteria are not available in large programs involving social problems, a fact escaping many seeking instant conversion. Here is the experience of one aerospace company as reported in Congressional testimony; and this example pinpoints a consensus of experience and opinion of the industry.

The company launched a study of urban mass transit, and attempted to define the requirements for an effective system and to design one.

This work, over a period of several years, resulted in a system concept that was truly innovative. The system incorporated the latest in technology, including computer control of vehicles, linear electric motor propulsion, and air-bearing suspension. Designed to transport automobiles and pedestrians interchangeably, it compared favorably on a cost per mile basis with the newer subways, surface transit systems and freeways in terms of automobiles or passengers moved per hour. In addition, the system stressed safety, freedom from noise and pollution, immunity to vandalism and crime, and had, by incorporating an underground installation, consciously sought to avoid social consequences resulting from disruption of established surface traffic and land-use patterns.

After widespread discussions with private and public figures, with governmental agencies and elected officials at the city, state and national levels, the company was forced to shelve the concept.

Why?

The company stated: "The first reason is that we were unable to find a source of the large amount of funds to develop and conclusively demonstrate the concept. The more important reason, however, related to the fact that there is no widely accepted criterion for what public mass transit should accomplish, and hence, a reluctance on the part of all the various agencies and public bodies to commit to an unproven system and — most importantly — an inability to accept the costs attributable to the social benefits embodied.

"Perhaps, in time, the Department of Transportation, in concert with state and local governments, will develop into a well-organized buyer, with the attributes earlier described for the DoD and NASA. And, also, perhaps in time we will be able to qualify the value placed on social and environmental benefits, so the buyer can define the producer's task.

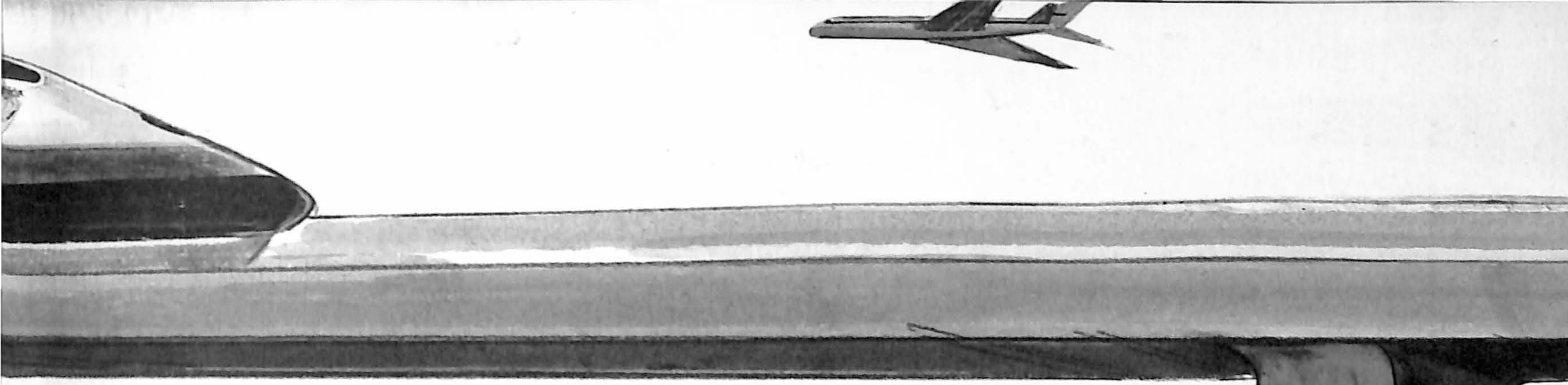
"The point of this experience is simply that technology and the economics of a new product can be assessed by the producer, but a mechanism for establishing *all* relevant criteria for product acceptability is lacking on the part of the buyer."

Aerospace technology has been described by a deeply involved executive as not unlike Gulliver—a helpless giant, tied down by fears, a need for resources, a lack of understanding, all of which prevent providing to the nation the benefits which are available.

One of the means of bringing technology to bear on the vast problems of society—market demand—is simply not yet visible in terms of funds or the contracting techniques to put funds to use when and if they become available. So Gulliver (read technology) remains bound.

The same aerospace executive strikes at the heart of the matter in defining the hurdles to be surmounted on the way to a cleaner, more habitable United States of America.

He states: "The first real hurdle is that we, as a nation, are impatient beyond description. We assume that our technology can produce overnight miracles, and solve problems once and for all, if we only pour the money in. This is not that kind of a problem. We must work patiently on one part of our task at a time, or we won't be able to afford all that we know how to do. Thus, *Task One* is that we must set some real priorities working together, and any mechanism we can devise which cuts down the hysteria



about these very real problems and lets us rationally set important and achievable targets will be of benefit to all of us.

"The second real hurdle (or it may be the first) is that we must better organize our government to handle the many planning, development, deployment, fund distribution, and just plain management tasks that will face us when we try some of the national programs that are bound to be necessary. Thus, *Task Two* is for us to participate in creating a method of handling the programs that must be undertaken when the priorities are set. Washington has all the tentacles of a large, stable, protected organization. None of its old elements are ever turned off, and new ones show up with every popular crisis.

"The problems we are discussing and the related problems of crowding, urban obsolescence, etc., are distributed among the Departments of Health, Education, and Welfare, Housing and Urban Development, Transportation, Ad Hoc Boards and temporary commissions in an almost random fashion. We have all been watching the Defense Department trying to justify its performance in the face of a malicious attack, and I would like to suggest to you that the order, precision, equity and effectiveness of Pentagon management is almost pristine compared to our first floundering efforts at social problems. My positive suggestion is that we should have a social systems management commission somewhat on the line of the Holifield Commission for military procurement to help set the stage before we get into these programs much deeper.

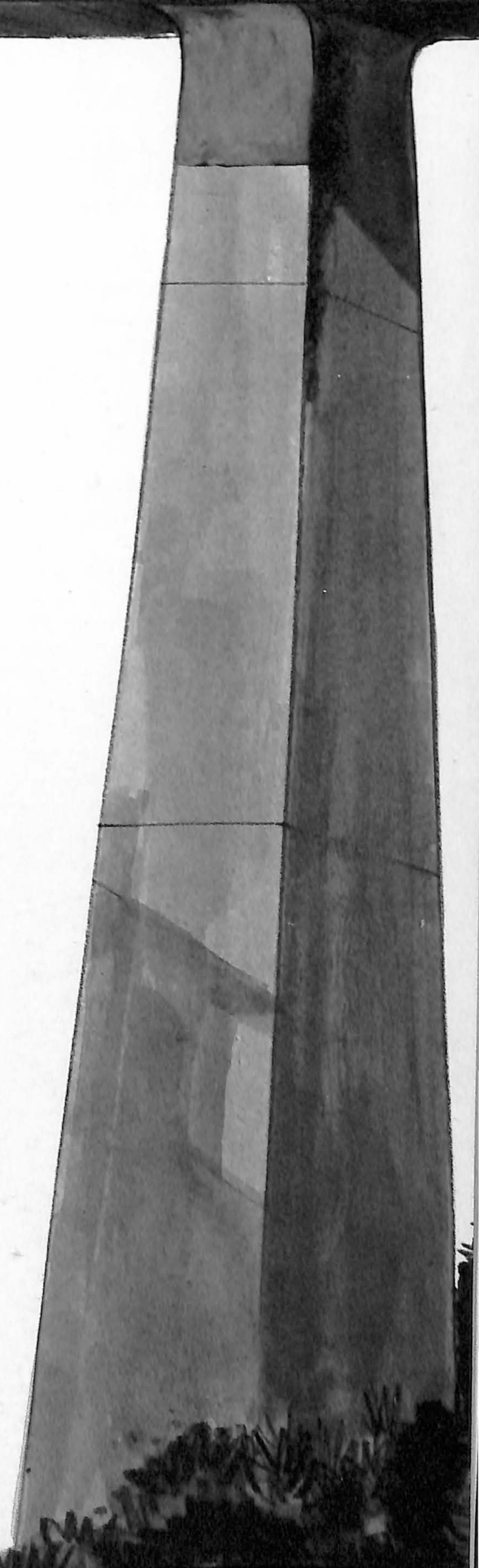
"Thirdly, I think we should recognize that we could drop the entire Defense Department budget into the social hopper and only make a dent in the tasks before us. The goals that we are about to set or demand for a better life for all are going to cost someone a lot of money. I have already noted that there is scant individual incentive to spend our own money, and we are not so close to disaster that the nation will rise as one to meet the challenge, so we must face the remarkably difficult task of creating national programs that will take away some cherished freedoms of choice and instituting programs of taxation or borrowing that will transcend our military programs in size at a time when we dare not reduce our military spending any further. This will be a real test of our way of government and our processes for retaining a healthy economy."

When the mechanism of technology transfer and application is simple and available, the results are quickly apparent. One aerospace firm, with several divisions involved in commercial product lines, has proven the concept of transferring technology across product lines. A division, which designs guidance systems for intercontinental missiles, produced an electronically controlled patterning device for incorporation into the knitting machines of a textile division. This development offers an almost infinite variety of pattern selections and can be changed from one pattern to another in a few minutes. Conventional equipment now requires several hours.

The answer to the question — can aerospace technology serve nonaerospace needs?—is an unqualified, "yes!" The technology is available.

"The years immediately ahead," John W. Gardner, head of Common Cause, has stated, "will test this nation as seriously as any we have known in our history. We have plenty of debaters, blamers and provocateurs. We don't have plenty of problem solvers."

And problem solving is what the aerospace industry does best.



Fact: Transfer of Aerospace Technology Is Under Way

Management of many aerospace industry companies is keenly interested in bringing about technology transfer to social uses, contrary to the charges of skeptics and despite the frustrating constraints described earlier in this issue. There has in fact been a tremendous variety of such activities.

From aerospace developments we have derived much of great value in the improvement of medicine, education, transportation, power generation, housing and other aspects of life. Many more such transfers are under way. Individual examples may be important in themselves; in the aggregate they are impressive evidence of a process that is only beginning. Here is a sampling of the thousands of items that could be cited.

MEDICINE

The Boeing Co. is nearing completion of a one-year study of possible non-aerospace applications of NASA's Integrated Medical and Behavioral Laboratory Measurement System (IMBLMS). Being developed for use on extended manned space flights, the system of compact electronic and electrical units, combined with a computer, will measure and analyze a crew's vital functions and relay the data to physicians on the ground. It is easily transportable, and experts believe the system could be valuable in the field of public health, where it could be used to screen large numbers of persons in remote areas.

A miniature thermionic device which converts heat from a radioactive isotope directly into electrical power may be used as a cardiac "pacemaker" implanted in heart patients. The tiny "ISOMITE" battery, about the size of a thimble, can yield about 100 times as much energy as chemical batteries of the same weight. It was developed and produced by the Donald W. Douglas Laboratories, a part of the McDonnell Douglas Astronautics Co., as a company-funded project.

The same organization, working under contracts from the Atomic Energy Commission and the National Institutes of Health, is evaluating a radioisotope power source which could be placed inside the abdominal cavity to operate a heart assist device. This "Stirling cycle" engine, in a casing about the size of a grapefruit, is connected to a heart pump in the chest. It is presently being tested in experimental animals.

To improve hospital management and patient care, and help make more effective use of physicians' time, Lockheed Missiles & Space Co. has conducted a company-funded study of hospital information processing methods. A five-year study of a number of varying types of hospitals has led to the design of a comprehensive information system that will bring computer-aided processing technology into routine service.

LMSC has also developed a computerized inventory system for blood banks which is in use in Sacramento, Alameda and Contra Costa counties in California and in Saint Paul, Minnesota. The incidence of outdated blood has been reduced to a negligible level, and the availability of critically needed types in various locations can be determined immediately.

Drawing on its experience in aerospace work on fluid dynamics, Avco Everett Research Laboratory scientists working with Massachusetts General Hospital have developed a new intra-aortic balloon pump that may open a new era in cardiac therapy. When employed within 30 hours of the onset of chest pain, the new pump has resulted in six survivors out of 16 cases of acute heart attack complicated by cardiogenic shock.

A different type of heart assist pump, hydraulically operated, is being produced by United Aircraft Corp.'s Hamilton Standard Division. Quickly and easily connected by minor surgery to the thigh arteries, it operates in a counterpulsating action to reduce the workload on the heart. The system is controlled by a servo valve, similar to those used in commercial jet aircraft, manufactured by Abex Corp.

A small, portable isotope X-ray device was developed through biophysics research by the Fort Worth Division of General Dynamics. Containing no fragile parts, and requiring no electrical power supply, it could be used for medical X-ray work in developing countries, in disaster areas, in airborne hospital facilities, and for backup of conventional equipment in city hospitals.

Present methods of interpreting heart and brain waves can be improved with the help of a unique sonar signal processor devised by Goodyear Aerospace Corp. in its anti-submarine warfare research.

A radiology technician listens to a doctor's tape recording of X-ray results which she feeds into a video terminal for immediate transmission to an attending physician. The system was developed by a major aerospace firm.

Honeywell has developed a low-cost, battery-operated device to diagnose and monitor the condition of patients with heart and lung ailments.

A surgical isolation garment developed by the Garrett Corp. has been under evaluation at Hollywood Presbyterian Hospital for a year, to minimize the transfer of bacteria from surgeons to patients during operations. An outgrowth of Garrett's work in spacesuits, the garment completely isolates the patient.

The same firm has produced a net suspension garment which encloses the trunk of the body and exerts equal pressure on all parts to prevent chafing and the development of high pressure points. Growing out of work on a lunar gravity simulator, the garment has been evaluated as a means of fostering early mobility in stroke patients by supporting five-sixths of their weight.

General Dynamics/Convair built a "dry immersion bed" in 1963 to provide a facility for simulating weightlessness in space. After the potential for medical purposes was realized, the first design was modified and utilized by the hospital of the University of Pennsylvania for treatment of trophic ulcers in chronic bed rest patients. A second modification is being employed at two other hospitals.

In the bed, the patient lies on a waterproof sheet and literally floats in water while remaining dry. This buoyant condition, causing minimum pressure against the body surface, is helpful in treating skin ulcers, severe burns and other problems.

The Aerostructures Division of Avco Corporation is continuing its development of modular-type structures with the construction of a demonstration patient care unit that will be assembled in Vermont as an addition to a conventional "brick and mortar" community hospital now being built. The unit is being manufactured in sub-assembled form, for the simplified shipment and rapid on-site erection which such construction permits. The division also is undertaking preliminary design of circular health service facilities, adaptable as a hospital or out-patient clinic, or as a combination of both.

TRANSPORTATION

An aircraft-type gas turbine engine powers the high-speed TurboTrains built by United Aircraft Corp. for service between New York and Boston. Aerospace technology was used throughout the two trains, which are operated by the Penn Central Railroad.

Turbo service began in April 1969, under a contract between UAC, the railroad and the U.S. Department of Transportation. It was extended in October 1970. In announcing the extension, President Nixon said that Transportation Secretary Volpe had recommended the action "because of our resolve to apply available space-age technology and expertise to Earth-bound problems."

Rohr Corp. has delivered the first prototype copies of cars for the Bay Area Rapid Transit (BART) System, in the San Francisco area. When BART goes into operation this fall, it will provide almost 65 miles of new rapid transit service. Rohr will ultimately produce 250 such vehicles.

Westinghouse is the major subcontractor for the cars. Other aerospace firms involved include Hercules, Kaiser, Garrett-AiResearch, and IBM.

The Atomics International Laboratories of North American Rockwell Corp. is working with the Southern California Rapid Transit District to develop and demonstrate a diesel exhaust emission control system to eliminate smoke and odor and substantially reduce noise.

Grumman Aerospace Corp. is conducting engineering design and technological studies for the Department of Transportation's tracked air cushion research vehicle (TACRV), which will be capable of traveling at 300 miles per hour. It will be powered by electric linear induction motors (LIM), for which Garrett-AiResearch is prime contractor, that will be pollution-free and virtually noiseless.

The Bendix Corp. is prime contractor for the Columbia Transit Program, which will supply an integrated transit system for the new, planned city of Columbia, Md., now under construction between Baltimore and Washington, D. C.

Bendix Aerospace Systems Div. has been awarded a DOT contract to assess the state-of-the-art in sensing headway (the separation measured in time between two vehicles traveling on a guideway) and recommend preliminary design and breadboard programs to test, evaluate and demonstrate the technology.

The same division is developing a transit system in which vehicles would be driven normally on streets or highways but be capable of fully automatic operation on special right-of-way networks called "guideways."

Goodyear has developed a "waitless" urban transportation system to relieve traffic in central business districts, airport terminals, and other congested areas. The "Carveyor" system would employ moving sidewalks and ramps with small passenger cars riding on conveyor belts that could transport as many as 22,000 passengers per hour.

The Sperry Management Systems Div. of Sperry Rand Corp. is developing a system of improved management of cloverleaf space through "gaiting" access and egress. Vehicle traffic is monitored in lanes; data is fed into a computer to change the flow of traffic.

Honeywell's Government and Aeronautical Products Division is talking with automobile manufacturers about using a sensor developed for a weapons systems as the trigger for an inflatable air bag that would protect car occupants in a collision.

On the strength of a unique tactical missile guidance, control and simulation technology developed at North American Rockwell's Columbus Division, the U.S. Bureau of Public Roads awarded the division a major R&D contract for work on a new concept in driver assistance. Under the concept—the Electronic Route Guidance System (ERGS) — highway route directions will be electronically displayed *in the car,* instead of visually read on the road. The driver will consult and dial a code number representing his destination into a control box under the dashboard of his car; the number will be received by a computer-like unit on the roadside which will then return directions in the form of arrows and words that light up on a screen mounted on the dash.

Some 100 intersections in northwest Washington, D.C., and 50 vehicles are now being outfitted with the necessary equipment to test out the concept.

A fleet of hydrofoils designed by The Boeing Co. may become a key part of the San Francisco Bay area transportation system. A naval architecture firm has recommended to local authorities two alternative systems, one containing both hydrofoils and high-speed ferries and the other ferries only. The hydrofoils, whose water-jet propulsion system and foil system are similar to that proven successful on a Boeing-built U.S. Navy all-weather hydrofoil gunboat, would carry 300 passengers at 30 knots.

A fabric inflatable bridge, developed for the U.S. Army by Goodyear Aerospace Corp., is capable of supporting the heaviest trucks on the highways. In civilian life, it can provide a temporary solution when a bridge is knocked out by a flood, tornado, or other disaster.

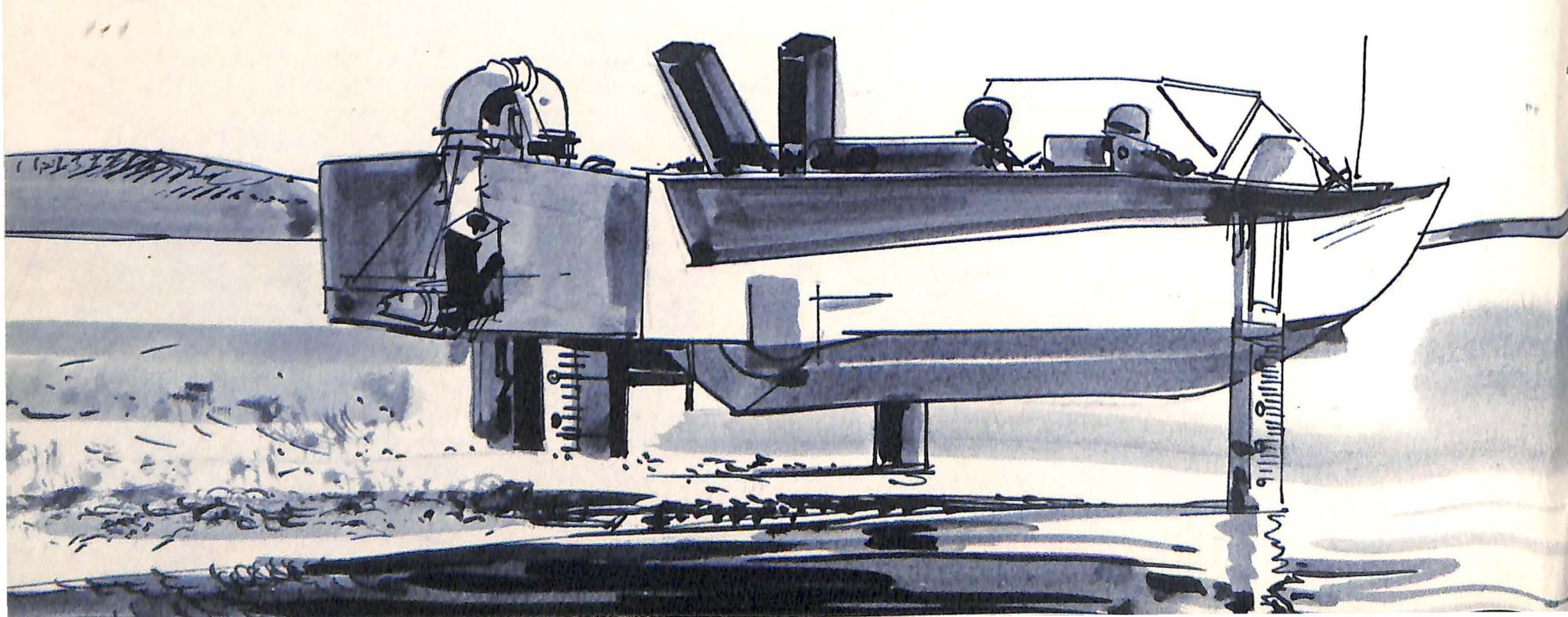
From a concept developed to isolate nuclear missiles and missile launching sites from shock, the Menasco Manufacturing Co. has produced shock isolaters for automobile bumpers which may significantly reduce the annual \$3.8-billion cost of property damage from low-speed car collisions in the United States.

A spinoff from Sundstrand Aviation's turbine technology is a low-pollution, organic Rankine cycle bus engine. The 80-horsepower engine will power a 25-passenger bus to be used as a demonstration vehicle by the Dallas Transit System. Fabrication and testing of the engine will be completed during 1971; road testing will begin in the spring of 1972. The feasibility test program is the first phase of a more extensive program leading to practical applications in mass transportation.

Hydrostatic transmissions developed by Sundstrand Aviation are used in more than 100 applications including power rollers, graders, ditchers, lift trucks, end loaders, farm tractors, combines, harvesters, cotton pickers and garden tractors.

Another significant spinoff from Sundstrand's aerospace technology is the dual-mode transmission (DMT), scheduled to go into production in 1972. This new hydromechanical concept in automatic transmission will be suitable for a wide range of heavy trucks, and might also find use in school buses, refuse packers, dump trucks and cement mixers. A single lever controls forward, neutral and reverse, and the driver can keep both hands on the wheel with no need to look at tachometers or shift patterns.

By applying a very old principle—



that of the flywheel—Lockheed Missiles and Space Co. hopes to develop an efficient new auxiliary power system for trolley buses in San Francisco and other cities. A small portion of the electric power in the overhead trolley lines would be used to turn a precisely balanced flywheel mounted in a vacuum chamber beneath the bus. Spinning at very high speeds, the wheel would act as a generator; should the main power source fail, the wheel would continue to spin and produce enough power to permit the bus to continue, or to leave its regular route to get around obstacles. Technology now being developed could make it possible to eventually abandon the overhead lines, and engineers say that still later the same approach could be used to power small automobiles.

INFORMATION SYSTEMS

Lockheed Missiles & Space Co. conducted one of the four original systems engineering efforts in state government. Designed to define the State of California's information system needs, the LMSC study recommended a unique approach combining a statewide computer network and central electronic index. After evaluating the report the state contracted with LMSC to assist in initial development of the system. Lockheed has done similar studies for a number of other states, including Massachusetts, Alaska, Kansas and West Virginia.

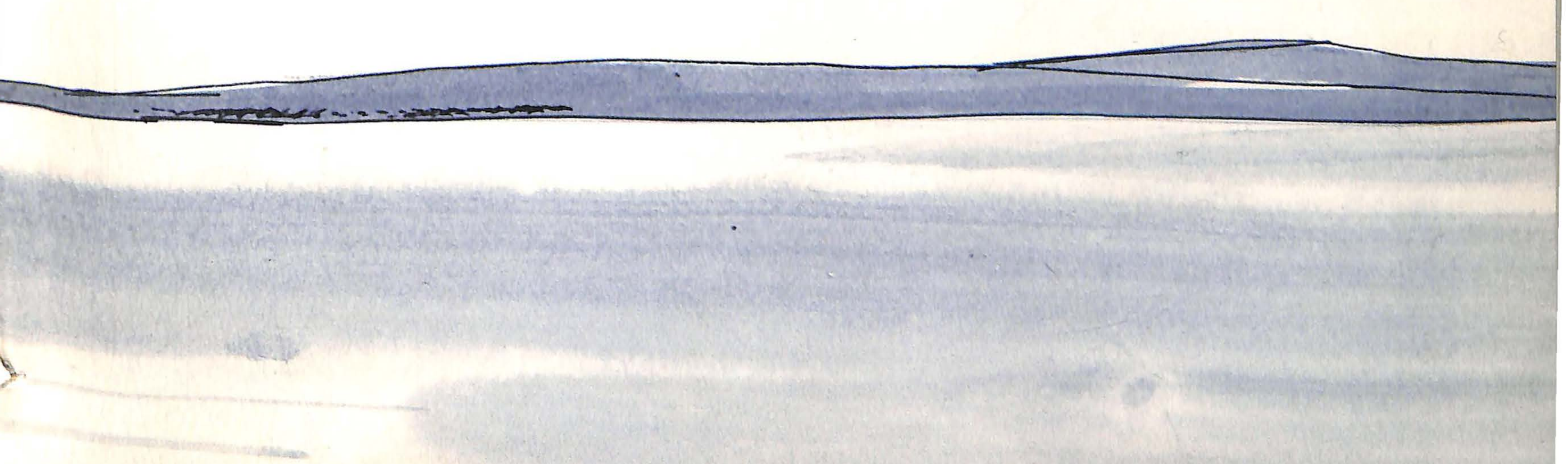
On the municipal level, Lockheed has been working under contract to the City of Burbank, California, for two years in the development of a comprehensive information system. The first phase of implementation is under way, and Lockheed, Burbank, and the University of Southern California are joined in a proposal to the Federal Department of Housing and Urban Development seeking award of a program that would make the system available to other cities throughout the nation.

Computer technology produced by the aerospace industry can be used for highway safety research or urban renewal design.

Under contract to the State of California, Lockheed has completed design of a computerized network for handling the review, validation and payment of MEDICAL claims. The state has proposed an initial prototype system development to process the concept in two counties, with a view toward eventual statewide coverage.

The Systems Application Center of TRW Inc. was recently awarded a contract to develop a computer model that will stimulate the Federal Reserve System's national payments mechanism. The computer model will portray the flows of checks and cash within and among the cities where the Federal Reserve has offices, evaluating alterna-

A proposed urban transportation system for the San Francisco Bay area would include a fleet of hydrofoil craft, each carrying 300 passengers, and built by an aerospace firm.



tives to the present system through which funds are transferred from one person or company to another.

The Lockheed Missiles & Space Co. has completed a State of California contract to study and make recommendations on state needs for a criminal records system. The proposed system would maintain computerized records on all aspects of criminal justice, from the crime to the ultimate release from prison of a convicted criminal.

A Space Age command center conceptually similar to the one that helps guide Apollo astronauts to and from the Moon will be designed and installed for the Cleveland Electric Illuminating (CEI) Co. of Cleveland, Ohio, by Philco-Ford Corp. to help guide the reliable flow of energy throughout CEI's 1700-square-mile service area. The work is being undertaken by Philco Houston Operations, which designed and built the Apollo Mission Control Center.

Philco-Ford is also implementing the display/control and "software" subsystems of the Houston Lighting and Power Co.'s Energy Control Center, and has performed similar work in other fields of industrial control.

POWER GENERATION

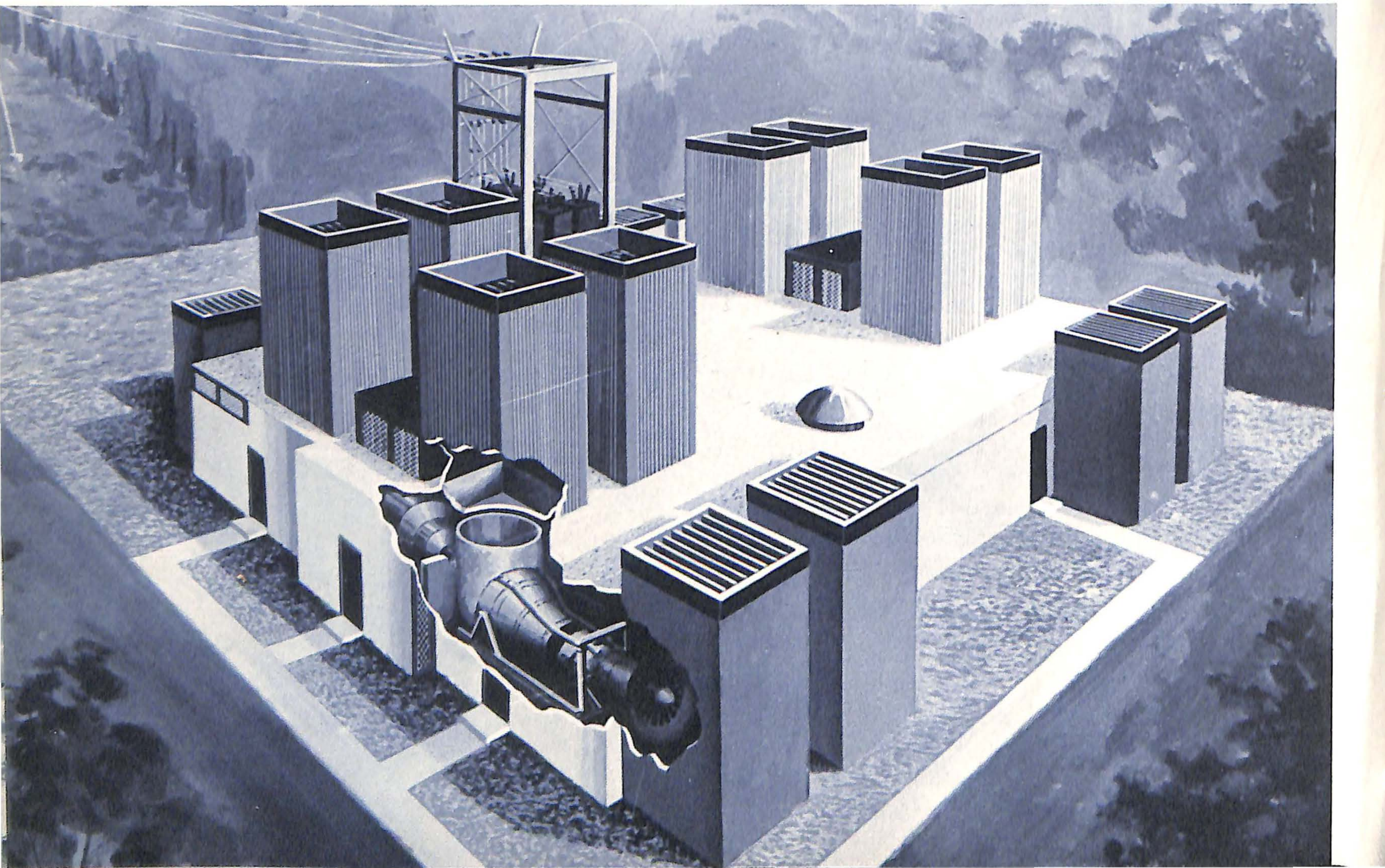
The success of fuel cells in automatically providing electricity for the Apollo Moon missions has spurred gas and electric utilities to try to establish the concept on Earth. In cooperation with Pratt & Whitney Aircraft, a division of United Aircraft Corp. which supplied the Apollo fuel cells, a nationwide group of utilities has so far invested more than \$40 million in private funds to bring forth a wholly new electrical power generation concept that could benefit society from environmental, conservation and energy supply points of view.

Experience in high-temperature gases which the aerospace industry gained in solving the ballistic missile re-entry problem has played a key role in the development of magnetohydrodynamic (MHD) power generator technology. Avco Everett Research Laboratory and a number of New England utilities headed by Boston Edison Co.; are designing a 50,000-kilowatt MHD power generator for emergency and peaking service. Such plants eventually will both supply the future demand for electric power and reduce the pollution, both air and thermal, created by both fossil-fuel and nuclear power plants.

Aircraft-type gas turbine engines have been modified by Pratt & Whitney Aircraft for non-aviation uses such as electric power generation, pumping of natural gas, and marine propulsion. More than 700 Pratt & Whitney Aircraft engines are installed or on order for industrial and marine utilization.

Sundstrand Aviation developed for the AEC a total electric power supply for a space vehicle which could also heat or cool the cabin as required. As a spinoff of this contract, the company is now developing an organic Rankine cycle total energy system to provide on-site electrical power generation for small commercial offices, clinics, hospitals and apartments. The waste heat created during the generation process will be captured for a building's heating and air conditioning systems. The system is completely silent and vibra-

Aircraft-type gas turbine engines built by an aerospace company drive an electric generator to develop 40,000 kilowatts for peaking and emergency power purposes.



tion-free and reduces air-polluting emissions to a minimum.

The highest output power ever reported for a continuous wave laser was announced recently by Avco's Everett Research Laboratory. The division has tested a laser that puts out 30,000 watts of power in a continuous, narrow beam. With a beam of many modes the Laboratory has been able to produce 60,000 watts. Known as the gasdynamic laser, the device was invented in 1965 and has numerous potential applications.

Also announced by Avco Everett was its offering of "Dial-a-Line," a new dye laser that is tunable over the entire visible spectrum.

EDUCATION

Lockheed-California Co., another division of Lockheed Aircraft Corp., was the first tenant of the Watts Industrial Park, developed in South-Central Los Angeles. More than 200 formerly unskilled and unemployed men and women, the great majority living within convenient walking distance of the plant, have been hired and trained by Lockheed and are now engaged in manufacturing aircraft parts and assemblies, work requiring the highest standards of workmanship.

The Lockheed Missiles & Space Co., at its own expense, joined with State of California officials in a project aimed at helping to solve the pressing problem of educating persons in poverty areas. The company drew heavily upon its experience in program management, systems analysis and information handling.

LMSC also helped design special programs for disadvantaged students in San Jose and San Francisco, provided a detailed curriculum for a Santa Clara high school course in electronics manufacturing processes.

During the last five years the company has performed studies drawing up educational programs for local, state and Federal governments. This year more than 75,000 seventh and eighth graders across the United States have completed an unusual course entitled Drug Decision, developed by Lockheed Information Systems. The program uses games and simulation techniques, together with a 45-page test and two hours of color films, and involves students in a simulated drug crisis. The youngsters learn the facts about drugs and then use their knowledge to make intelligent, informed decisions to combat the hypothetical community problem.

Electronics techniques created in aerospace work are being applied increasingly to a variety of programs aimed at improving education at all levels.

HOUSING

The Lockheed Aircraft Service Co. has developed an attractive manufactured house, consisting of precast concrete modules, which is suitable for low-cost urban housing. Building of the "Panel Lock" houses in the Philippines, Puerto Rico, Indonesia, Hawaii, Guam and other locations is expanding rapidly.

Atlanta's Model Cities proposal was approved and funded due in large measure to technical personnel loaned by the Lockheed-Georgia Company. Lockheed Missiles & Space Co. is lending assistance to the Model Cities Program in San Jose, California.

Expandable shelters that can be airlifted or trucked anywhere in the world folded up, then quickly deployed and put into use, are being manufactured by Goodyear Aerospace Corp. Designed originally for the U.S. Air Force, they are also suitable for several non-military uses — such as foward oil exploration and production areas; remote radio transmitter headquarters; emergency housing, such as is needed following tornadoes or hurricanes, and resort or summer homes in remote areas. End walls of the shelters are made of lightweight Bondolite paneling developed by Goodyear Aerospace.

By applying systems engineering and aerospace production methods to the fabrication of conventional homes, Avco Corp.'s Avco Systems Division has entered the sectional housing field with the assembly-line production of low-cost quality homes. Production of the houses, slated to start in April, will be in a recently acquired plant in New Hampshire. By mid-year, the facility will be producing at the rate of one home per day.

The Boeing Co. is under contract to the U.S. Department of Housing and Urban Development as developer for an 80-unit Operation Breakthrough low-cost housing project in Seattle.

Thiokol Chemical Corp.'s Georgia Division has converted urethane-foam

Drill bit is lowered in a test of a system for rescuing trapped miners, built by an aerospace firm using technology developed in space and undersea programs.

facilities from making protective packaging for chemical bombs to the manufacture of foamed-in-place decorative doors.

SAFETY

The Vought Missiles and Space Co. of LTV Aerospace Corporation has applied space technology to produce a new traffic monitoring system which detects unsafe speeds, automatically, day or night and without the need of a patrol car. Called ORBIS, the system is in operation in Arlington, Texas, and has been ordered by nine other cities throughout the nation. It provides a photograph of the car, license plate and occupants together with information as to location, time, date, vehicle speed and posted speed limit.

Selected fire departments across the country are testing new fire-protective garments developed by NASA for use by its rescue crews. The clothing is composed in part of nonflammable materials developed to ensure the safety of Apollo crews.

The gas generator formerly used by the Thiokol Chemical Corp. with Poseidon missiles is being adapted to development of an auto crashbag system under the dashboard which would inflate instantly in a collision to protect the driver against injury.

Equipment and systems management capability developed through aerospace technology by Westinghouse Electric Corp. has been applied to development of a system for rescuing trapped miners. In West Virginia this January, a task force successfully tested electronic sensors, hard-driving drills and other equipment. The electronics detected and located the thump from a miner's pick far below the ground and transmitted radio messages through the earth; the drills bored a hole 777 feet straight down, coming within 18 inches of their target, and rigged it for rescue. Other parts of the system, applying underseas life support technology to underground survival, also performed successfully.

The work was carried out under contract to the U.S. Bureau of Mines.

Honeywell's Aerospace and Defense Group, with funding from the U.S. Bureau of Mines, is researching the application of a low electric current to rock formations to determine if they contain water or air pockets that might represent danger to miners.

MATERIALS

Research and development in glass fiber rocket motor cases and the com-

Extremely lightweight, but very strong, pipe material evolved by a manufacturer of rocket motor cases is considered the first major advance in fluid conveyance since early in this century.

bination of fiberglass and steel led scientists at the United Technology Center, a division of United Aircraft Corp., to develop Techite — a pipe that weighs one-sixth as much as some pipe in common use but has great strength and is practically maintenance-free. Its light weight makes it possible to transport it by helicopter to otherwise inaccessible or remote construction sites. Techite is considered to be the first improvement in fluid conveyance material in over 50 years.

North American Rockwell's Space Division has been among the most active developers of nonmetallic materials for use in high-temperature environments. Recognizing the need for a structural plastic that would be self-extinguishing in oxygen-rich atmospheres, the Division developed polyimide, a polyaromatic resin matrix for glass-reinforced laminates. In testing, the laminates have remained intact at temperatures up to 600°F, proved nonflammable in 16.5 psia pure oxygen environments, and showed strength-to-weight ratios superior to those of aluminum. Furthermore, complex parts fabricated from the material are far less expensive than similar aluminum parts.

The NR Space Division has established an Insulation Systems Project, based primarily on its versatility in the use of polyurethane foams, developed during its work on the Saturn space launch vehicle. Polyurethane has a great variety of densities, flexibilities, strengths, surface finishes, and thermal efficiencies; and it can be applied in various ways — rigid sheet, spray, froth and pour.

Avco Systems Division has developed a new high-strength boron filament for heavy-duty, lightweight structural applications.

SYSTEMS MANAGEMENT

On occasion, a system developed within a company for its own purposes works so well that it is worthwhile to put it on the market. For example, the Rohr Corp. in 1968 developed an automated retrieval system for a materials handling and storage facility at its main plant in Chula Vista, Calif. It worked so well that the company decided to produce and market similar systems. Early this year it received a contract from the Caterpillar Tractor Co. for design and construction of such a system at Morton, Ill.

ENVIRONMENT

Applying advanced aerospace technology to pollution and power shortage problems, United Aircraft Research Laboratories has designed under Federal Government contract a power generating system which could produce low-cost electricity while virtually eliminating sulfur oxide emissions. The highly efficient system would combine high-temperature gas turbine engines and steam turbines. Fuel would be 98% desulfurized gas derived from coal or low-grade fuel oil.

The same organization has also performed a water pollution control study for the U.S. Department of the Interior. It is aimed at avoiding thermal pollution of rivers and lakes by using advanced-design gas turbine engines, which would not use water as a coolant, as the primary power source for utilities which generate electricity.

A minicomputer system designed by scientists at Lockheed-Georgia Company will serve customers of a major petroleum pipeline company as meter reader, delivery man, and guardian against pollution. In addition to automatically reading meters, temperatures and pressures, and printing delivery tickets, it will average the pressure and temperature at both ends of the pipeline and activate alarms if a leakage develops that could cause pollution.

A portable radioisotopic kit was developed at the Fort Worth Division of General Dynamics for monitoring bacterial contamination in jet fuel systems. Refinements are expected to make it possible to detect the viable bacteria in rivers, swimming pools, waste disposal plants, and water purification facilities.

A unique sonar signal processor created by Goodyear Aerospace Corp. to separate submarine signals from other undersea noises can help reduce noise pollution and better identify seismic disturbances for earthquake detection and oil exploration.

Telemetry science generated by aerospace work has been applied by the Thiokol Chemical Corp. to a water resources monitoring and flood warning system in the State of Washington. Developed by Thiokol in conjunction with a State agency, the system uses small sensing units and automatic radio telemetry stations to derive instant data about snow and water conditions from deep wilderness locations. Previously, the collection of such information required strenuous field trips which sometimes took weeks to obtain the necessary data.

The Wasatch Division of Thiokol and the Pacific Engineering & Production Co. of Nevada (PEPCON) are working together on marine waste treatment systems. The joint effort utilizes a highly efficient electrolytic cell developed by PEPCON which has been employed to manufacture oxidizer for solid propellants and to sterilize waste water. Some are in use in a secondary sewage treatment plant. Thiokol has been conducting extensive research on marine sewage treatment systems, applying aerospace-generated technology and using the PEPCON cell.

Honeywell scientists have applied aerial surveillance techniques, using optical instruments and computers, to forestry. They found it possible to trim to 100 days the 10 years it now takes for the national forest census. This would free foresters who now do the classification manually for other equally important work. The system could also monitor industrial effluents, urban development, crop disease, or even harvest conditions.

Honeywell's Corporate Research Center has developed a device that can be attached to an automobile exhaust and analyze emissions to determine the amount and content of the discharge.

The Industrial Division has developed systems for monitoring water quality.

Facilities built by Thiokol to build large solid-fueled rockets for the space program have been adapted to produce an organic agricultural pesticide for Union Carbide Corp.

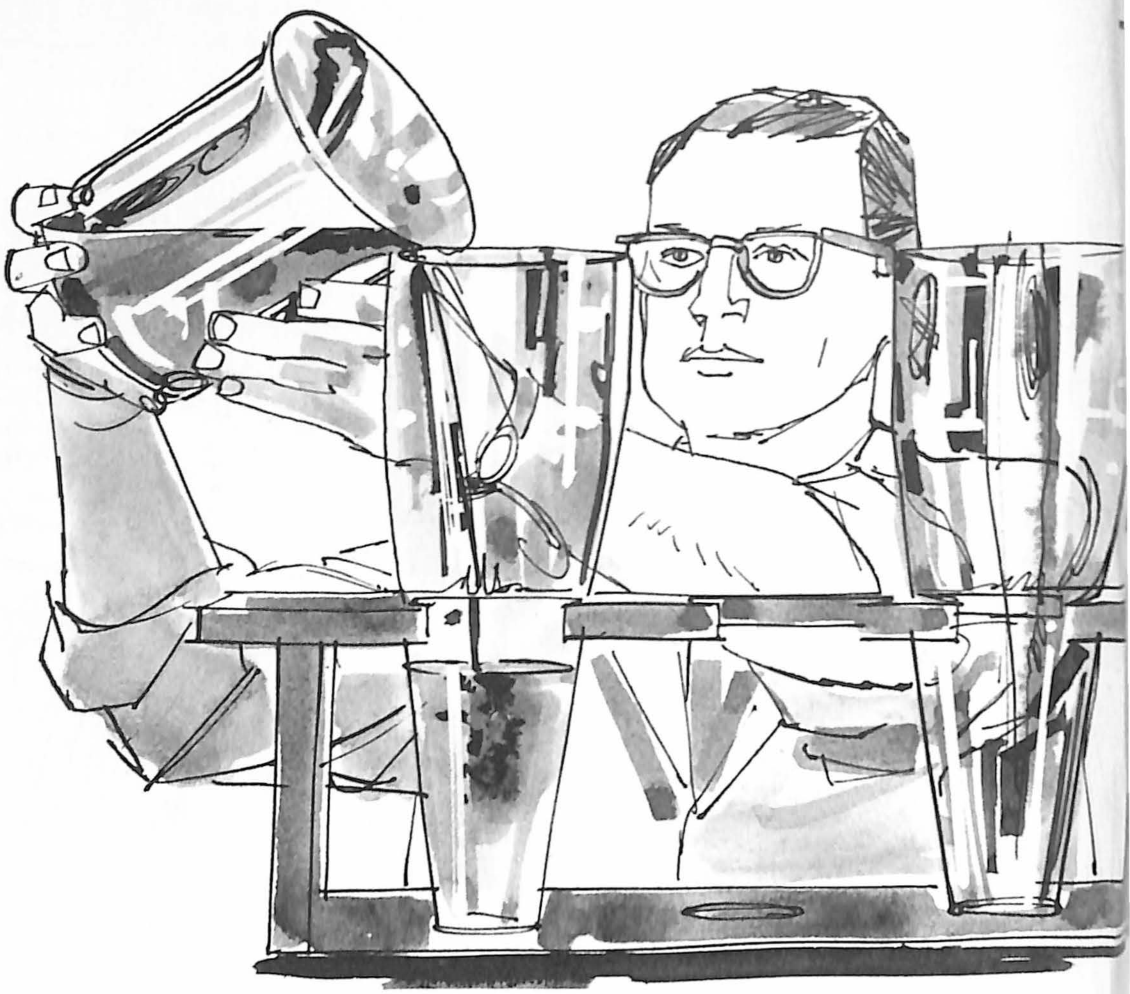
A "life detector" experiment designed by The Bendix Corp. for space exploration has applications in the detection and analysis of water pollutants in sewage effluents.

United Aircraft Research Laboratories, which had been working since 1959 on vortex-type gaseous-core nuclear reactors for the National Aeronautics and Space Administration, is using the resulting technology to build a device for the Coast Guard for cleaning up oil spills. The system, based on a vortex oil-water separator, could be deployed by a variety of Coast Guard vehicles, including helicopters and cutters.

At the same time, Avco Corp.'s Lycoming Division is developing equipment for use with a new airborne system for preventing oil spills at sea. Under development for the Coast Guard, the system is designed to remove oil from distressed tankers before it can pollute the surrounding water and beaches. The system uses an Avco diesel engine to pump oil from the ship's tanks into floating bladders, which are then towed into port where the oil can be pumped into storage tanks.

Avco's Systems Division, taking another approach, is investigating the use of ferrofluids — fluids with magnetic properties — to remove oil slicks from bodies of water.

Lockheed engineers have demonstrated a new device capable of skimming oil from the surface of water. It is relatively simple, consisting of a paddlewheel which picks up the oil from the water, and a system to pump the retrieved oil into containers or to a



A laboratory technician determines settling characteristics in waste water from a chemical plant. Aerospace companies work continuously to improve such techniques.

disposal area. Demonstration models have been built and successfully operated, and an effectiveness study is being made for the Coast Guard. A number of oil companies have also asked for development proposals.

Avco Everett Research Laboratories is studying the use of a laser to monitor and detect air pollution emitted by industrial smokestacks.

Avco Systems Division has acquired patent rights to a water crystallization "wash column" that promises to remove salts or dissolve industrial wastes from water economically. It plans to develop the system for use first in a water desalination plant, and later to expand its use in the area of industrial waste treatment. A demonstration is planned for late this year.

North American Rockwell developed a substantial technology in the area of water and waste water pollution control, largely through its aerospace work on large rocket engines, nuclear reactors and environmental systems for the Apollo spacecraft. To help solve the problems of commercial application of this technology, a new company — the Envirotech Corporation — was formed, with North American Rockwell having a minority equity position. The company has become a major firm in the pollution control industry, with a broad line of special water/waste water treatment equipment. NR not only provides Envirotech with access to its advanced developments but also receives R&D support from them.

The Aeronautic Division of Philco-Ford Corp. has demonstrated to U.S. Government officials a portable laboratory demonstration model of a water purification system applicable both on Earth and in space flight. Developed after several years of intensive research for the Department of the Interior and NASA, the low-cost lightweight system uses a purification process known as reverse osmosis in which polluted or brackish water is forced at high pressure through a membrane to achieve purity. Scaled-up systems could be built in the foreseeable future to purify thousands of gallons of water daily. The system has great potential both domestically and in the less-developed countries of the world.

Research and development jointly sponsored by the U.S. Government and the Garrett Corp. has resulted in technical breakthroughs in the areas of waste water treatment, water purification and waste management and disposal. In addition, Garrett is researching in two other areas: agricultural (bovine) waste disposal systems utilizing the pyrolysis principle (combustion with no excess oxygen) with economically recoverable by-products; and institutional and municipal waste management systems, again using the pyrolysis principle, oriented to an end by-product of an oil suitable for use as a fuel in power generation.

The B.F. Goodrich Chemical Co.'s polyvinyl chloride (PVC) plant in Pedricktown, N. J., has built a $1-million waste water treatment system funded in part by a demonstration grant from the Federal Water Quality Administration. In the system, waste water is mixed with bacteria and other micro-organisms at the same time that oxygen is dissolved in the water for use by the micro-organisms in devouring the organic content of the wastes and decomposing the organics into harmless end-products.

The Dynatronics Operation of General Dynamics/Electronics recently delivered to the Florida Air and Water Pollution Control Office a completely automated system for monitoring water quality. The system collects data, transmits it over a 200-mile telephone link, analyzes it in a computer and makes it available for printout on a teletypewriter.

Convair Aerospace Division of General Dynamics is developing a ground-based optical sensing system for measuring urban air pollution under a contract from the U.S. Environmental Protection Agency. It is also developing, under NASA contract, an airborne sensing system to measure air pollution over a wider area than is possible with a ground-based system. The latter system would be flown first in an aircraft and might later be used in satellites.

Company-funded work by the division includes development of advanced prototype systems for application to smokestack and automobile emissions.

UNDERSEA OIL DRILLING

Lockheed Missiles and Space Co. is in the prototype hardware testing stage of a subsea petroleum system designed for deep water operations up to 1,200 feet and beyond, but also adaptable for shallow water applications. A consortium of 10 of the world's major petroleum companies — including Shell, Esso, Standard Oil of California, British Petroleum and Tenneco — is cooperating with Lockheed in system tests.

AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St., N.W., Washington, D. C. 20036

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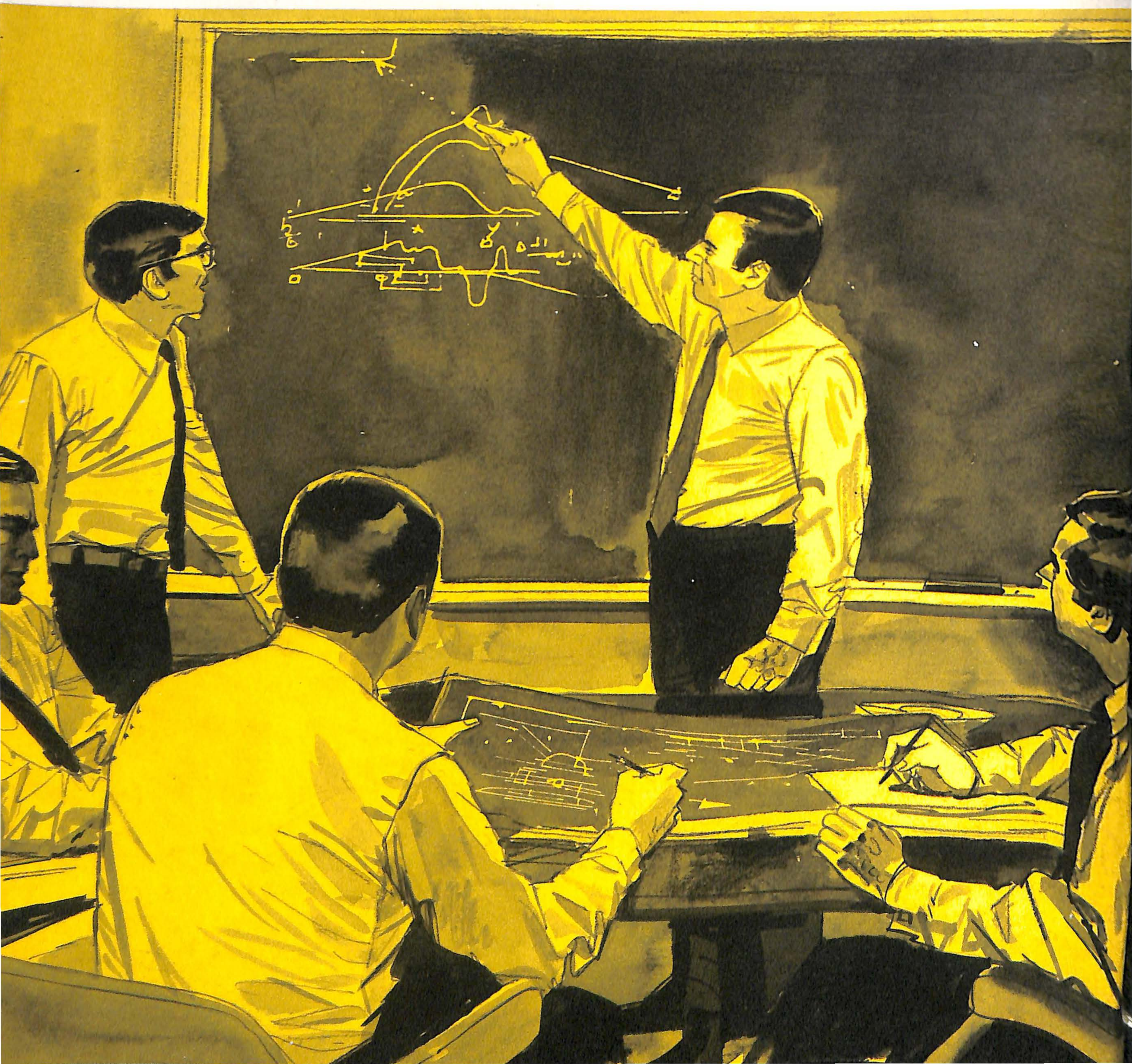

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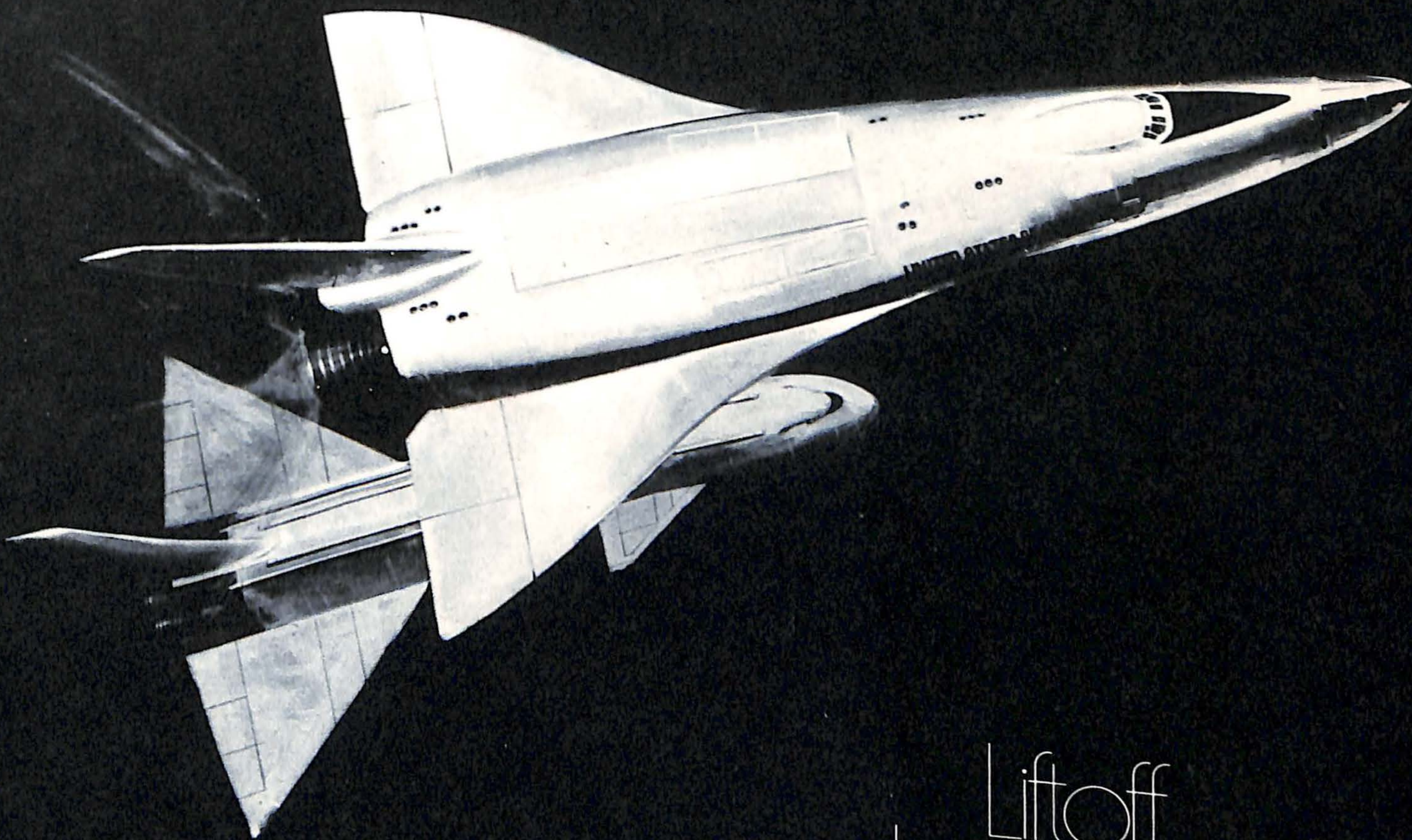


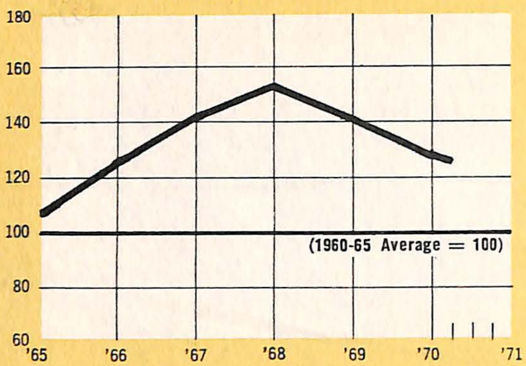
Liftoff to Economy–
THE SPACE SHUTTLE

BY SENATOR HOWARD W. CANNON

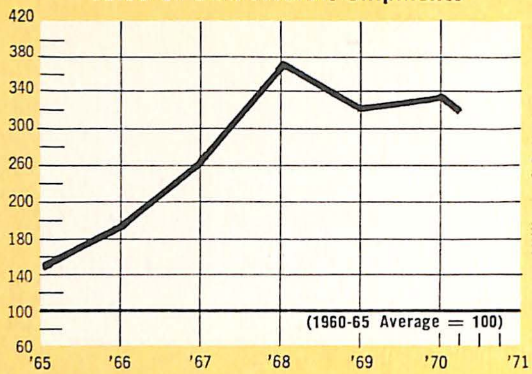
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

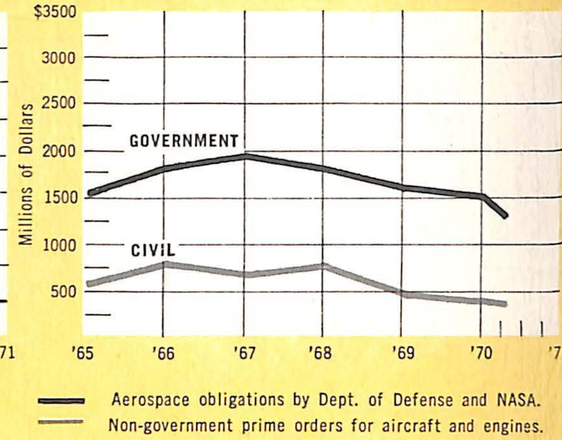


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1960-65 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	First Quarter 1971	26.0	24.8	24.6
	Billion $	Quarterly	4.8		6.0	6.5	5.6
DEPARTMENT OF DEFENSE							
Aerospace Obligations: Total	Million $	Monthly	1,151	3/71	955	827	1,148
Aircraft	Million $	Monthly	601	3/71	637	498	778
Missiles & Space	Million $	Monthly	550	3/71	318	329	370
Aerospace Outlays: Total	Million $	Monthly	1,067	3/71	1,291	1,045	1,104
Aircraft	Million $	Monthly	561	3/71	828	589	669
Missiles & Space	Million $	Monthly	506	3/71	463	456	435
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920 ✢	3/71	937	551	1,066
Aircraft	Million $	Monthly	447	3/71	701	328	797
Missiles & Space	Million $	Monthly	473	3/71	236	223	269
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	5/71	324	291	238
Expenditures	Million $	Monthly	130	5/71	268	242	272
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	First Quarter 1971	27.1	24.7	24.9
U.S. Government	Billion $	Quarterly	11.6		13.4	12.9	13.1
Nongovernment	Billion $	Quarterly	3.7		13.7	11.8	11.8
EXPORTS							
Total (Including military)	Million $	Monthly	110	4/71	306	509	407
New Commercial Transports	Million $	Monthly	24	4/71	133	282	158
PROFITS							
Aerospace — Based on Sales	Percent	Quarterly	2.3	First Quarter 1971	2.3	1.6	1.7
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		4.0	3.7	3.9
EMPLOYMENT: Total	Thousands	Monthly	1,132	4/71	1,206	1,013	989
Aircraft	Thousands	Monthly	469	4/71	534	432	417
Missiles & Space	Thousands	Monthly	496	4/71	501	416	408
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	4/71	4.10	4.28	4.27

R Revised.
E Estimate.
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
\# Averages for 1961-65.
✢ Averages for fiscal years 1960-65.

Source: Aerospace Industries Association

BY KARL G. HARR, JR.

President,
Aerospace Industries Association

"Everybody talks about the weather,
but nobody does anything about it."

It's one thing to realize that a problem exists, but it's another and more imporant thing to accept the challenge and try to do something to solve the problem.

Since Charles Dudley Warner, a perceptive editorial writer for the Hartford, Connecticut, *Courant,* wrote the above quote late in the 19th century a lot has been done about the weather by both science and industry in a team effort that has produced everything from air conditioners to weather satellites.

During the last three decades, however, some of our problems have become so big and so complex that simple solutions no longer are possible. Therefore, each major problem must be broken down into its component challenges which then can be met by finding answers to fit together into an overall solution. This is the way we have conquered space, strengthened security, nurtured air transportation. It is the way that we will conquer pollution and other major societal problems.

Industry, and especially the high-technology aerospace industry, is facing problems of increasing risks, growing costs and dwindling profits. The situation has reached the point where a viable industry that is essential to the growth and the security of this nation is threatened.

Therefore, during the last half of 1970 the Aerospace Industries Association decided to define industry's overall problems, isolate their various elements and study them individually with a view toward recommending solutions. A two-part effort developed.

First, the councils, services and committees of AIA, composed of staff members working with legal, financial, management, technical and procurement experts from the association's member firms, stepped up their efforts to study the separate aspects of the Government procurement process. To date they have produced or updated nine studies and others are nearing completion.

Second, AIA established an Aerospace Research Center to carry out in-depth studies of fundamental Government/industry relationships in an effort to bring about better understanding of such matters as the economics of the industry, critical procurement problems, research and development, and national transportation policies.

The first two reports resulting from Aerospace Research Center studies have been published. These are: "National Technology Support" and "Aerospace Profits *vs.* Risks." These reports are the source of two of the three principal features in this issue of *Aerospace* magazine.

It is hoped that a continuing study effort by this nation's most innovative industry, which also is its largest manufacturing employer, will be of value — not only to those who establish working procedures, but to those who formulate the laws, policies and regulations.

AIA

aerospace

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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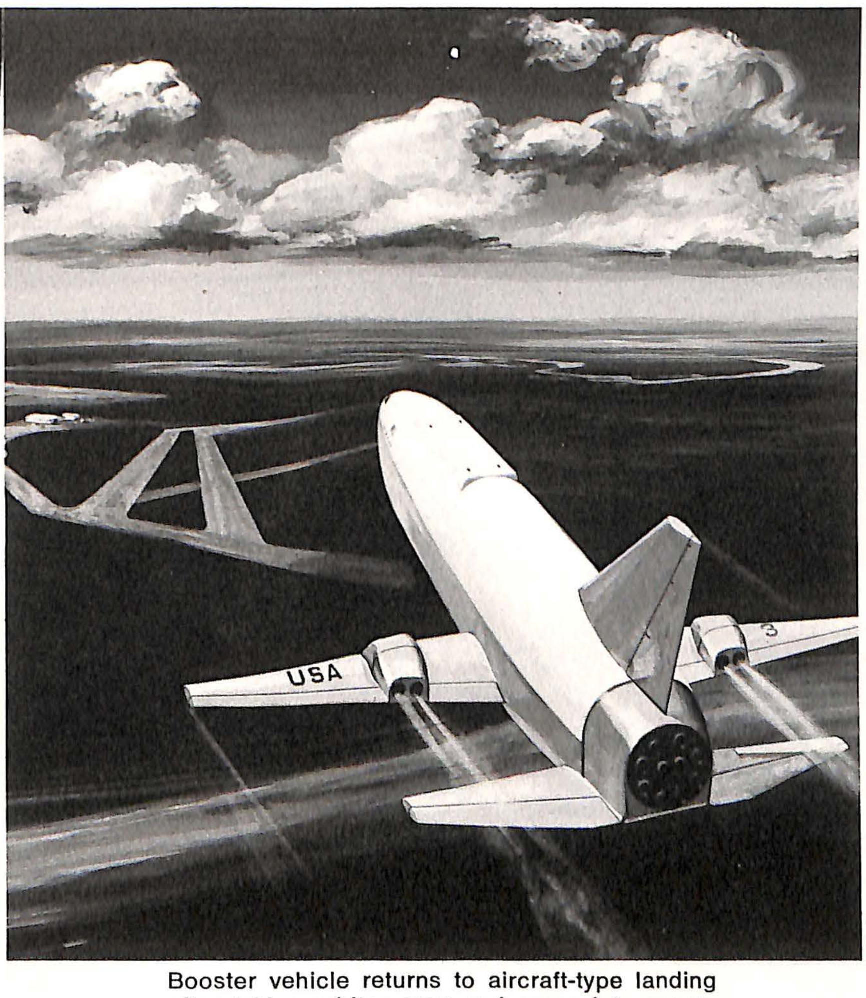
UNITED STATES
UNITED STATES

Liftoff to Economy— THE SPACE SHUTTLE

BY SENATOR HOWARD W. CANNON
Member, Senate Committee
on Aeronautical and Space Sciences



Booster vehicle returns to aircraft-type landing after taking orbiter crew and cargo into space.

Many people are asking the question: Now that we have landed on the Moon, why must we continue with such large expenditures on our space program?

To my mind, however, the question really is: Does the United States wish to reap the benefits of its substantial investment in space exploration — or are we content with what has been accomplished so far, and prepared to draw back into what has been called a state of "technological underambition?"

The Apollo Lunar landing program that stirred the spirits of mankind for a decade is nearing an end; after this month's Apollo 15 mission only two more such flights are contemplated. Thus, the Nation's space program is about to enter a new phase: using and expanding the vast new knowledge we have gained in space activity for the betterment of humanity.

Many benefits already have come out of the program, both in new scientific information about our Earth and universe, in improved communications, weather forecasting, national security, and byproducts from space technology to medicine, education, transportation, materials and many other non-aerospace fields. But the real potential has barely been touched — indeed, cannot be wholly comprehended.

The Nation faces a formidable array of social and environmental problems that must somehow be solved. The solutions will be expensive, and because funds are not unlimited, rational priorities must be assigned to expenditures.

The space program, far from being an enemy of social progress, has much to offer in resolving the technological aspects of these problems. It is the principal possessor of our most advanced science and technology, with an unparalleled record of finding solutions to technical challenges of unprecedented complexity—just the kind of problem-solving that will be required together with the best efforts of leaders in politics, economics, sociology, and many other fields, if we are to cope successfully with all of our growing needs.

Space-derived science and technology can help in many ways in dealing with air and water pollution, transportation control, mass transit shortages, and other problem areas. Much has in fact been done along these lines, although there are unresolved difficulties (mainly governmental) involved in transferring the technology into non-aerospace fields. (See Spring Issue of *Aerospace.*)

THE SPACE SHUTTLE

Nearer at hand, in terms of capability, are the further social benefits to be attained *directly* through future space work, rather than by transfer of technology. Geodetic, weather and communications satellites have demonstrated their value for years now, and are constantly being improved. Within the next several years, a U.S.-built and launched satellite will be used to broadcast educational programs to the Indian subcontinent so that they can be picked up by inexpensive community receivers in thousands of villages where television has never been seen.

It is also expected that within a few years Earth resources satellites will be in operation—locating previously unknown deposits of fresh water, oil and minerals and reporting on the depletion of known sources; keeping a constant inventory of crops and forests and spotting crop diseases and forest fires; reporting on air and water pollution; tracking the movements of fish in the oceans; and performing many other tasks of great benefit to mankind on this overcrowded planet.

The long-term economic dividends from the activities of these Earth-orbiting satellites are difficult to estimate, but they will amount to many billions of dollars by helping to make the best possible use of our global resources. More important, of course, they will help to ensure the continued existence of a livable world.

Key Is Reusability

To move forward into this new phase of space exploitation and capitalize on our investment will require continuity of practical investment levels. Our spacecraft themselves have become larger and more complex, and our present systems for getting into and using space are costly. We must take a new approach to make space more practical and economical for all users—the National Aeronautics and Space Administration, Defense, other Government agencies, and commercial enterprise.

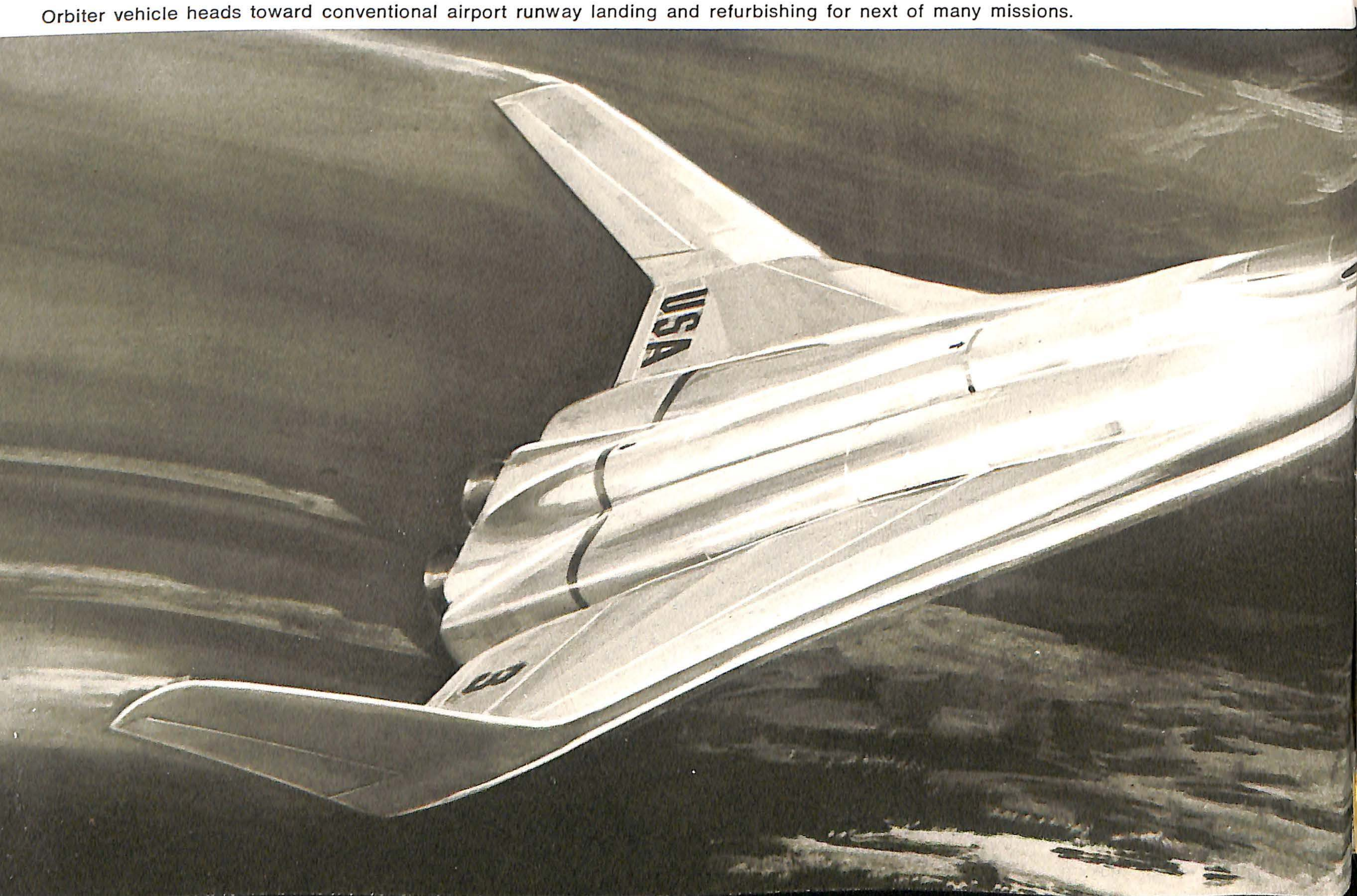
Realizing this, NASA officials several years ago came up with the concept of a space shuttle—a *reusable* space transportation system to deliver both manned and unmanned payloads to low Earth orbit. It will consist of a "booster" and an "orbiter," both of which can be used up to 100 times or more, in contrast with present vehicles which are expended in the course of a single mission.

NASA is presently studying two approaches to development of the booster. In the first, a reusable booster would be developed and tested concurrently with development and testing of the reusable orbiter. In the second, "phased," approach, the orbiter vehicle would be developed first and initially tested with an interim expendable booster; full-scale hardware development of a reusable booster would be started later, but some design and preliminary development work for it would proceed concurrently with orbiter development and testing. NASA expects to decide this fall which approach to follow. In either case, the goal of a reusable system is the same.

It is hoped that the space shuttle can reduce the present cost of $1,000 or more to put a pound of payload into orbit to only $100—there are some estimates that the per-pound cost may go as low as $50. This is startling when we recall that in January 1958—less than 14 years ago—we put our first (31-pound) satellite into orbit at a cost of $100,000 per payload pound.

The shuttle system would be used to

Orbiter vehicle heads toward conventional airport runway landing and refurbishing for next of many missions.



place into orbit virtually all of this Nation's payloads, scientific and applications, manned and unmanned, civilian and military. Later the satellites could be brought back by the shuttle for repair and reuse, or modified and repaired in orbit by shuttle crew members.

This obviously will open up another avenue to cost reduction, since the satellite themselves will be reusable, the same spacecraft performing their functions for lifetimes of indefinite duration. Fewer satellites will be needed. Most important, because the shuttle will have as much payload space and weight capability as a jet airliner, it will be possible to use relatively inexpensive off-the-shelf type equipment in space, rather than space payloads highly miniaturized and expensively tested and checked out.

Still another saving factor of the system is that the shuttle will land on a conventional airstrip on land rather than at sea, and thus will not require a recovery force of ships, airplanes, helicopters and frogmen.

And finally, the shuttle represents economy because it will replace almost all present expendable launch vehicles. It will carry spacecraft into orbit for the U.S. Weather Bureau, the communications industry, NASA's space science and applications program and the Department of Defense. It will also take care of the future needs of commercial users, other Government agencies, and foreign governments. Later, it will convey passengers and cargo between the Earth and an orbiting space station or laboratory.

Apart from economic considerations, the shuttle offers a means of rescue in the event of an emergency in space. It will be designed much as modern commercial aircraft so that it can be launched within a few hours notice. If an Earth-orbiting station or another shuttle becomes disabled, a rescue shuttle could be sent up to reach it within 24 hours.

Several teams of contractors are presently working on shuttle design details and NASA and the contractors are proceeding toward establishment of a schedule for design and development. The Congress has appropriated $115 million for such work in Fiscal Year 1972, which began July 1.

A Strange Reluctance

The space shuttle program is the keystone for future U. S. space exploration and utilization. It is essential for the program to proceed if America is to continue as a dominant world factor in advanced technology and research.

Sen. Clinton P. Anderson (D-N.M.), chairman of the Senate space committee and a strong shuttle advocate, said in a speech recently: "Without a shuttle . . . I do not believe we can afford to capitalize effectively on our scientific opportunities in space. Such major missions become too expensive. Nor can we capitalize effectively on our scientific and technological investments that already have given us space communications, weather satellites and geodetic programs. The commercial and social benefits of the next generation of space applications—contributing to such fields as natural resources management, pollution monitoring, weather modification and climate control, television distribution, earthquake prediction and avoidance, education, public health and safety, to name a few—will not be fully realized unless we get costs down, efficiency up, and introduce a flexibility of action not earlier thought possible. That, of course, is what the space shuttle is for, and why without it we will lose a program of promise and value."

Logic dictates that we should move ahead with the shuttle program. Experience tells us that the aerospace industry can respond to even seemingly impossible challenges—and that nations that reject the major challenges of their times do not remain major powers. And a hard fact of international economics is that the United States can remain prosperous in this world only by maintaining and utilizing its advanced technology.

Beyond national considerations, there is the responsibility that a rich and technologically advanced society has to humanity.

As the philosopher, artist and lecturer Earl Hubbard wrote recently, "We live in the simplest times in the history of man. All men face the same challenge, on the same frontier, at the same time, from the same place. The challenge is survival. The place is Earth. Here lies the basis of union—the survival of the race of man, this minority of one, on a speck of dust, circling a minor star in a minor galaxy in a universe broader than our awareness."

Yet, despite logic, the lessons of experience, economic facts of life, and the imperative of long-term survival, there are those who now challenge space exploration and oppose taking the next step toward an effective Space Transportation System, commonly called the shuttle.

Why?

The answer appears to be that we as a

society are frequently floundering in a kind of paralysis imposed by an excess of self-criticism, nowhere more self-defeating than in areas of technology. In our preoccupation with problems of racial relations, poverty, urban decay, crime, the environment, we increasingly tend to find fault with ourselves and our abilities. In a time when more than ever before it is of urgent importance to accomplish, we are becoming expert in critical self-analysis and less expert in following our tradition of *doing* the things that must be done.

Both in government and in private endeavors there is growing reluctance to undertake ventures of great potential usefulness if there is any remote possibility that someone — anyone — might disapprove. Too often, the result is immobilization of our capabilities.

In the case of the shuttle program, some critics point out that it has not been demonstrated in detailed certainty that the effort will be economically rewarding—a difficult assignment when the program is still in the conceptual state, with the design phase of the shuttle not yet under way!

History is full of examples of major ventures that would have been delayed for generations or perhaps never undertaken if such total proof-in-advance had been required. In global exploration, who could have *guaranteed* that the voyages to Cathay or the New World would pay dividends? More recently, on the technological side, what of automobiles, steamships, railroad trains, and heavier-than-air craft?

In fact, of course, all of these innovations had their adverse critics, some of them distinguished scientists of their times.

As to railroads, for example, Egon Larsen's "A History of Invention" recounts that: "When they tried to build the first 'long distance' passenger and freight train from Manchester to Liverpool, a great campaign of abuse began. It was claimed that the terrible spectacle of a locomotive rushing by would affect people and animals; ladies would have miscarriages, cows would cease to give milk, hens would lay no more eggs; the poisoned air from the engine would kill all the livestock in the distance as well as the birds in the trees, and houses along the line would be set on fire by the sparks."

Martin Van Buren (then Governor of New York) wrote to President Andrew Jackson in 1829: "As you may well know, Mr. President, 'railroad' carriages are pulled at the enormous speed of 15 miles per hour by 'engines' which in addition to endangering life and limb of passengers, roar and snort their way through the countryside, setting fire to the crops, scaring the livestock and frightening women and children. The Almighty certainly never intended that people should travel at such breakneck speed."

Regarding airplanes, an example of early skepticism was the declaration by G. R. Borelli in 1680 that; "It is impossible that men should be able to fly craftily by their own strength. I have no faith in any invention designed to lift man from the earth."

As late as 1903, Simon Newcomb wrote: "Aerial flight is one of that class of problems with which man will never be able to cope." Later in that year, Professor Samuel Langley tried unsuccessfully to fly his aircraft and a *New York Times* editorial derided his effort as a "fiasco" demonstrating that it would be millions of years, if ever, before man would fly. Before the year was out, the Wright Brothers made their first successful flight.

Even after that, in 1910, the celebrated astronomer William H. Pickering observed that: "The popular mind often pictures gigantic flying machines speeding across the Atlantic carrying innumerable passengers in a way analogous to our modern steamships . . . it seems safe to say that such ideas are wholly visionary, and even if a machine could get across with one or two passengers, the expense would be prohibitive to any but the capitalist who could use his own yacht."

And at about the same time even Octave Chanute, one of America's greatest aviation pioneers, predicted that: "The (flying) machines will eventually be fast, they will be used in sport, but they are not be thought of as commercial carriers."

In the military field there was a parallel reluctance to accept the potential of airplanes. General William [Billy] Mitchell, contending that bombers were capable of sinking battleships, was forced to conduct a vigorous campaign before senior officers in the Army and Navy would agree to a demonstration. Then, in 1921, a small flight of bombers easily sank three captured German World War I naval ships including a dreadnaught.

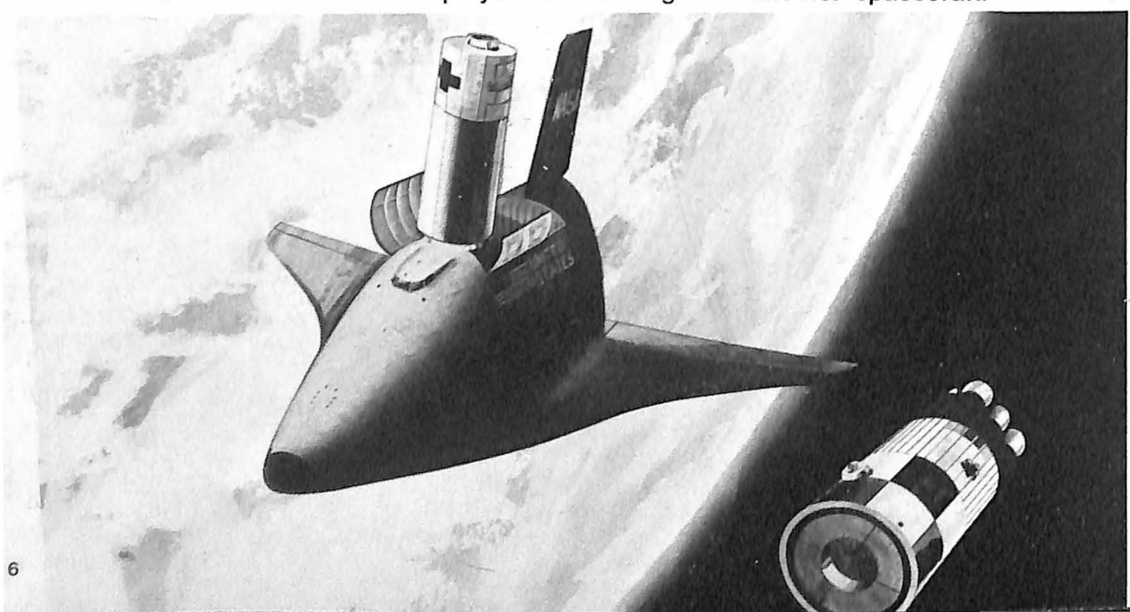
Beginning in the 1930s, piston-engined aircraft steadily proved that they should, indeed, be regarded as commercial carriers, and as an important element in the transportation system. In the 1950s, the introduction of jet transports into commercial service was accompanied by some doubts as to their safety and economics, but these were quickly resolved by the jets' performance in operation and their enthusiastic acceptance by the flying public.

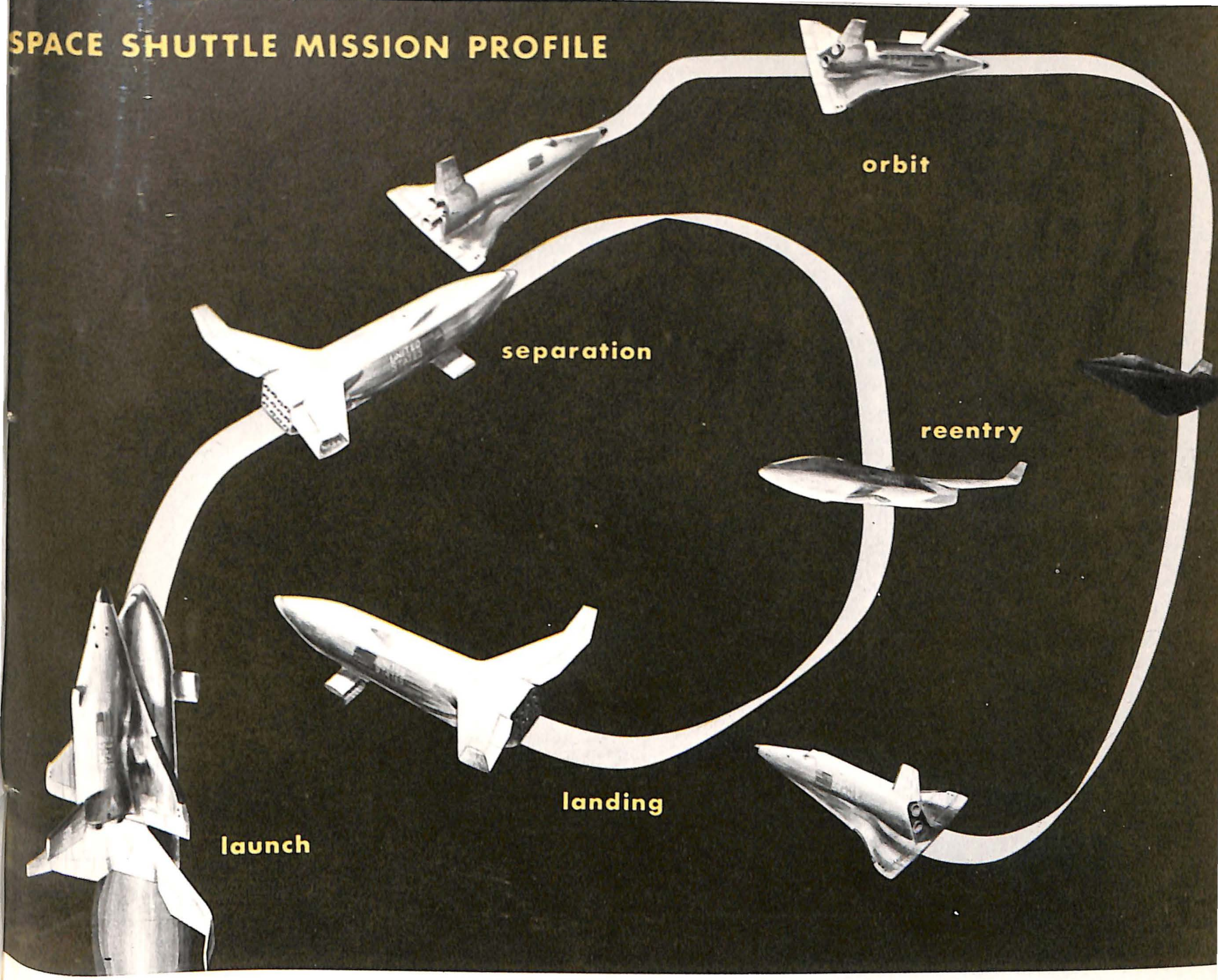
In the field of rocketry, Dr. Robert H. Goddard and other U.S. inventors and advocates suffered at the hands of scoffers for decades, and little support was given to rocket and missile development—until Germany startled the world with its V-1 and V-2 rocket attacks on Britain late in World War II.

After the war, the United States military, utilizing the experience of Dr. Wernher von Braun and his team of German experts, began to pay serious attention to rocketry. Then, in 1956, the Russian launch of the world's first artificial satellite prodded this nation into the accelerated space program that resulted in the first manned Moon landings in 1969—together with a wealth of tangible, down-to-Earth benefits.

Today, few would deny that we have in

One of many functions of the shuttle will be rescue missions. Here a rescue canister is deployed for docking with another spacecraft.





hand, or can readily develop, the technology needed to expand our space activity. Only the willfully negative would ignore the potential of the space program for reaping vast new harvests for mankind. There is little opposition on grounds of scientific or technical feasibility; the criticisms are economic, based on an unrealistic attitude of not proceeding without *precise* (obviously not available) calculations in dollars-and-cents of what the results will be years into the future. Yet we know that we are very poor at predicting the future: that technologically the future always produces more than expected; and that the best way for an advanced people to proceed is to have faith in the future.

One implication of these critics is that huge sums are being spent on space to the detriment of urgent societal and environmental programs. In fact, the space budget is a tiny fraction (about four percent) of that being used to fund those other programs. Furthermore, the detractors ignore the fact that the space effort represents many thousands of jobs (and thereby tax revenues to help finance other programs), and is of great importance in maintaining and advancing technology (of vital importance to our position in international trade).

We have heard a great deal lately about priorities, and I am as anxious as anyone to see us solve the pressing problems of poverty, crime, pollution, etc. But I think it is useful to make the distinction between money that is spent to help solve these problems and money that is spent to create the strong economic base that will be necessary if we hope to solve *any* of our problems in the future. Advanced technology is the key to attaining this strong economic base, and R&D is the mandatory prerequisite to advanced technology. The space program in all of its facets, of course, is our Nation's most important R&D effort, and it is becoming increasingly evident that the space shuttle is an essential element in maintaining a strong space program. Thus, in a very real sense, there are many of us who see the development of the space shuttle as one of the most important undertakings of the 1970's if we hope to have a strong and prosperous America.

"The truth, the central stupendous truth, about developed countries today is that they can have — in anything but the shortest run — the kind and scale of resources they decide to have . . . It is no longer resources that limit decisions. It is the decision that makes the resources. This is the fundamental change — perhaps the most revolutionary mankind has ever known." — U Thant, Secretary General, The United Nations.

The keystone for this revolutionary change has been and will continue to be technological progress which is largely created by a commitment to research and development across a broad front. In view of this critical role of alvanced technology in economic growth and national security, today there exists in many policy and professional circles deep concern over the social and political attitudes surrounding the leveling trend in Federal-supported R&D coupled wth a gradual but significant shift in the direction of government and industry support of R&D.

Serious questions have been raised about the future capability of the U.S. technological base. The Aerospace Research Center of the Aerospace Industries Association, in a report entitled "National Technology Support," identifies the trends in national R&D and their implications.

National Funding Patterns

Total R&D expenditures, which include all expenditures made by the Federal Government, private industry, academic and non-profit institutions, have doubled in the past decade. But this increase does not accurately reflect the real situation since total R&D funding, in constant dollars, remained essentially level after 1968. While non-Federally funded R&D increased from 9 percent annually in the first part of the decade to almost 10 percent per year since 1966, the Federal growth rate dropped sharply from 9 percent annually to only 1 percent.

The recent decline in the total R&D growth rate can be attributed to reduced Federal R&D expenditures, particularly in applied research and development associated with defense and space programs. These decreases have not been offset by commensurate increases in the level of R&D funding by other agencies. In constant 1966 dollars, the total R&D growth rate amounted to less than one-half percent per year since 1966.

Several factors suggest an even greater decline in the nation's R&D effort than these comparisons indicate. The higher costs associated with increasingly sophisticated technology, as well as the fact that more complex technological advancements usually require longer lead-times, suggest that the current low priority of R&D may have more serious long-term consequences.

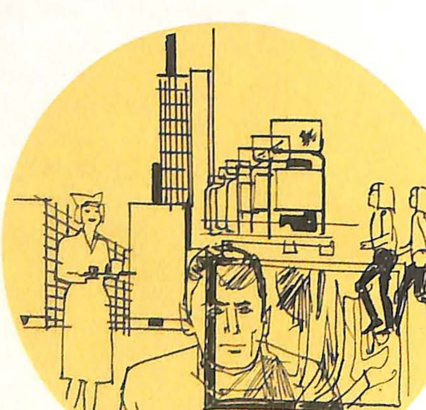
Changing Federal Priorities

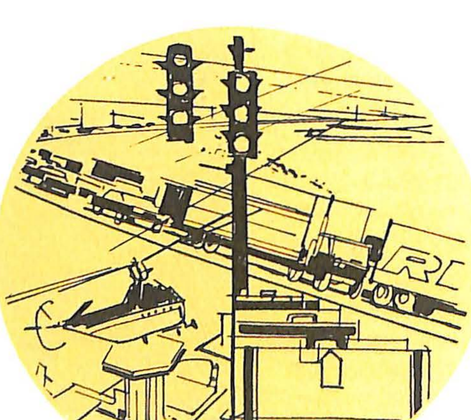
Gradual shifts in national priorities and government spending are reflected in the changing allocation of Federal budget resources and in the recent downward trend and changing nature of Federal R&D expenditures. Although total Federal expenditures for human resources and national defense have continued to account for about 75 percent of the Federal budget, the relative share of defense has dropped from 50 percent in 1960 to a projected level of 34 percent by 1972, whereas the percentage allocated to human resources has increased from 27 percent to 42 percent over the same time period.

The change in Federal budget expenditures points up the gradual shift in total Federal spending from defense and space oriented programs toward domestic programs. Changes are evident in the relative share expended for defense, space, health, housing, and education.

The relationship of Federal R&D expenditures to total Federal outlays and the allocation of R&D funds among agencies and program further highlight the recent changes in national priorities. Federal R&D expenditures, as a percentage of Federal budget outlays, reached a peak of about 13 percent in 1965, primarily

National Technolo





as a result of significant increases in the National Aeronautics and Space Administration R&D budget, and then declined gradually to a present level of about 8 percent. From 1960 to 1965, increases in NASA R&D tended to offset the variations in the level of the Department of Defense R&D.

Until 1965, the combined total of DoD, NASA, and the Atomic Energy Commission R&D expenditures accounted for nearly 90 percent of the total Federal R&D budget. Part of the disparity in R&D expenditures among these three agencies and all other agencies can be attributed to the high costs of development associated with complex defense and space programs. With the completion of the development phase of the lunar space program and reductions in the level of DoD and AEC R&D, the FY 1970 share of DoD, NASA, and AEC dropped to about 82 percent. The downward trend in the total share of the agencies continues to prevail in the FY 1972 budget request.

These emerging trends in Federally-funded R&D are the result of several factors, some of the major ones being:

- Budgetary constraints on all controllable elements of Federal spending to combat inflation, resulting in increased Congressional pressure for justifying R&D;
- The reordering of national priorities, which has intensified competition among defense-space related programs and urban and other domestic programs for limited funds;
- A growing criticism of technology;
- The continuing pressure for decreasing defense and space oriented expenditures;
- The failure to establish long-range national scientific and technological objectives which could lead to a consistency of effort related to national priorities.

The Federal Government/Industry R&D Mix

Government and industry expenditures on R&D dominate the research effort of the nation, accounting for approximately 96 percent of the total. Academic and other non-profit institutions finance the remainder. Consequently, national R&D trends are determined largely by the allocation of funds within industry and government-sponsored research and development. As a result of the increase in company-funded R&D and concomitant decline in Federal R&D, changes have occurred in the nature, level, and orientation of total R&D.

Federal expenditures have increased from roughly $9 billion in 1960 to almost $15 billion in 1970, while industry expenditures went from about $5 billion to $11 billion. The Federal share, as a percentage of the total, reached a high point of 65 percent in 1963 and 1964, and declined to 55 percent in 1970. The industrial share has exhibited an opposite trend in moving from a low of 31 percent in 1963 and 1964 to 41 percent in 1970. Because industrial R&D focuses primarily upon development, this shift has implications for the allocation of funding among basic research, applied research, and development.

Industrial firms continue to account for roughly 70 percent of the performance of total R&D, indicating a drop from 77 percent in 1960. While industrial performance of R&D has remained at a fairly constant percentage of the total since 1965, the source of funding has shifted. Prior to 1968, the Federally-financed share of industrial R&D exceeded that of industry. Company financing of industrial R&D now exceeds that of the government, reflecting the impact of reductions in defense and space oriented R&D.

Recent trends indicate diminishing governmental leadership in the nation's R&D effort. This has a direct effect on the initiation of certain high risk-high cost technologically oriented programs, which cannot be independently financed by industry.

Dr. Edward E. David, Jr., Science Advisor to President Nixon, puts it this way: ". . . in some sense we have in this country a state of technological underambition. There are certainly many more needs and opportunities that we can identify, very concrete ones, than we can bring to fruition.

"To bring those to fruition and to make a program out of them for the future must be done with the cooperation of industry and government. Neither industry nor government can do it by themselves."

Although projected increases in FY 1972 R&D obligations suggest a slight change from the leveling trend of the past few years, the increase is considered insufficient to offset the effects of continued inflation.

gy Support

R&D FUNDING PATTERNS
Average annual rates of growth

Year	Current			Constant		
	Total	Federal	Non-Federal	Total	Federal	Non-Federal
1953-61	13.7	16.3	10.1	11.3	13.9	7.8
1961-66	8.9	8.6	9.4	7.1	6.8	7.5
1966-71	4.6	1.0	9.7	0.3	−3.0	5.2

Additional dissipation of Federal research and development may occur through the spreading of R&D funding across more agencies and programs.

Industrial R&D

Next to the Federal Government, industry finances the largest share of R&D, with academic and other nonprofit institutions accounting for less than five percent of the total. Historically, industrial research and development differs from the Federal Government in that a considerably larger portion of the total is devoted to development (about 80 percent) and a smaller amount to basic research (about 4 percent). The relative shares for applied research are roughly the same.

Since the mid-1960's industrial expenditures for R&D and the relative share financed by industry increased gradually, indicating the priority attached to a consistent and continuing research capability. As early as 1964, Federal funds contracted to the industrial sector, particularly aerospace, started declining. Although company-financed R&D increased steadily, it failed to take up the slack created by reductions in Federal R&D. According to one estimate, R&D financed by industry is expected to increase from 1971 to 1974 by about 6 to 10 percent per year versus a projected 1.2 percent per year increase in Federal financing of industrial R&D. Obviously this shift in expenditures suggests a change in R&D priorities at the national level, partly as a result of Federal budget constraints.

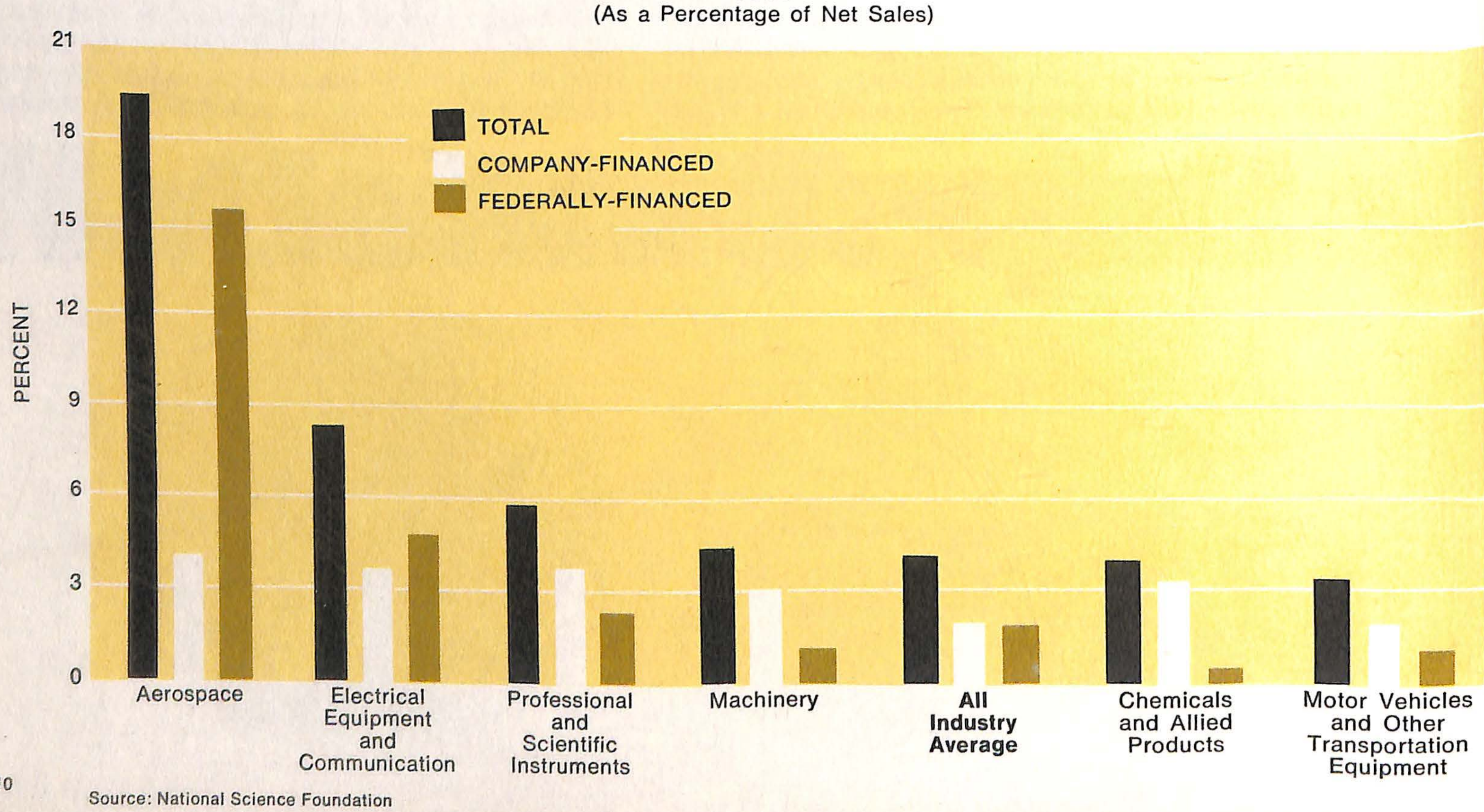
The aerospace industry and the electrical equipment and communications industry traditionally have been the largest performers of R&D, accounting for about 56 percent of all industrial R&D A recent survey by the McGraw-Hill Department of Economics, however, suggests that the aerospace industry may relinquish its leadership position to the electrical equipment and communications industry by 1974. Even with the slower growth rate in aerospace R&D, estimated new product sales (not produced in 1970) are expected to account for 31 percent of the total 1974 sales, in contrast to an average for all industry of 16 percent.

Scientific and Technical Manpower

Previous changes in Federal support of various activities or programs have had a feedback effect on the desirability of pursuing certain careers, although changes have been gradual. This feedback on scientific careers was evident particularly in the post-Sputnik period, and now another shift is emerging in the current interest in environmental and social problems.

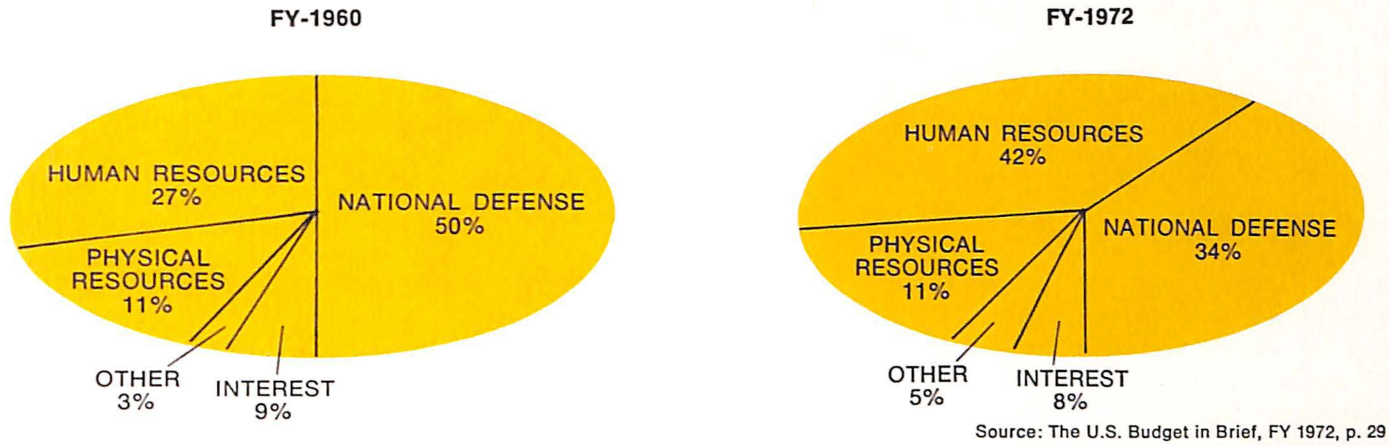
Whereas the number of natural science and engineering graduates increased significantly from 1955 to 1960, the number of graduates in these fields has leveled off since 1965. In the National Science Policy hearings, Dr. Philip B. Handler, President of the National Academy of Sciences, pointed out that the "effect on student attitudes of Federal vacillation and seeming disinterest in science is reflected, in part, in declining undergraduate enrollments, particularly in the 'hard sciences' and will

R&D PERFORMANCE BY SELECTED INDUSTRIES
1968
(As a Percentage of Net Sales)



Source: National Science Foundation

CHANGING COMPOSITION OF THE FEDERAL BUDGET



Source: The U.S. Budget in Brief, FY 1972, p. 29

soon affect graduate enrollments in all of the natural sciences."

The lack of adequate consideration of the long-term balance among various fields of science implies future imbalances due to the leadtime required in establishing different capabilities and in providing incentives to pursue certain disciplines. Dr. Handler cautioned that, ". . . those who would arbitrarily restrict the size of our future total pool of scientific personnel are taking a limited view of the national future and indeed placing a mortgage on that future. Such proposals, generated in the current Federal atmosphere, are conditioned by those events which make for stringency of funding. . . . Clearly, if we seriously restrict the number of people entering graduate school hereafter, we may lose our options for the future . . . Federal decision should not be conditioned exclusively by current projections of the level of effort in defense or space R&D."

In addition to assuring future scientific capability through higher education policies, provisions for the retraining and transfer of current manpower resources also ensures the maintenance of a skilled scientific base. The current lack of mobility within the aerospace industry and constraints on the transferability of capabilities to other industries have become critical issues. Along with the declining rate of Federal R&D expenditures, the average annual rate of growth in R&D scientists and engineers also has declined.

Conclusions

The viability of the nation as a leading economic political power has been attributed largely to the maintenance of scientific and technological capabilities. Underlying factors in the present debate over technology involve the level and orientation of funding to be devoted to research and development activities. The quantitative data developed in this study indicate that new patterns are emerging in the magnitude and direction of research and development in the United States and lead to the conclusions that follow.

- Recent R&D trends reflect diminishing governmental leadership in R&D which would lead to an erosion of the national research effort. The impact of continued inflation, the higher costs and longer leadtimes associated with increasingly sophisticated projects, plus accelerated efforts to meet specific national goals, suggest an even greater degradation of the total R&D effort than an examination of expenditures would indicate.
- Because of the different nature and emphasis of industrial and Federal R&D programs, the recent growth of industrial financing and leveling of Federal funding indicate a shift in the overall direction of national R&D activities. Whereas industrial research and development has focused primarily upon product improvement and product development, most of the nation's basic research and the high risk-high cost activity has been financed by the Federal Government. Although their respective R&D programs frequently are complementary, certain technological projects traditionally initiated or sponsored by the Federal Government are beyond the financial scope of private enterprise. Consequently, a reduction in Federal R&D activity could have a negative impact on the level of sophisticated effort nationally.
- Investments in higher education, the level and nature of Federal R&D support, and the utilization of existing manpower, provide some indication of the long-term scientific and technical capability of the nation. Previous Federal support of certain programs has had a feedback effect on the desirability of pursuing certain careers. Thus the failure to consider the long-term relationship among various fields of science implies future imbalances due to the leadtime required in developing trained manpower.
- Investments in research frequently have an impact on future development capabilities. Consequently, current shifts in research expenditures, which are indicative of changing priorities at the national level, may be reflected in the future allocation of development funding. More importantly, erosion in certain research areas could limit or predetermine future technological options.

These factors underscore the already recognized need to establish longer range R&D priorities, along with a well defined national technological strategy. In contrast to the fluctuations over the past decade, a long-term commitment to maintain a continuing and constant R&D effort at the Federal level would guarantee a scientific and technological base capable of responding to problems of national concern. The failure to establish a national R&D strategy clearly could limit future options and establish serious constraints on the adequacy and quality of the technological base upon which our future national progress is dependent.

Aerospace Profits vs Risks

Economic risks involved in the aerospace industry are higher than in other industries and are still going up while profits, already below those of other manufacturing industries, continue to decline.

This is a basic conclusion of a report, "Aerospace Profits *vs.* Risks," prepared by the Aerospace Industries Association's Aerospace Research Center.

Risk is defined as the inability to project the level of future profits with certainty. In any industry, higher risks must be reflected in higher potential profit rates in order to attract new capital and to provide for growth, i.e., to maintain the viability of an industry. While risk is present in all industries to some degree, it appears to be particularly high in aerospace due to several factors, some of which are largely unique to this industry. In the final analysis, however, all risk can be reduced to financial risk, or more specifically, the probability of obtaining profits substantially below a competitive average.

The Nature of Risk

Four broad categories of risk will be discussed: research and development risks; production risks; risks associated with major dependence upon one buyer; and market risks.

In considering each type of risk, the objective was to determine qualitatively the degree of risk which is inherent in the aerospace industry relative to other economic activity. The burden of this risk is shared between the industry and the government.

Research and Development Risks

When considering the risks associated with research and development contracts, it is important to realize that the term encompasses the unpredictability of quality, performance, and development time as well as the often publicized cost problem. Concerning total risk, it is obvious that the greater the percentage of any firm's business which involves research and development, the higher the total risk. Production work is not as risky since past experience can be more easily applied as a yardstick to estimate future performance regarding quality, timing, and costs.

In comparing research and development of the aerospace industry with that of commercial activity, it appears that this industry faces higher than average risk on two accounts. First, the complexity and sophistication of the average aerospace system is definitely greater than that of most commercial

products. In this industry scientists and engineers are generally on the frontier of knowledge and, therefore, the outcome on costs, quality, and timing is more difficult to predict. In general, commercial research and development activity concentrates more on refinements of current systems and less on complete development of new systems.

The second point involves taking account of the mix in final sales, i.e., research and development versus production work. Few would deny that research and development work is more risky than production work for the reasons earlier expressed. Since the magnitude of research and development work in the aerospace industry is many times that of the average industry, by definition, the uncertainty must be greater.

Production Risks

Under the general category of production risk, there are two principal types. The first concerns the lengthy production phase which is characteristic of so many major aerospace systems and the other is the unique nature of the fixed capital of the industry.

Lengthy production phase (also called lead time) means the time that elapses between inception of development of a product and the time that the operational system becomes available. The lead time for major defense systems is clearly longer than that for typical commercial products.

The relative inflexibility of the capital facilities, mostly the equipment, presents a definite risk since it is often so sophisticated that its use to produce other products economically is extremely limited. For many industries, the equipment is much more flexible, and, when the demand for a given product declines, it can be used to produce other marketable items. This is not the case for the aerospace industry, at least not to the degree which is found in other economic activity.

Economic theory teaches that, in the long run, a firm will exit from an industry if profits drop below some level which is necessary to maintain the flow of capital into the firm. However, the ability of any individual firm to diversify depends heavily upon the capability of the firm's management to adapt its capital facilities and equipment to new markets.

Single Major Buyer

The reliance of a major portion of the aerospace industry on essentially one large buyer (the Federal Government) constitutes risks which are also unique to this industry.

One of the major problems which confronts the contractors on R&D type work is that often the contracting agency does not have a thorough understanding of what performance should be on a given program. Not only does this constitute a risk for the contractors at the beginning of any program, but it normally indicates that there will be numerous changes and modifications during the course of the contract.

The second major element of risk associated with contracting with the Federal Government is the volatility of funding. Sometimes a program is funded for a given year and then reduced the next year, only to be increased during some future period. This fluctuation causes both an under-utilization and an over-utilization of both fixed investment and labor.

Market Risks

There are several other risks which the aerospace industry currently is beginning to face and will be increasingly important in the very near future. These include a declining market and the tendency toward fewer but larger contracts.

Although several factors contributed to the market decline, the overriding factor is that of a realignment in national priorities. One of the first impacts was a drastic cut-back in the space exploration program. In addition, pressures on the DoD to reduce their total expenditures increased, leading to a decline in total DoD procurement expenditures.

A reduction in the commercial side of the market also was evident during the last two years. Two factors are important here. First, the conversion to the first generation of jet aircraft by the airlines is just about completed and, secondly, the rate of increase in the demand for air travel has declined.

A declining market obviously constitutes a definite risk to firms in that market. Given that there are certain economies of scale in the production of major systems and a reduced market can only support a few firms which can take advantage of these economies, then there is a definite risk that certain firms must merge or leave the industry.

The movement toward a decrease in the absolute number and an increase in the unit value of major systems constitutes another increase in risk. With only a few large contracts, the loss function is substantially different, since a loss on a single contract could bankrupt a given firm. In conclusion, the nature of the product and the dependence largely upon one buyer indicate that the risks in this industry are greater than those found in other economic activity.

Risk on Capital Investment

Business firms risk capital in two types of investment: fixed plant and equipment, and working capital. Investments in fixed plant and equipment are relatively long-term commitments of capital which must be recouped by using the facilities over a number of years. Equipment is generally depreciated over an 8 to 15 year life and plants over a 40 to 50 year life. The greater the uncertainty of the future demand for the products of the industry, the greater is the risk to the firm of not being able to recoup its investment in plant and equipment from future production. The more specialized the plant and equipment, the greater are the problems in converting the facilities to economical production of other products.

Calculations show that the government is providing only 17 percent of the higher risk fixed capital; it supplies about half of the working capital, and 37 percent of the total capital requirements of the industry. Since about 20 percent of the industry's production is for commercial customers, these percentages would be somewhat higher for government contract work alone.

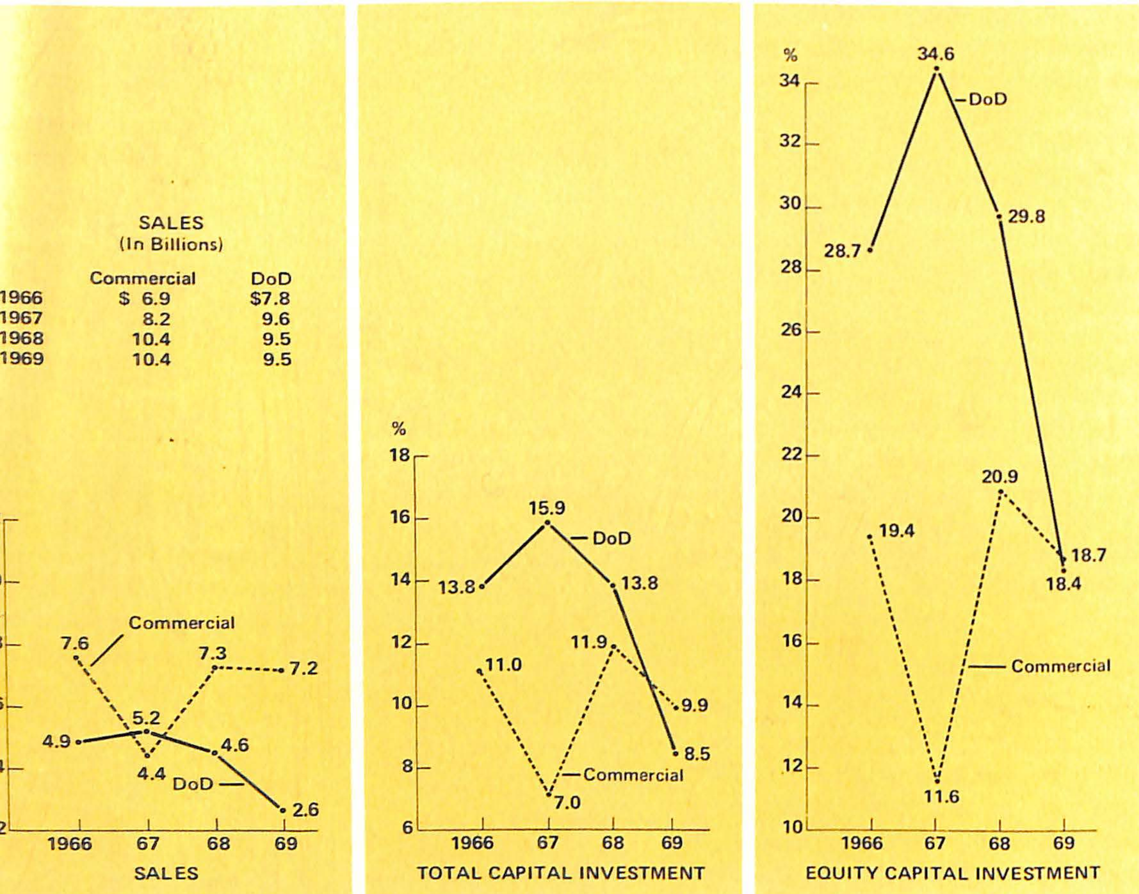
It is interesting to note that the share of the working capital per dollar of sales furnished by the companies alone is in line with that of other industries, and only slightly less than that for the average of all manufacturing industries combined.

The Sharing of Risk

In any competitive environment, economic theory holds that there will be a tendency toward equality in the rates of return on investment across firms and among industries. That such a tendency does not usually produce equality is attributed to several factors including imperfect knowledge concerning returns in alternative industries, efficiency, and risk.

Economic theory also holds that the realized rate of return should be commensurate with the level of risk, i.e., as risk increases, so should the expected rate of return. What happens in the marketplace is that investors balance

PROFITS BEFORE FEDERAL INCOME TAXES:
12 AIRCRAFT, MISSILE AND SPACE CONTRACTORS



Source: GAO, *Defense Industry Profit Study*, 1971

low return-low risk against high return-high risk situations until some equilibrium is found where a schedule of risk exposure and its corresponding risk premiums are developed.

It is unfortunate that the empirical work does not present stronger evidence of payments for risk premiums. Nevertheless, it is more than likely that many other factors such as differences in market structure, technology, and managerial ability influence rates of return. Given that the long-run viability of any industry depends primarily on an adequate continuing profit rate which properly reflects the degree of risk, it seems appropriate to continue to seek an objective measure of risk.

The points involving contract type, warranties, regulatory requirements including unallowable and nonrecoverable costs, and total package procurement are significant. That risk has increased and industry profits have not increased but, in fact, have declined, indicates that the industry is truly in a much weaker position now than it was a decade ago, and that the trend, in terms of future health of the industry, should be of broad concern.

Profit Rates and Risk

Rates of return may be measured by various methods, each selected for a particular purpose. Generally accepted methods are sales, equity capital (net worth), and total capital invested (TCI).

Rate of return on total capital invested was the method employed in both the Logistics Management Institute (LMI) profit reviews and the General Accounting Office (GAO) Defense Industry Profit Study, though each used a different definition.

The GAO report includes the results of a study of profits on DoD contracts for the years 1966-1969. In this study, the GAO calculated rates of return on all three bases: sales, equity capital, and total capital invested. The calculations were made separately for DoD contracts, other defense agency contracts, and commercial business. (See Chart, p.14). Perhaps the most important aspect of the data is the significant drop in all the rate of return measures on DoD work in the past two years.

The aerospace industry has experienced a considerable shift in the distribution of its sales between government and commercial markets over the past decade. The commercial share has increased from approximately 12 percent in 1959 to almost 25 percent in 1968, dropping back to slightly under 21 percent in 1970.

Implications for the Future

In assessing the future outlook, economists traditionally differentiate between the long-run and the short-run (the next few years). In both cases, past experience modified to reflect current and expected changes in government policy serves as the best indication of the future. Given that government policy changes considerably and exerts a strong impact on the future of the aerospace industry, implications will be restricted to the short-run. In addition, it must be assumed that the Federal Government will continue its present fundamental policies regarding its contracting relationship with the private sector.

Changing Risk

The complexity of major systems, including the inherent problems of integration of subsystems and components, is sure to continue to increase. This situation will make it more difficult to estimate costs, delivery time, and final performance of research and development work in the future.

The increase in the general sophistication of systems plus recent moves away from concurrent development and production also will cause an increase in the lead time from program inception to operational readiness. These conditions, coupled with the continuing phenomenon of price inflation, suggest increased uncertainty in projecting costs.

Perhaps one of the most significant current trends which constitutes a dampening of optimism for the aerospace industry is that of market size. More precisely, in the near future, sales will most likely witness a decline and at best show some marginal improvement. Based on a composite of several generally accepted projections, the future would appear to be as follows.

The years 1971 and 1972 will be marginally below recent previous years for space exploration. In all probability, NASA expenditures will remain slightly over 3 billion dollars a year for the next few years. Concerning DoD expenditures, there may be a slight upturn in expenditures during the latter part of 1972 which will carry through into 1973.

Both the procurement of production items and research and development expenditures should see some modest growth, with emphasis on R&D to maintain national options. On the commercial side, the outlook is rather pessimistic for the near term. The overcapacity problem that commercial airlines are now witnessing will be reflected in declining sales for the aerospace industry during the next few years. This market outlook is definitely an element of increased risk.

Profit Rates

The profit rates of the industry over the past seven years have been below those of all manufacturing industries combined (based on either sales or total capital invested). With consideration of the high risk in the industry, these rates do not appear to be sufficient to attract further equity capital to the industry. In fact, the industry has raised over 75 percent of its new long-term capital by borrowing over the past seven years. Borrowing is becoming more difficult and the bonds of the companies in the industry are generally rated low.

The drastic drop in profit rates experienced by the industry over the past two years, together with the poor sales volume projected over the next several years, indicate further financial problems for the aerospace industry unless profit rates are significantly and rapidly improved.

Other Implications

The working capital requirements of the aerospace industry (including that furnished by the government) have been shown to be high relative to other industries. In view of the low profit-to-sales ratio of the industry, the complete financing of this working capital by the industry could be prohibitive. For example, the working capital furnished by the industry plus short-term debt to banks (on which interest must be paid) amounted to 25 percent of sales in 1970.

Profit rates alone are not a sufficient yardstick by which to gauge the fairness of contract pricing or industry performance. Profit rates must be viewed in light of the risks and industry efficiency relative to other industries. Until some objective measures can be established for both risk and industry efficiency, profit rates will continue to be viewed subjectively and interpreted to reach widely divergent conclusions. To some, low profit rates will be attributed to low industry efficiency rather than to inequitable contract pricing. Conversely, high profit rates will not be attributed to high efficiency but will be labeled "exorbitant."

Conclusions and Recommendations

Altogether, the evidence can only lead to the conclusion that:

- *Risks in aerospace business are very high and have been increasing over time.*

While economic theory and business practice of all types recognize that rates of return, i.e., profit, should be relative to risk, there appears to be no adequate yardstick available to measure risk other than very coarse and, one would suspect, highly visceral or intuitive measures. There is no guage today which can say, for example, that a given program is 3.2 times as risky as the norm and therefore should carry a potential of 3.2 times the profit. Neither are there adequate measures of ameliorating risk, such as by type of contract used or level of capital supplied, for such would also require the ability to firmly state that a given action would reduce risk by a given percentage. Thus, in aerospace work both the government and industry are limited to coarse measurements such as "low" or "high" and lacking certainty, to conservative judgements. This situation can only lead to the conclusion that:

- *The absence of an adequate measure of risk weakens the ability to equate risk with profit, which particularly penalizes higher risk enterprises.*

Not only is aerospace work burdened with the foregoing difficulties of risk, it is also subjected to the popular notion that the government supplies most of the industry's capital needs, thereby reducing its financial risk. Such risks are popularly divided into two types: fixed plant and equipment, and working capital.

Plant and equipment are relatively long-term commitments of capital which are depreciated over an extended period of time and are relatively more risky. Working capital, on the other hand, represents relatively short-term commitments of funds to finance inventories and work-in-progress. It has generally been contended that the government provides most of the facilities and working capital used by the aerospace industry. The facts, however, are that the government currently furnishes only 17 percent of the total fixed capital, and about one-half of the working capital of the industry, for a combined contribution of about 37 percent of the total. Considering that the working capital requirements per dollar of sales of the industry are almost double that of all other manufacturing industries, it is concluded that:

- *The popular contentions that the industry has little risk and that the major portion of capital requirements of the aerospace industry is furnished by the government are incorrect and highly misleading.*

The trend of rapidly falling aerospace profits will have to be reversed or the capabilities of the industry will be seriously eroded. It is clear that this trend has been aggravated by reduced sales, but it seems equally clear that the decline can be traced to the fundamental lack of adequate recognition of the high risks of the industry in profit considerations by the government customer.

The question of how to rectify this inequitable situation in a timely manner would appear to be of as much importance to government policy makers as it is to the industry. To ignore it is to court continued stress and problems in the future to the detriment of not only the industry, but also to the nation, its economy and its technological capabilities. Because of the interrelationships of various forms of risk, timely action should be taken in several areas in order for an effective adjustment to result. This study points to at least two major areas where change could be justified based on available data:

1. Change policy so as to fully reimburse contractors, consistent with sound commercial practices, for all reasonable costs incurred in government contracts except where expressly barred by law.

Such a change would provide immediate relief by appropriately recognizing ordinary and necessary costs of doing business which currently are disallowed in whole or in part.

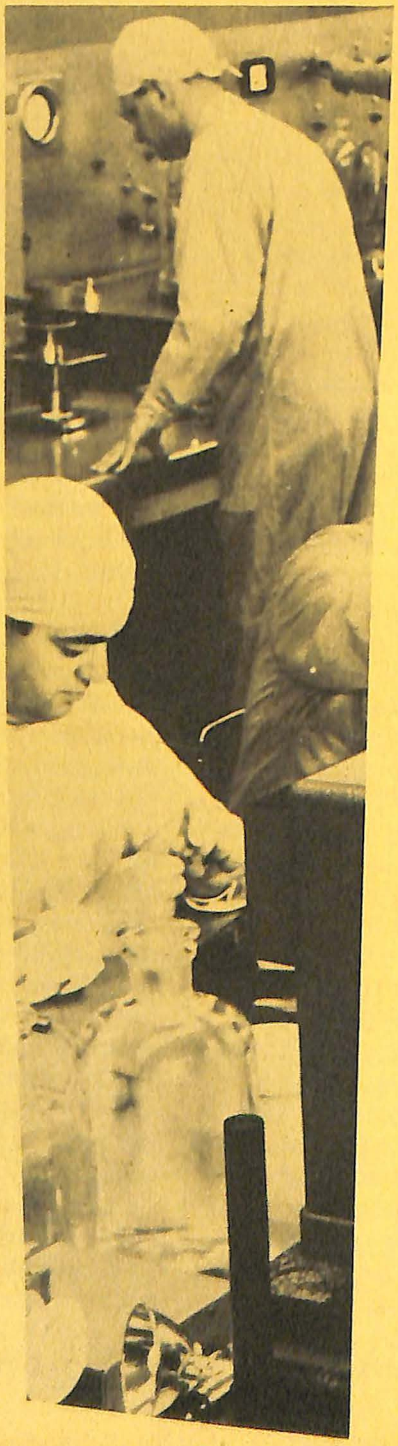
2. Provide policy recognition to the inherently greater risk in aerospace programs and increase profit rates in negotiations accordingly.

Even though a precise measure of risk is not available today, it is abundantly clear, regardless of the type of contract or profit measure used, that past practices have not adequately provided for risks and that excessively conservative target levels have been utilized, even though higher levels are authorized in current regulations.

Science and Technology: 'A POSITIVE OUTLOOK'

BY DR. WERNHER VON BRAUN
Deputy Associate Administrator
National Aeronautics and Space Administration

Condensed from a speech by Dr. von Braun before the Aviation/Space Writers Association, Washington, D.C., May 27, 1971.



. . . There is a chronic misunderstanding about science and technology on the public's part that I am afraid is growing, but which isn't altogether the public's fault. This concerns the role that science and technology play in the development of society and the economy. There is, unfortunately, no visible link between scientific discovery about natural phenomena on the Moon, for example, and our everyday lives here on Earth. Yet, there are concepts and knowledge coming out of the Apollo explorations, and experiments with the rocks and dust brought back from the Moon, that offer the potential of improving agriculture and the treatment of disease, and as we learn more about interior of heavenly bodies may even help us in locating mineral resources here on Earth or predict earthquakes.

Most concepts and scientific knowledge take years from the time a scientist formulates them and they enter the technology until some no-nonsense pragmatist comes along and turns the idea or knowledge into a product and a flock of new jobs. By that time, everyone has forgotten, if he knew at all, that it was the scientist who started it in the first place. The interesting thing about this process is that the scientist is labeled "impractical" because he deals in theories and squiggly mathematical symbols. . . .

We face a militant, highly emotional, even fanatical segment of the population which has seized upon a valid and good cause, but which will accept no facts, no reasoning that run counter to its own fixed ideology. The anti-science/technology people are demanding that we pull the plug on modern civilization in the belief that somehow we shall all be better off in a more primitive state.

However, in primiitve times, the major question for mankind was physical survival. It is not hard to guess the predictable fate of hundreds of millions of people who depend upon modern technology for the necessities of life. We have only to consider for a moment what we would do without electricity, permanently. Even the famous naturalist, Konrad Lorenz, has been warning student audiences that if they destroy our store of knowledge to make a "fresh" start, they will fall back not a few centuries, but several hundred thousand years. "If you make a clean sweep of things," he observes, "you won't go back to the Stone Age, because you are already there, but to well before the Stone Age."

But it isn't the young people, the students, who are really to blame for this attitude of hostility to science and technology. They are simply misguided by certain social philosophers, cultural historians, and the like, whose teachings and published works provide only a very lopsided view of science and technology pictured as causing the downfall of man.

When you teach impressionable and idealistic youth that the rational, logical, puritanical work approach to life is bankrupt, and that technology serves only to erode the quality of life, you are bound to ring responsive bells in many minds of a generation that has never known the deprivation, the want, and the poverty of some older generations.

When a historian and philosopher of Lewis Mumford's stature inveighs angrily and brilliantly against the "megamachine" of science and technology, and declares there can be no reform until the present "megatechnical wasteland" is destroyed, a revolutionary spirit is fanned among the young. The natural fires of rebellion we have all felt against "the system" or the "establishment" are now stoked by an eminent and respected "authority. . . ."

It seems strange that America is about the only nation in the world where technology and science are held in such low repute. All the so-called "have-not" countries in Africa and Asia are straining their limited resources to gain what some of our students seem bent on destroying. The older European countries would give their eyeteeth to have our technological capabilities. The Soviets are especially envious, and frequently announce they will surpass the United States in production or some other field of technology. So far they have failed to do so. . . .

The anti-science and anti-technology voices making blanket attacks on science and technology in the name of conservation, a clean environment, or improving the quality of human life, are doing the nation and all of us a great disservice. The problems they are rightly anxious and concerned about cannot be solved by a return-to-nature cult. That course leads only to disaster for multitudes of people.

Closely related to the general attacks on science and technology is the denigration of the space program among some persons. Mumford describes the space rocket as "the most futile in tangible and beneficial human results," and sees only that while man is indeed conquering space, the "megamachine" is carrying further its conquest of man.

Surprisingly—or perhaps, not so surprisingly—Mumford ignores the apparently limitless resources of knowledge that await man in space. Some of this knowledge, as we have just begun to learn, has great significance to man, to Earth environment, and to the ecology. We are learning of the relationships between Earth and Sun and their effects on our lives which could be learned in no other way save by means of the rocket and spacecraft. Nor does Mumford make an allowance for man's need to extend his intellectual horizons by physically exploring new worlds, no matter how barren and unfit for organic life, such as the Moon may be today.

This kind of knowledge and intellectual broadening apparently is of little or no value in the eyes of social philosophers and historians preoccupied with man in the microcosm. They have not yet learned to visualize mankind extending into the macrocosm, or for the spiritual need to do so. The desire to know is more powerful than they may suppose. Pragmatism is a valuable, stabilizing human characteristic; but without imagination we would not be human, and as long as man exercises this precious faculty, he will not long be imprisoned in the successive shells the pragmatists try to enclose him.

Those who look upon science and technology as a megamachine that dominates their lives and holds them in thrall to a strictly programmed existence have their own special hang-ups. There is another view, and it was expressed by Glenn Seaborg:

"The difference is . . . a positive outlook, some imagination, and the desire to put science and technology to work more creatively."

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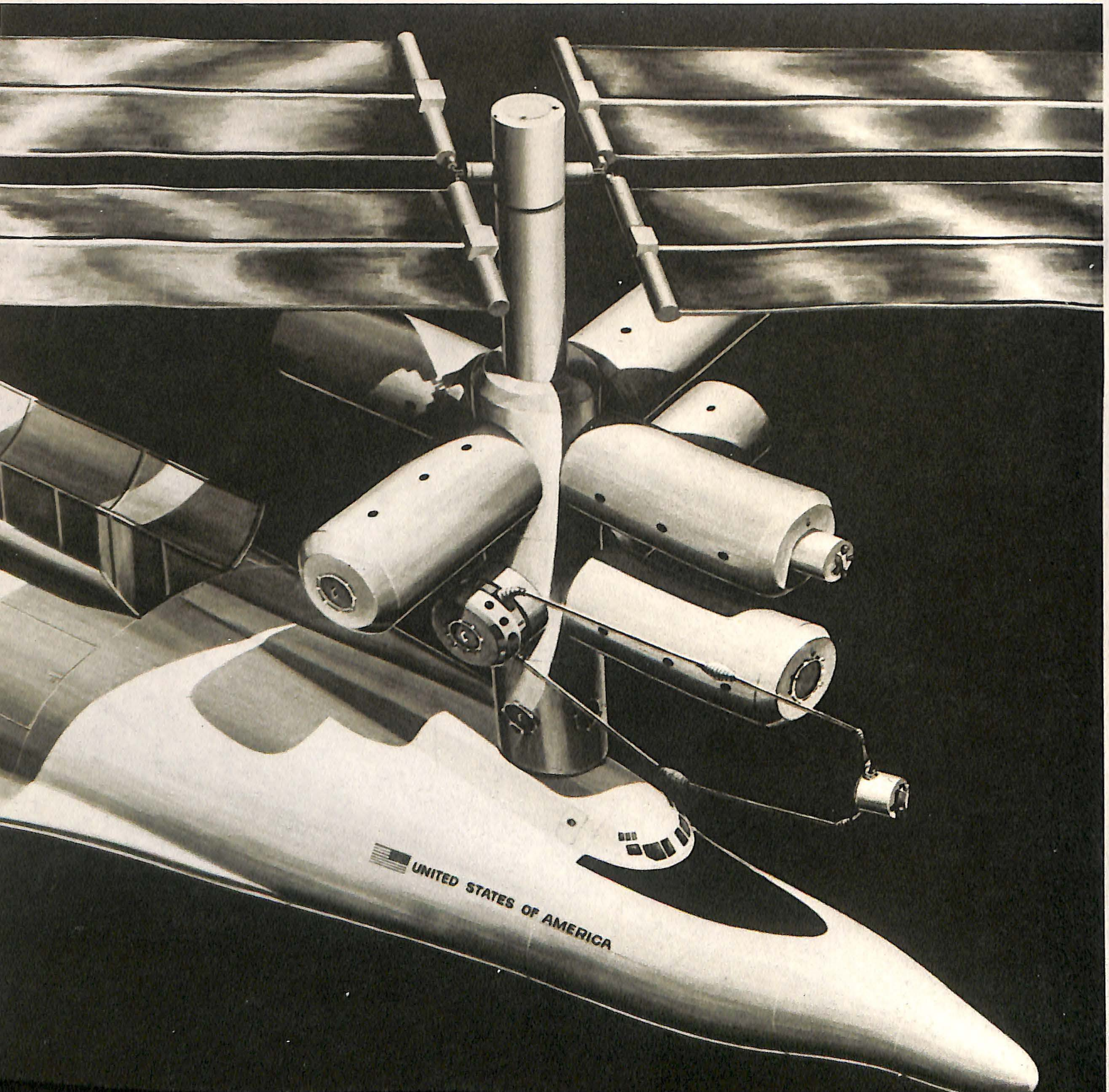
NASA's space shuttle orbiter vehicle docks with satellite on repair mission. (See **Liftoff to Economy — The Space Shuttle,** page 2).



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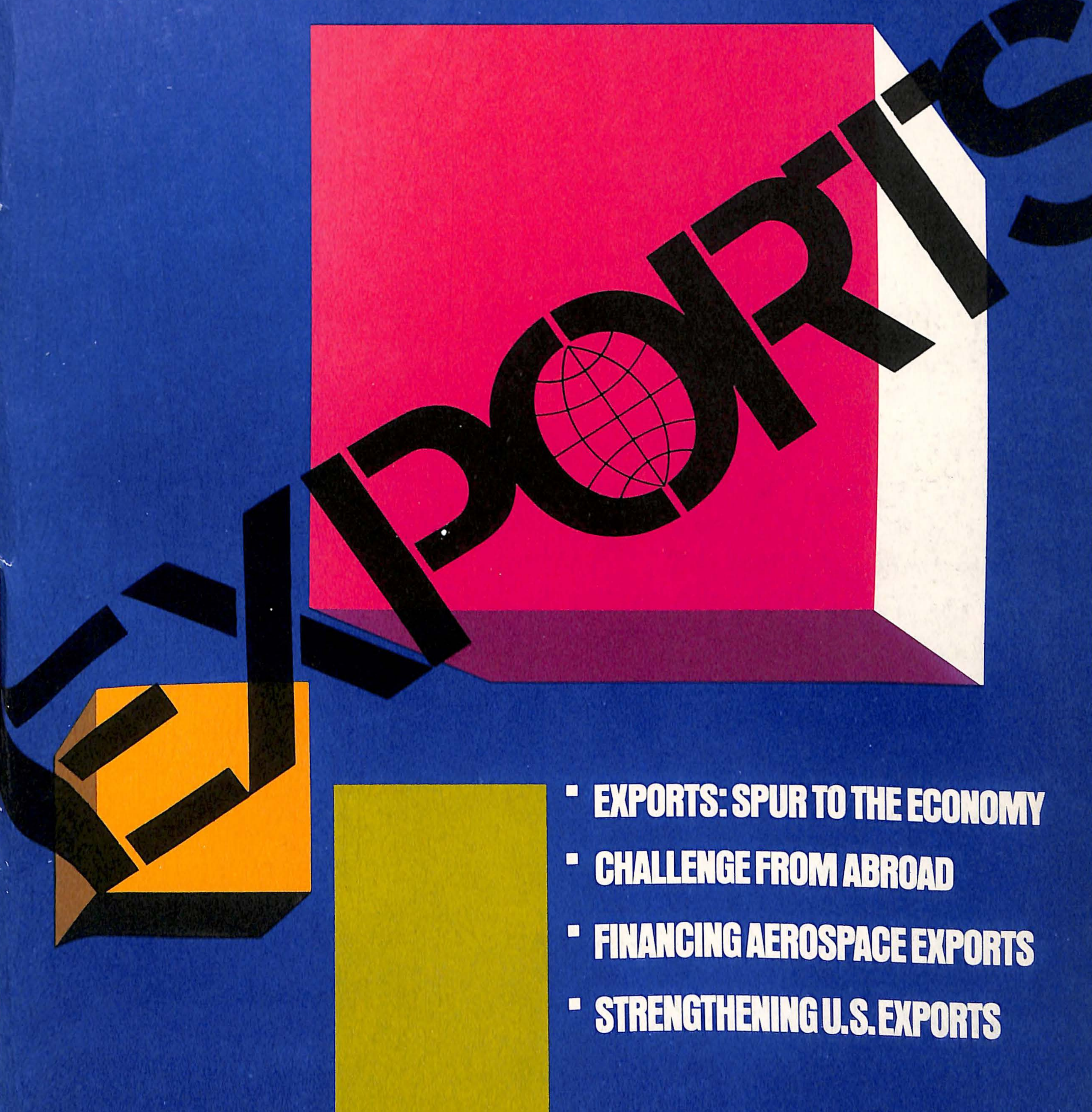

- EXPORTS: SPUR TO THE ECONOMY
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- FINANCING AEROSPACE EXPORTS
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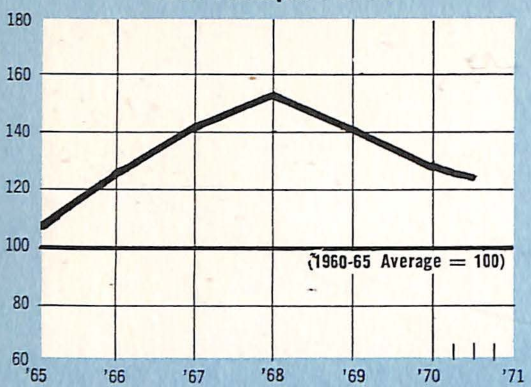
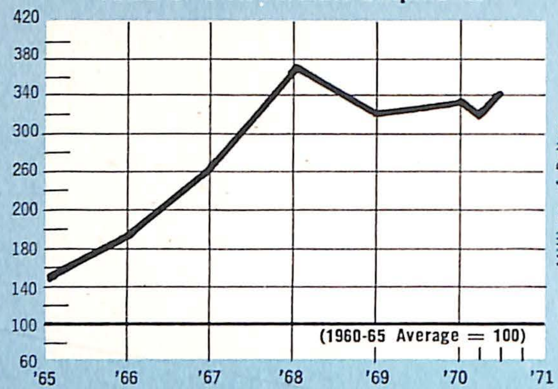
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

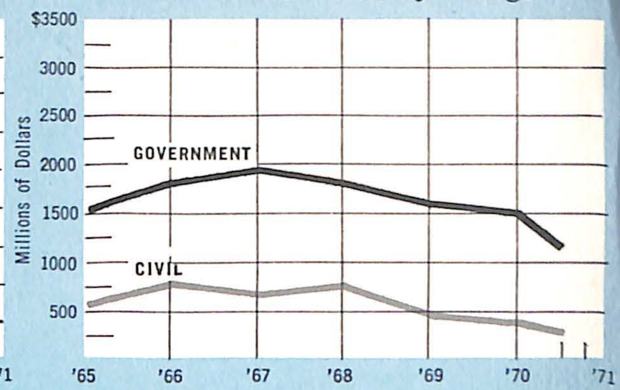


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1960-65 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	2nd Quarter 1971	25.6	24.4	24.1
	Billion $	Quarterly	4.8		6.5	5.4	6.2
DEPARTMENT OF DEFENSE							
Aerospace Obligations: Total	Million $	Monthly	1,151	May 1971	34	883	782
Aircraft	Million $	Monthly	601	May 1971	—17	582	387
Missiles & Space	Million $	Monthly	550	May 1971	51	301	404
Aerospace Outlays: Total	Million $	Monthly	1,067	May 1971	1,217	1,112	1,041
Aircraft	Million $	Monthly	561	May 1971	763	666	628
Missiles & Space	Million $	Monthly	506	May 1971	454	446	413
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920✣	May 1971	797	620	538
Aircraft	Million $	Monthly	447	May 1971	591	390	339
Missiles & Space	Million $	Monthly	473	May 1971	206	230	199
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	June 1971	496	238	424
Expenditures	Million $	Monthly	130	June 1971	386	272	252
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3#	2nd Quarter 1971	25.2	24.5	22.5
U.S. Government	Billion $	Quarterly	11.6		12.6	13.0	11.6
Nongovernment	Billion $	Quarterly	3.7		12.6	11.5	10.9
EXPORTS							
Total (Including military)	Million $	Monthly	110	June 1971	236	494	299
New Commercial Transports	Million $	Monthly	24	June 1971	80	210	69
PROFITS (After Taxes)							
Aerospace — Based on Sales	Percent	Quarterly	2.3	2nd Quarter 1971	2.1	1.7	1.9
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		4.4	3.9	4.5
EMPLOYMENT: Total	Thousands	Monthly	1,132	June 1971	1,158	976	968
Aircraft	Thousands	Monthly	469	June 1971	510	408	403
Missiles & Space	Thousands	Monthly	496	June 1971	479	404	401
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	June 1971	4.11	4.30	4.32

R Revised.
E Estimate.
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
\# Averages for 1961-65.
✣ Averages for fiscal years 1960-65.

Source: Aerospace Industries Association

BY KARL G. HARR, JR.

President,
Aerospace Industries Association

Until recently in the relatively brief history of the United States, special circumstances — great natural resources coupled with available labor to support growing industrialization — tended to reduce the importance of significant trade abroad, and more often than not the average citizen was not aware of the critical importance of international commerce.

Within the space of a few decades this situation has changed. Now our economic health, including high domestic employment, relies on success in international commerce, as well as on inventiveness, efficiency, quality and high productivity.

The extent to which the health of our economy is dependent upon a strong position in world trade never has been more strongly emphasized than it was in President Nixon's recent statements on the new economic policy for the nation. In his October 7th address the President gave "free trade as long as it is fair trade" equal weight with wage and price controls in the effort to solve the Nation's economic problems. "This will mean more sales of American goods abroad and more jobs for American workers at home," he said.

Today, as the President acknowledged, our economic health is not good and we are in trouble in our accustomed overseas markets.

In 1970 net U.S. aerospace exports amounted to $3.1 billion, and our favorable balance of trade was $2.2 billion. Obviously, without aerospace exports — a field in which foreign competition is growing dramatically — we would have had a foreign trade deficit in 1970. During the 20 years preceding April 1971 there hadn't been two months in succession during which United States imports exceeded exports. Beginning with April of this year we have suffered an international trade deficit for five consecutive months. The U.S. trade surplus for the full year probably will disappear altogether for the first time since 1893.

This trend, which spokesmen in Congress have termed "frightening," is the result of a steady growth in the amount of raw materials and low-technology products we are importing. In the past such imports have been offset by greater exports of high-technology goods — including computers and aerospace products — and exports of agricultural products and chemicals.

This overall offsetting factor has diminished sharply, largely because of declining support for both Government and private research and development, which provides the new techniques, materials and end items that are the lifeblood of high-technology production.

Fortunately, there are signs of a growing realization, in government and elsewhere, that if we continue to skimp on the main sources of our strength in international commerce we inevitably will hurt *all* Americans. Out of these concerns a basic truth is emerging — realization that one of the most important strengths our nation has left is our capability for high-technology development and production.

A dynamic economy demands that we concentrate our fire where the opportunities are. The underlying theme of this issue is that exporting advanced technology is a salient capable of jetting further upward if properly nurtured.

AIA

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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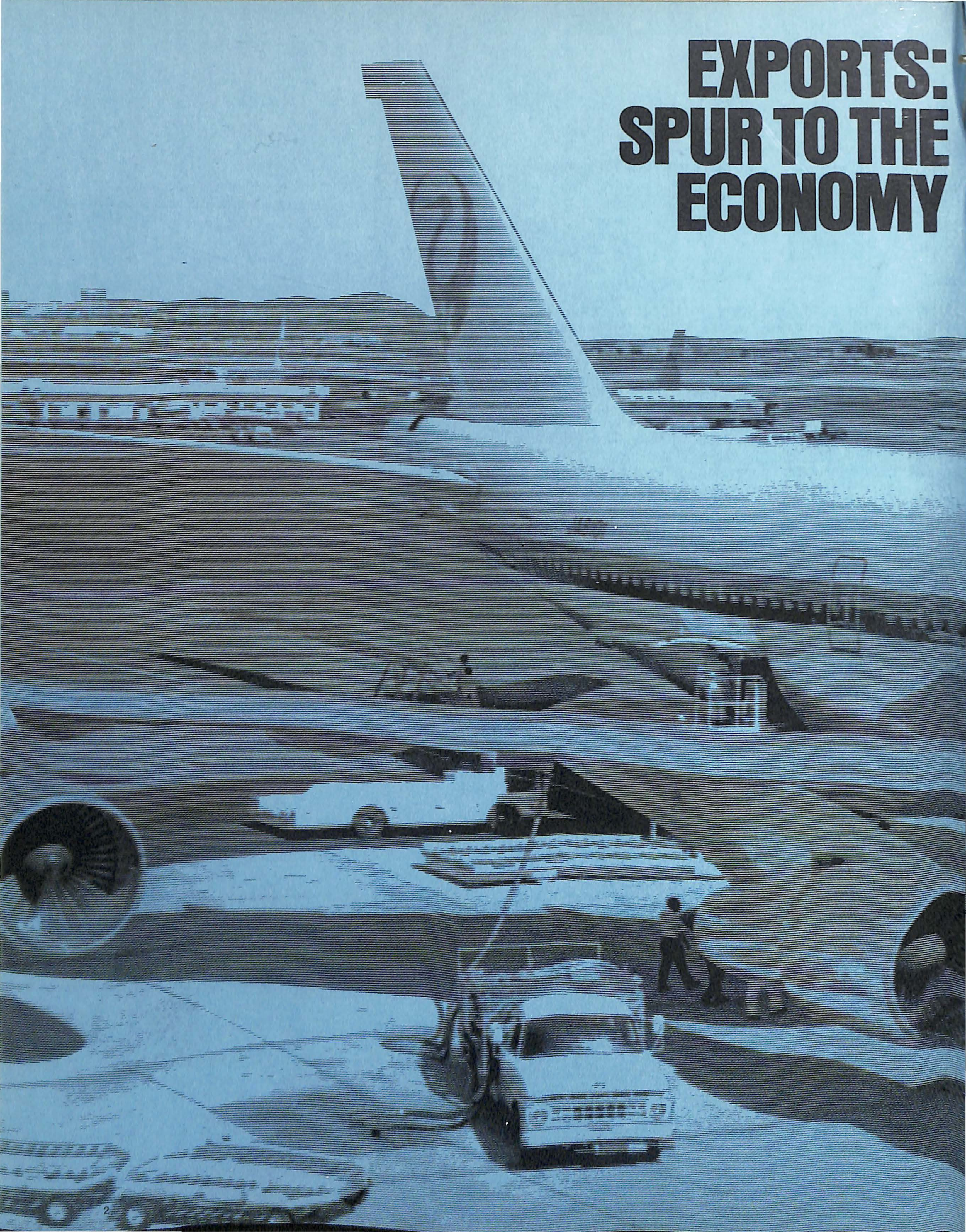
EXPORTS: SPUR TO THE ECONOMY



The balance of trade, a dry term of economics, today is becoming a matter of intense national concern. Technically, it is the relationship between what we buy from foreign nations and what we sell to them.

Today the overall U.S. balance of trade has slumped from surpluses of $5-7 billion in the early 1960s to $1-2 billion since 1967. Now, in 1971, this trade surplus may disappear entirely—for the first time since 1893.

What has caused this turn-around in international trade?

Part of the answer involves another term of economic yardstick: productivity growth—a measurement of changes of output per unit of labor input. From 1870-1950 the U.S. rate of productivity growth exceeded Europe's by 60 percent and Japan's by 70 percent. Starting in 1950, the situation was reversed and today our productivity growth is substantially behind that of Japan and Europe.

From 1950 to 1965 the U.S. lagged behind Europe by 35 percent in productivity growth and behind Japan by 60 percent. The trend continues. Since 1965 the U.S. has trailed Europe by 60 percent and Japan by 84 percent.

These startling indicators primarily reflect a decline in an area where we have heretofore been predominant: technological strength. Four factors are involved:

- Accelerated world-wide transfer of existing technology.
- Relatively lower U.S. investments in civil research and development and capital expenditures compared to foreign competitors.

• Growth of foreign government incentives to business.

• Increasing costs and risks of major technological breakthroughs that are often beyond the capability of individual companies or even consortiums of companies.

High technology today remains our strongest hope for regaining and expanding our foreign markets. Without it today the U.S. would be a second-rate nation.

At the forefront of the technology is the aerospace industry. It is not surprising then that aerospace exports have been the principal contributor that has kept our balance of trade on the plus side in recent years.

It is hard to overstate the importance of aerospace to this nation's position in international trade. In addition to the positive impact of its exported products, aerospace is a stimulus to a number of other high-technology industries that have added significantly to U.S. exports.

These industries include electronics and computers (fields in which the U.S. still leads the world), scientific instruments and sophisticated metals, all of which depend to a significant degree upon the demands of the aerospace industry.

What is the impact of aerospace exports, particularly in the commercial aircraft field?

The answer: *Aerospace exports are the single largest contributor to U.S. export earnings.*

For example, the U.S. computer industry generated export sales in 1970 which were only one-third as large. The aerospace industry in 1970 supplied over 8 percent of total export sales and in 1971 it is expected to provide 11 percent of the total.

During the past five years there has been a sharp rise in U.S. aerospace exports, and in 1971 they are expected to reach $5 billion, a 47 percent increase over the 1970 total of $3.4 billion.

In the space of four years—between 1966 and 1970—export sales more than doubled. This year the industry made its first major foreign deliveries of the wide-bodied turbine transports. These deliveries will provide the major rise in the industry's export earnings in 1971.

However, the outlook is bleak for maintaining this level beyond 1971. In 1972, shipments of wide-bodied jets are expected to be much less. This is due in part to the fact that excess seat capacity now plaguing U.S. carriers will probably spread to the foreign carriers. A further, and much more important reason for the long-term future, is the consortiums formed by European nations to build competitive aircraft. Furthermore, the U.S. also has dropped out of the competition for supersonic transport sales, and the market today belongs exclusively to the British-French Concorde and the Russian TU-144.

A recent study by AIA's International Committee provides some highly interesting, and sobering, facts of what commercial aircraft exports alone mean to the U.S. economy.

Here are some key points:

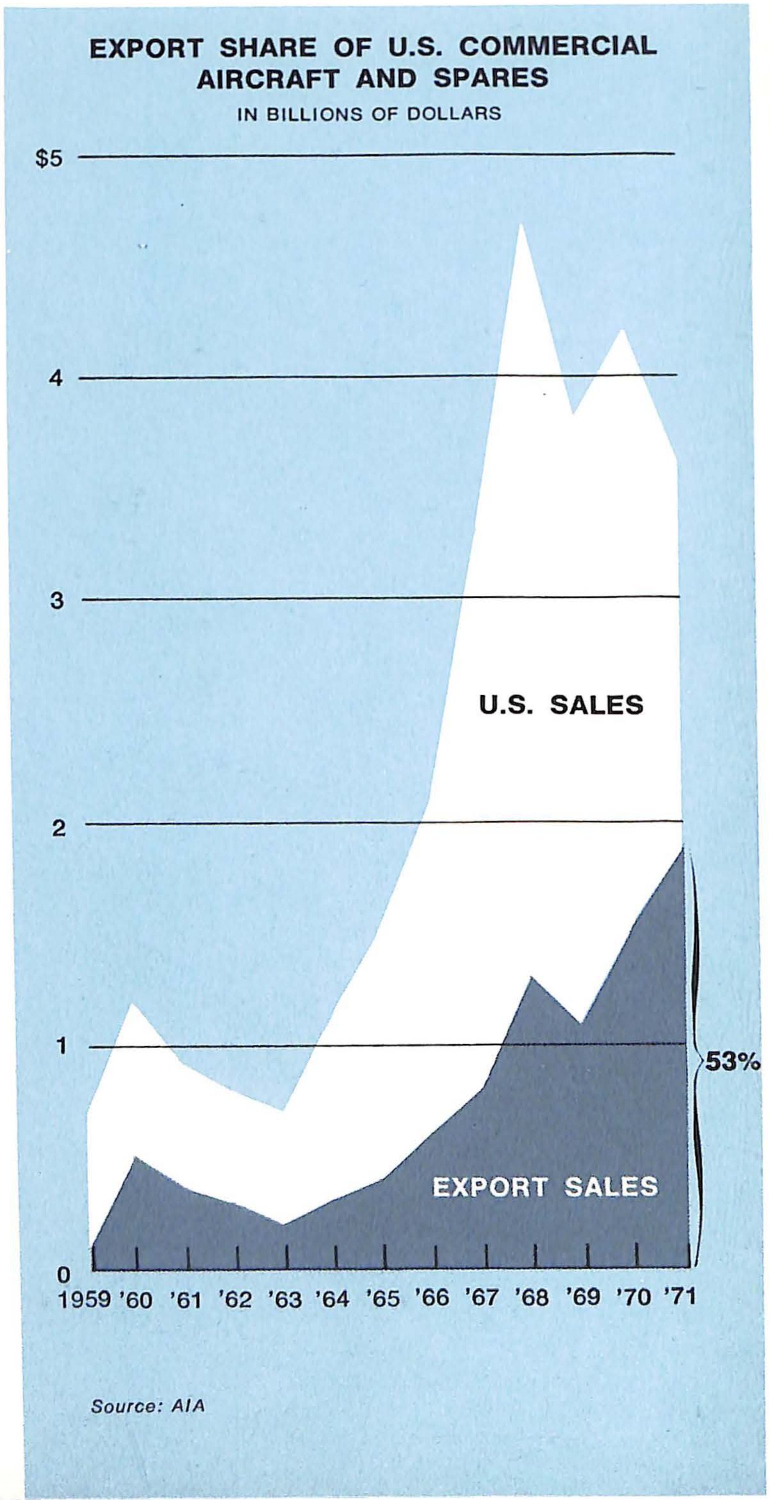
• The net balance of trade for large jet transports and spare parts was nearly $1.5 billion in 1970, a gain of 45 percent over 1969, while the nation's net balance for *all* trade was $2 billion.

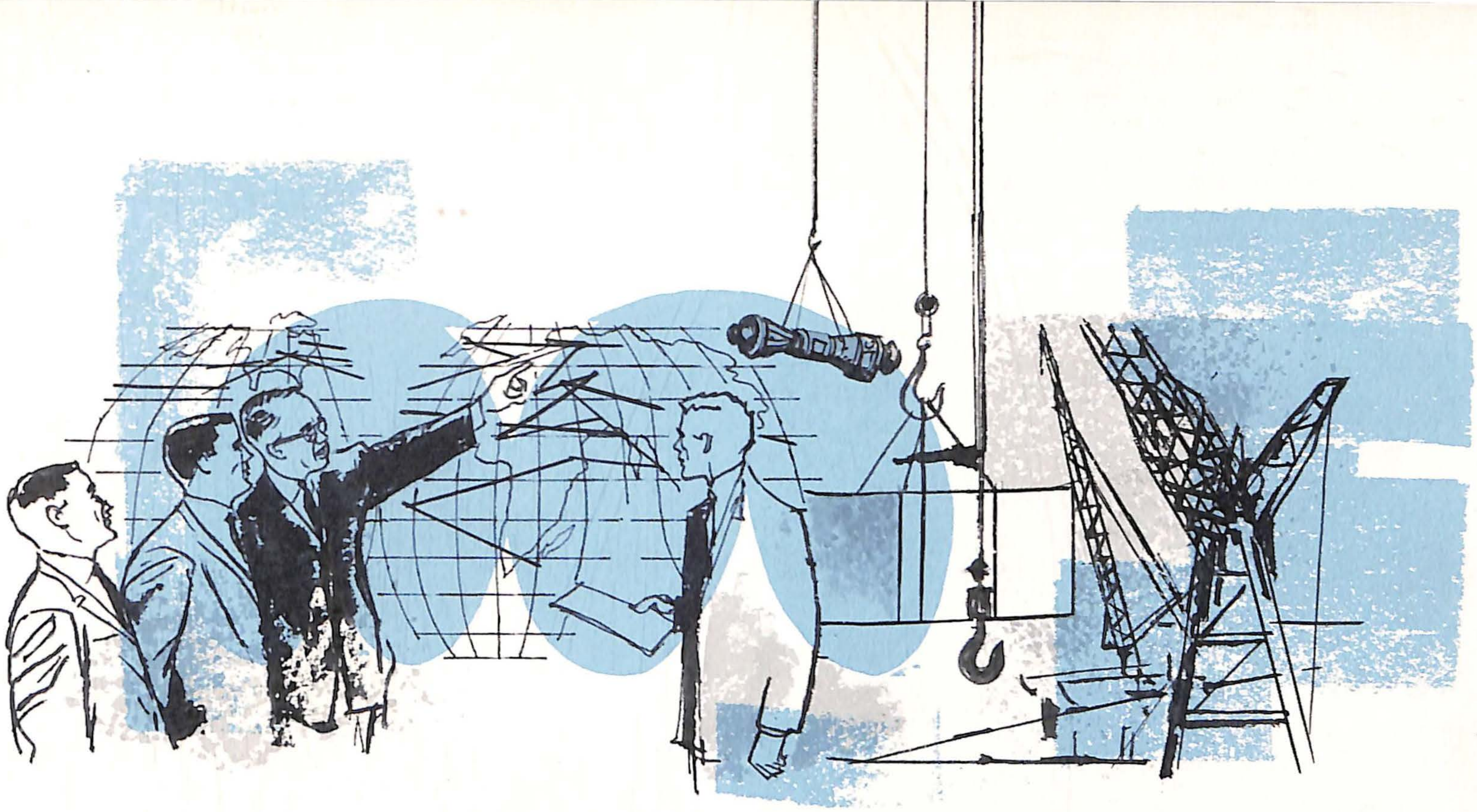
• 250,000 persons were employed in the manufacture of commercial jet airplanes in 1970. More than 40 percent (104,000) owe their jobs to export sales.

Although transport aircraft manufacturing is primarily a Pacific Coast industry, all 50 states share in employment through a vast network of sub-contracting. For example, Wisconsin has 3,360 jobs directly attributable to the commercial transport industry; Missouri has 4,060; Florida has 1,630; Masaschusetts has 2,970.

These jobs in turn generate a wide circle of secondary jobs—grocers, carpenters, garage mechanics, salesmen, doctors, the whole gamut of services.

While exact measurement of secondary employment is not possible, a Wharton School of Business study suggests that during a period of rapid export advance every 100 new jobs in aircraft manufacturing activate an additional 163 jobs in unrelated fields. Thus the





net effect of more than 104,000 jobs in aircraft manufacture due to export sales has been to generate 270,000 jobs outside this area.

Taxes that result from aircraft exports are a bonus. These include personal and corporate income taxes, indirect business taxes and other levies. The Federal Government, over a four-year period, collected $780 million, and state and local governments $711 million from this source.

The entire spectrum of national benefits, which range from a man with a job to a nation's pride—cannot be completely identified. But exports underpin all of them.

What about the future?

The basic strength of the aerospace industry and its export potential for the future lies in its ability to promote and utilize its unique technological capabilities.

There are signs today that export markets will become available for the aerospace industry's capabilities in non-aerospace areas.

Karl G. Harr, Jr., president of the Aerospace Industries Association, states, "A condition of the survival of companies within this industry has been development of an extraordinary degree of flexibility. The capacity to shift with change has been the hallmark of competitive success."

To date the domestic market for aerospace techniques and capabilities in socio-economic areas, such as air and water pollution control, crime control and pollution, rapid urban transportation, oceanography and waste disposal, has not matured, largely due to fragmented approaches to responsibility and funding.

But there is a developing export market for non-aerospace products and services that holds an excellent promise of becoming significant.

The Department of Commerce reports these developments:

- Germany plans to spend $60 million annually over the next 15 years on water and waste water pollution control equipment. Today the German market for air pollution control equipment exceeds $100 million annually.
- France plans to spend about $45 million annually through 1973 for municipal and industrial waste treatment equipment and more than $60 million for air pollution equipment.
- The Netherlands over the next 30 years will spend about $10 million annually for waste water treatment equipment and another $10 million over the same time period for air pollution control equipment.
- Belgium has scheduled water treatment equipment expenditures that will amount to $33 million while the air pollution control equipment market will be $8 million.
- Italy spends about $7.2 million annually for municipal waste, $4 million for industrial waste measures, and $15 million for air pollution controls.

Another major international market is in the field of communications and meteorological satellites. In the field of satellite communications, there is already a market for the construction of ground stations to work with communications satellites.

Currently, twelve countries have 15 of these stations, valued at about $6 million each, and another 14 stations are under construction. Estimates show that this single area of aerospace capability will grow to about $1 billion by 1972.

The future of the overall viability of U.S. exports is linked to advanced technology—and that is what the aerospace industry is all about.

CHALLENGE FROM ABROAD

For more than 25 years, propelled by the impetus of the amazing force marshalled to win World War II, the United States has been the technological giant of the free world.

Even before World War II, of course, the United States was technologically pre-eminent as one of the most industrialized nations in the world. And under the impetus of the war American scientific and production bases invented and produced what was needed, from superior radars to superior rifles; from superior aircraft to superior ammunition.

After World War II, as no other nation in history before us, the United States turned to the job of putting the world back together. America exported every idea, every technology, every skill that it could in order to help other nations get back on their feet.

This nation invented the transistor, for example, but before many years went by the U.S. was buying many of its transistors abroad. A sign of the times is the fact that today far more radios manufactured abroad are purchased in the United States than those manufactured here. Electronics and computer industries—whose growth is directly linked to the aerospace industry—are flowing offshore, and by next year for the first time the U.S. may import more such products than it exports.

In only four major areas has the U.S. consistently exported more than it has imported—agricultural products, chemicals (including pharmaceuticals), electronics (particularly computers) and aerospace products—and the single biggest difference between plus and minus in foreign trade in the area of manufactured products rests with the aerospace industry.

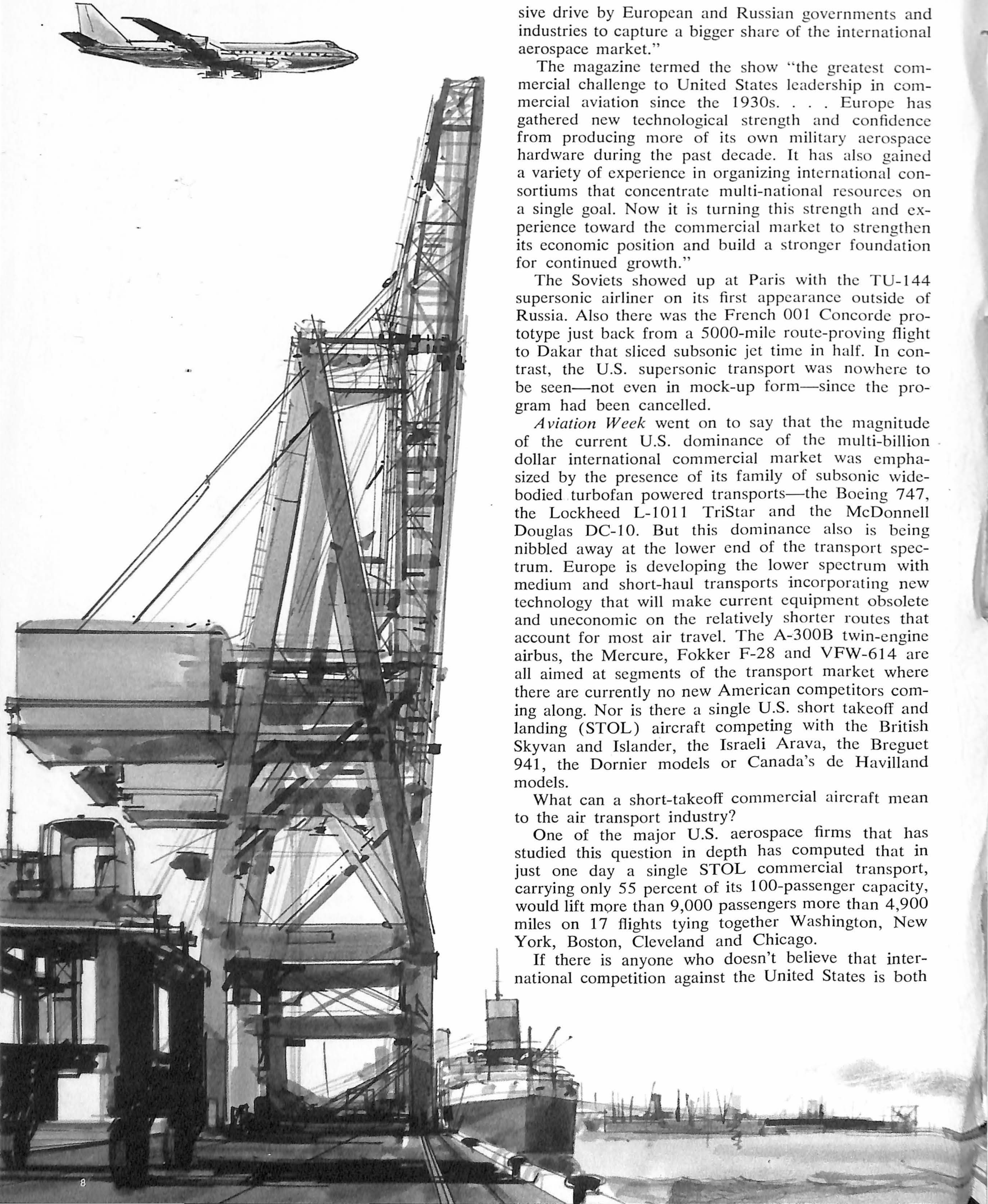
What do aerospace exports mean to the basic economy of the U.S.?

The combination of a quality product and competitive financing, much of it through the Export-Import Bank, has resulted in the sale of more than 1000 U.S.-built commercial jet aircraft to foreign carriers. Aircraft exports have grown to the point where they now account for half or more of the total aircraft output, measured in terms of dollars. U.S.-built airplanes have been sold in 64 countries and are operated by most of the world's major airlines. They constitute 82% of the non-Communist world's jet transport aircraft fleet.

The reason the United States enjoys the highest standard of living in the free world rests upon its having the most advanced technical base so that it can support high labor rates and still export products to the rest of the world at an advantage to this nation. That advantage shows up in a healthy industrial base with a large employment and sound tax base that in return pays for the social programs that an advanced society needs, such as low cost housing, health and medical care, welfare reform, law enforcement, pollution control, urban transportation, as well as national defense. All of these social programs absorb tax dollars but do not create national revenue in the same sense as do our basic industries.

Today the U.S. faces a serious challenge from forward-looking nations that are charging into the aerospace industry field—charging ahead full tilt with government-encouraged and supported industries.

In May of this year, *Aviation Week & Space Technology* reported from the 29th Paris Air Show a "mas-



sive drive by European and Russian governments and industries to capture a bigger share of the international aerospace market."

The magazine termed the show "the greatest commercial challenge to United States leadership in commercial aviation since the 1930s. . . . Europe has gathered new technological strength and confidence from producing more of its own military aerospace hardware during the past decade. It has also gained a variety of experience in organizing international consortiums that concentrate multi-national resources on a single goal. Now it is turning this strength and experience toward the commercial market to strengthen its economic position and build a stronger foundation for continued growth."

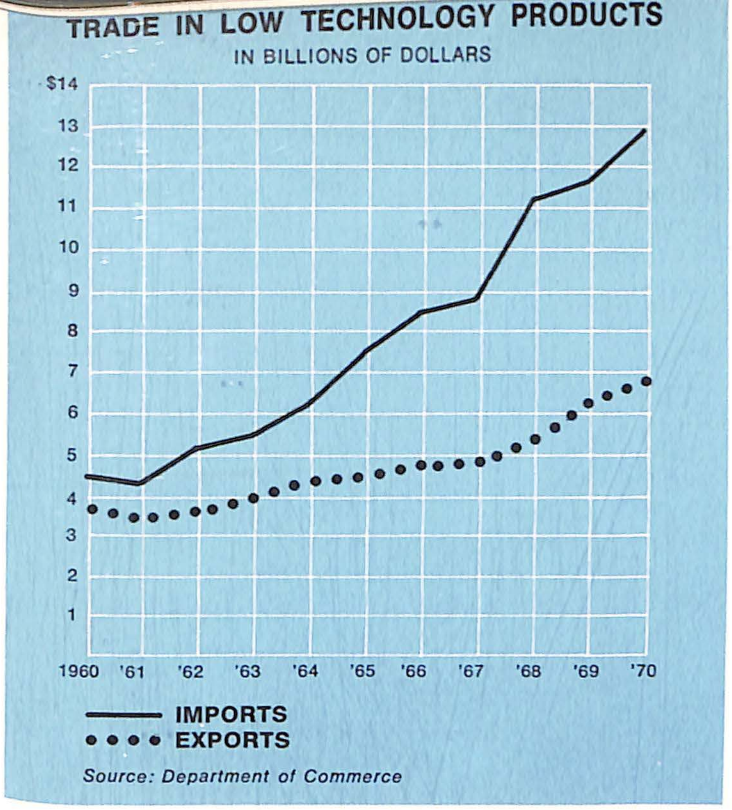
The Soviets showed up at Paris with the TU-144 supersonic airliner on its first appearance outside of Russia. Also there was the French 001 Concorde prototype just back from a 5000-mile route-proving flight to Dakar that sliced subsonic jet time in half. In contrast, the U.S. supersonic transport was nowhere to be seen—not even in mock-up form—since the program had been cancelled.

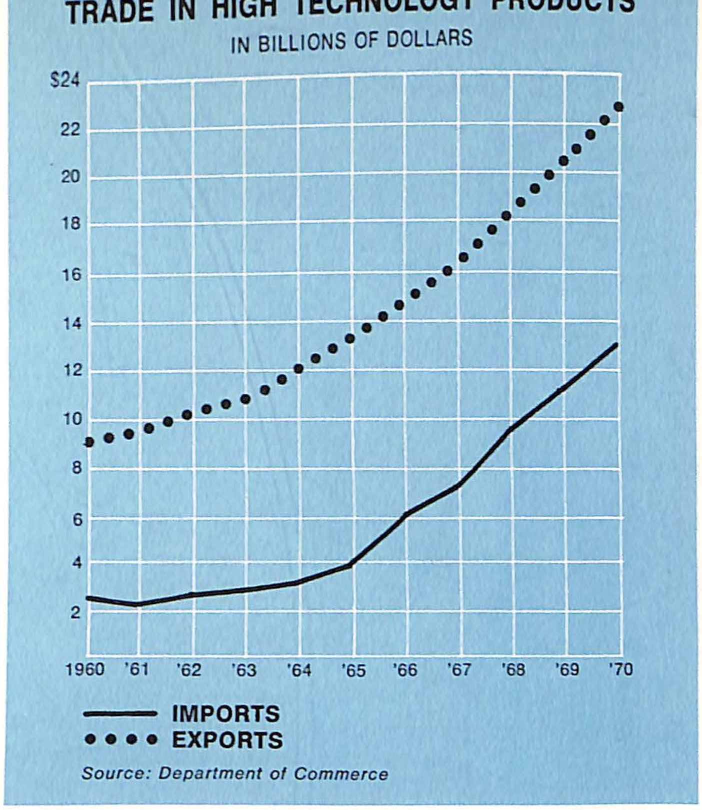
Aviation Week went on to say that the magnitude of the current U.S. dominance of the multi-billion dollar international commercial market was emphasized by the presence of its family of subsonic wide-bodied turbofan powered transports—the Boeing 747, the Lockheed L-1011 TriStar and the McDonnell Douglas DC-10. But this dominance also is being nibbled away at the lower end of the transport spectrum. Europe is developing the lower spectrum with medium and short-haul transports incorporating new technology that will make current equipment obsolete and uneconomic on the relatively shorter routes that account for most air travel. The A-300B twin-engine airbus, the Mercure, Fokker F-28 and VFW-614 are all aimed at segments of the transport market where there are currently no new American competitors coming along. Nor is there a single U.S. short takeoff and landing (STOL) aircraft competing with the British Skyvan and Islander, the Israeli Arava, the Breguet 941, the Dornier models or Canada's de Havilland models.

What can a short-takeoff commercial aircraft mean to the air transport industry?

One of the major U.S. aerospace firms that has studied this question in depth has computed that in just one day a single STOL commercial transport, carrying only 55 percent of its 100-passenger capacity, would lift more than 9,000 passengers more than 4,900 miles on 17 flights tying together Washington, New York, Boston, Cleveland and Chicago.

If there is anyone who doesn't believe that international competition against the United States is both





real and serious, a few news items from *Aviation Daily* and *Aerospace Daily* may help to dispel disbelief:

• *Item*—"Financing has been arranged for all Concordes that can be sold. Loans guaranteed by French and British governments will be at 7% for 10 to 15 years."

• *Item*—"The British European Airways Group (BEA) which earned a profit of $1,257,600 for the last fiscal year, arrived at this figure after allowing for payment of nearly $19.2 million in interest on capital borrowings, but after crediting a similar sum from the special account set up by the U.K. government to compensate BEA for any losses it might incur in being refused to operate aircraft of its own choice (it wanted to buy Boeings but was obliged to buy British (BAC) Super 111s and Tridents)."

• *Item*—"Japan's Ministry of International Trade and Industry (MITI) has granted permission for the export of seven Kawasaki-Vertol 107 gas turbine helicopters to the Swedish navy by Kawasaki Heavy Industries Ltd. of Tokyo."

• *Item*—"The upcoming Concorde demonstration flights through South America are nothing more than one more trade mission to an area in which the United States has suffered crushing sales defeats within the past 30 months, chiefly through the vetoing of aerospace and military sales . . . The loss of American sales to European countries (sales that have been made)—principally by the U.K., France and Italy—has reached a staggering $1.032 billion since the beginning of 1969 . . . In almost every case the sales would have been made by the U.S."

In the meantime, what is the United States doing?

• It has scrapped a 12-year program that would have regained the lead in the supersonic transport speed spectrum with the *second generation* of a supersonic transport.

• It has no airbus on the drawing board.

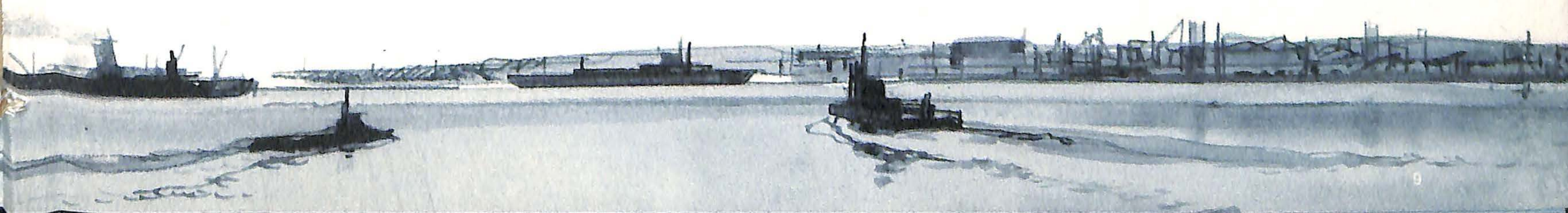
• It is virtually ignoring the unique capability of the helicopter to provide convenient city-center to city-center transportation.

In short, the United States is left with three major commercial airframe producers covering one segment of a market for transportation that can and must expand upward and downward—into the supersonic area and into the airbus and V/STOL area.

Recent independent surveys by America's airframe manufacturers agree that the market for new commercial jet aircraft during the next 10 years or so will amount to 3,000.

If 3,000 commercial aircraft are produced and sold during a 10 to 15-year period, the market (including at least 20 percent additional cost for spare parts for each aircraft during its productive lifetime) is close to $55 billion.

How much of this market will the U.S. capture, compared to the 82% it now holds of the free world commercial jet aircraft market? With only long-range and wide-bodied jets in production and nothing larger or smaller, or faster or slower under development, the



U.S. will be fortunate to get one-quarter to one-third of the purchase orders. The lack of a full spectrum of transport models in the U.S. makes those models which are produced more difficult to sell internationally.

And on the military sales side, many countries want superior U.S. military aircraft, such as the F-4 Phantom and the F-5 Freedom Fighter. What has happened during the last three years? The United States has refused or has stalled about selling modern U.S. military aircraft to Central and South American nations.

Has this deprived these nations of modern military aircraft?

No.

Six Latin American nations—Argentina, Brazil, Chile, Colombia, Peru and Venezuela—have turned their backs on the United States after being refused the aircraft that they wanted and have purchased 168 military aircraft—at several million dollars each—from England, France and West Germany. The shopping has included 60 French Mirages, 31 British Hawker Hunters, 7 British Canberras and 70 West German F-86Ks. These sales probably total nearly half a billion dollars that the U.S. could have had in foreign trade.

In terms of what this means to the United States in direct and indirect jobs related to the aerospace industry the number is in the many thousands. In fact, knowledgeable experts estimate that the loss of more than $1 billion in foreign sales represents at least 50,000 jobs in the U.S.

Another significant trend—downward from the standpoint of the United States—is the growing number of U.S. firms that are licensing European technology in missiles, electronics, helicopters and aircraft for production in the 1970s. This is a situation exactly the opposite of that which existed during the last 20 years during which the licensing flow was an overwhelming tide from the U.S. to Europe.

The question today is: Can U.S. managers, designers and producers in the aerospace industry—no matter how imaginative, talented and dedicated they may be—compete against foreign manufacturers supported by their governments as a matter of national policy?

Can U.S. private industry, on its own, compete against the British-French Concorde supersonic transport which is totally subsidized by government and which will be sold under government loan guarantees?

The answer is "no."

In the summer of 1971, Maurice H. Stans, Secretary of Commerce, testified before a Senate committee: "The high costs and risks of technological development, for example, might well be spread among a number of firms, but our antitrust rules now prevent this by prohibiting joint ventures and joint research."

With foreign consortiums supported by government financing threatening to make serious inroads into the international markets for such products as transport aircraft and helicopters, antitrust rules which restrict the nation's economic growth in exports and affect the quality of our technological base can be considered to be *inhibiting* competition that would be in the best interests of the nation, although their original purpose was to *promote* competition.

The United States is committed to inventing things first, to improving existing products first, to making things better than anyone else. It exports technology and depends on being on the forward slope of the wave of the future. With its standard of living and labor and material costs this is the only course open. If the nation is not successful in this course its standard of living will deteriorate and there may well be too little money derived through taxes on the economy for all of the socio-economic programs so important to individuals and the nation.

Today, with the exception of the United States, all of the countries involved or interested in the world aircraft market recognize, as a matter of national policy, that success will depend upon substantial government support, and that the numerous benefits that derive from aircraft exports fully justify this support.

Although the U.S. commercial aircraft industry has achieved its present position in the world market without this kind of comprehensive national support it will be difficult to maintain this position without more help than it has had. Although the manufacturers will have to be aggressive, to plan carefully and perhaps to assume greater program risks than before, the Government too, must increase its commitment. Essential will be an increase in Eximbank involvement and the adoption of even more flexibility than at present in dealing with foreign financing competition.

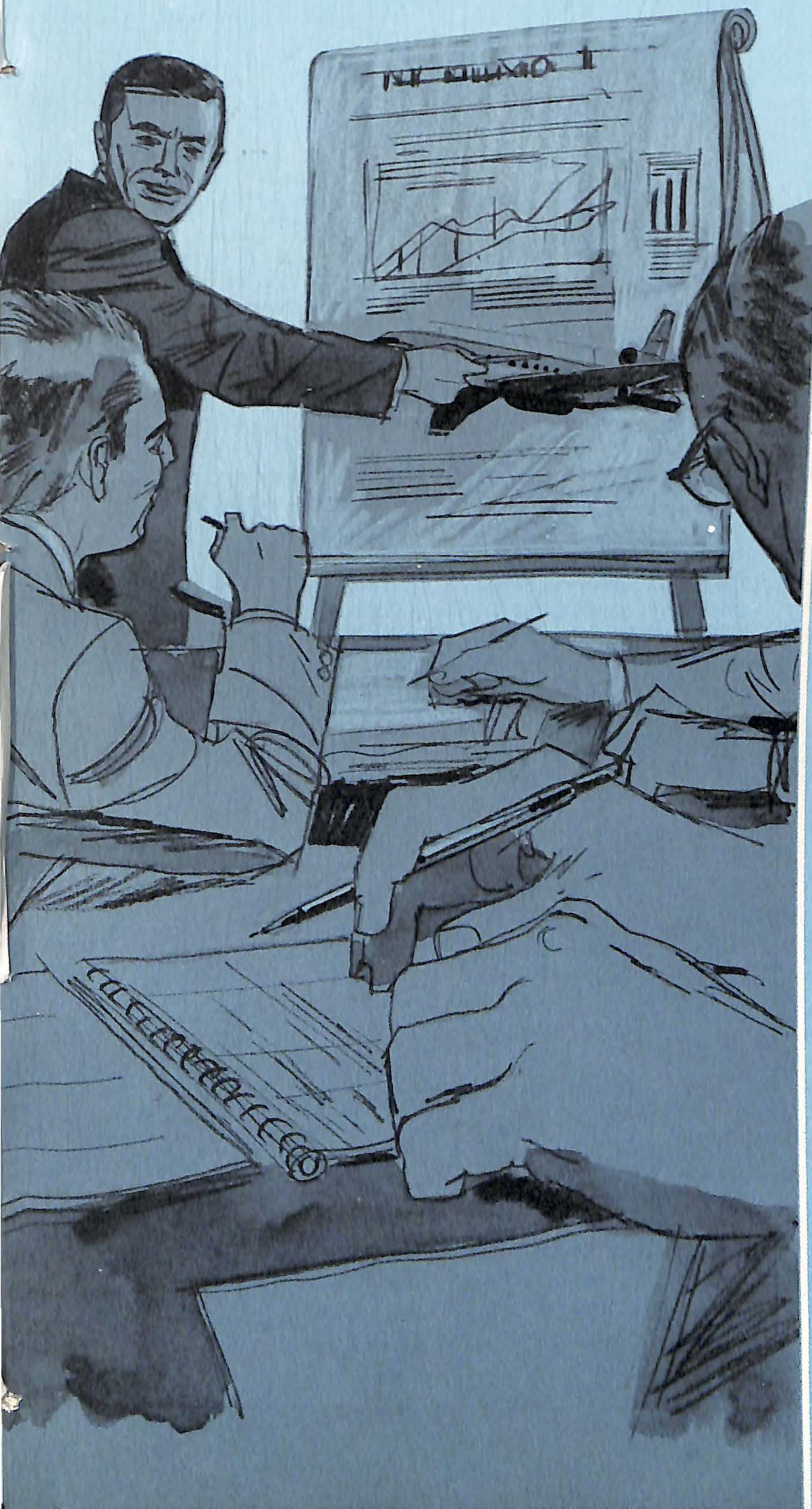
Based on what the United States has to gain—or to lose—in aircraft trade in the future this nation, more readily than any other country, should pledge itself to encourage and support continued aircraft export leadership.

The United States must be the international leader in all aspects of the aerospace field. This means that reasonable and appropriate criteria should be established for the use of Federal funds to foster commercial aerospace ventures when such ventures:

- Clearly are in the national interest, but the risk, time and magnitude of the program are such that private financing is inadequate or unavailable.

- Are in the public interest and are significant in terms of generating foreign sales and are threatened by foreign government-subsidized competition.

FINANCING AEROSPACE EXPORTS



As the cost of American aerospace products for the civilian and military markets has continued to rise over the years, new methods of financing have had to be developed to enable foreign airlines and governments to purchase these products.

Before the arrival of the jet age in commercial air transportation, commercial banks supplied much of the financing of foreign airlines. Even when the first orders were placed for jet aircraft, this method of financing persisted, and provided a substantial amount of financing until about 1960.

Change became necessary when costs suddenly rose from $1.7 million for a single piston aircraft to nearly $5 million for one of the first jets. Foreign airlines could still cover part of their cash needs, but now had to rely on the U.S. capital markets for most of the funds required to finance the acquisition of U.S.-manufactured equipment.

At this point, the Export-Import Bank (Eximbank) assumed a major role in the financing picture. It began participating in aircraft financing either by loaning up to 80 percent of the cost of the aircraft or by guaranteeing as much as 80 percent of the cost if the loan was obtained from a commercial bank.

This was the pattern until 1965, with Eximbank and the commercial banks acting in cooperation with the manufacturers to handle the U.S. financing for foreign airlines' purchases. Then, in 1966, interest rates began to rise and the "Voluntary Restraint Program" was introduced; limiting the amount of American funds available to foreign borrowers. During this difficult time, most of the burden shifted to the Eximbank.

In the following two years, the so-called 50/50 deals were devised. Commercial banks took the first 3½ years maturities and the Export-Import Bank the last 3½ years maturities of a 7-year financing package. This helped the commercial banks because it enabled airlines to repay their loans over a longer term at a time when bank commitments were limited to five years from date of original commitment to final maturity, including lead time of 1½-2 years between the order and delivery of the aircraft. Eximbank participation took such loans outside the "Voluntary Restraint" limitations.

In this way, with commercial banks assuming half of the lending burden, aircraft manufacturers were able to undertake a large volume of export sales. At the same time, pressure was taken off the Eximbank's budget. An unanticipated dividend of the technique was that aerospace exports were increased during the ensuing period of high interest rates through the Bank's maintenance of a 6 percent rate on its portion of the loans, substantially reducing the cost that otherwise would have applied to export financing.

At present, Eximbank participates in 36 percent of the financing of narrow-bodied jets, providing financing at 6 percent over the 7-year term referred to earlier. In the case of wide-bodied aircraft, in Fiscal Year 1970 the Bank agreed to extend its financing from seven to ten years, and commercial banks have similarly agreed to take the first five years maturities rather than the first 3½ years. Eximbank participation in wide-bodied export financing (including engines) is 27 percent, a figure which many manufacturers and private bankers would like to see increased because of the already high commitments incurred as a result of the development and manufacture of the big planes.

Eximbank provides three general types of assistance —loans, guarantees and insurance, and participation financing.

• *Direct Loans*—Dollar credits extended by the Bank directly to borrowers outside the United States for purchases of U.S. goods and services. Available for long-term (more than five years) transactions.

• *Financial Guarantees and Insurance*—Guarantee of repayment of credits extended by private lenders to foreign purchasers of U.S. goods and services. This program is available to both U.S. and non-U.S. financial institutions for long-term transactions; commercial bank guarantee and insurance programs both are available for medium-term (one-to five-year) transactions, and insurance can be provided for short-term transactions.

• *Participation Financing*—Combination of direct lending with loans provided by private sources. If required, Eximbank may extend the financial guarantee to the private lender.

Effective use is being made constantly of the participation financing-guarantee program. The Bank's policy now is to limit direct lending to transactions in which a commercial bank or other private source agrees to participate. This has enabled the Bank to stretch its own resources further, draw private funds into credit financing, and assure that its loans supplement, rather than compete with, private sources.

(The Eximbank enters into a transaction *only* after its Board of Directors has determined that such participation is necessary in order to complete the export sale. One of its basic policies is to avoid offering financial assistance if it can be obtained from private sources.)

This "blending" of Eximbank credit at the current 6 percent yearly rate of interest with the commercial rate also eases the effective rate of interest the borrower must pay for total financing of his purchase.

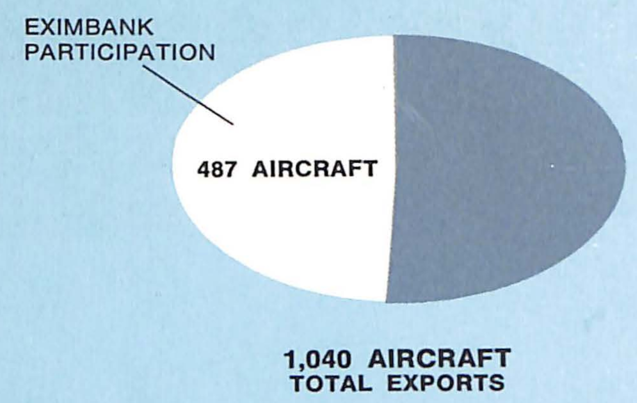
This participation plan has brought billions of dollars of private funds into export financing. Commercial banks have been providing a little more than half the financing of wide-bodied jets, and 40 percent of other jet exports. This is done through credits extended to non-U.S. buyers of U.S. goods or services. The U.S. supplier receives the money; the foreign purchaser repays in dollars, with interest.

The participating bank may be either a U.S. or a non-U.S. institution. Where necessary, Eximbank may agree to take the later maturities, so that the private bank is paid off first. It will also guarantee the private bank's portion of the loan against either commercial or political risk, or both.

In addition, the Bank will provide, without cost or obligation, a preliminary commitment to participate in a transaction. The buyer, the seller, or the commercial bank may apply for the commitment, which enables the exporter to offer financial terms in the initial sales presentation.

Also available is a discount loan procedure for medium-term transactions, although it does not apply to wide-bodied jets. Where it does apply, Eximbank will at any time lend the private bank up to 100 percent of the value of the export debt obligation. The interest charged the commercial bank is one percent less than the bank charged the borrower, or one-half of one percent if the transaction has been insured or guaranteed by Eximbank.

FINANCING U.S. COMMERCIAL JET EXPORTS
(1959 THRU 1970)



Source: Eximbank Annual Reports

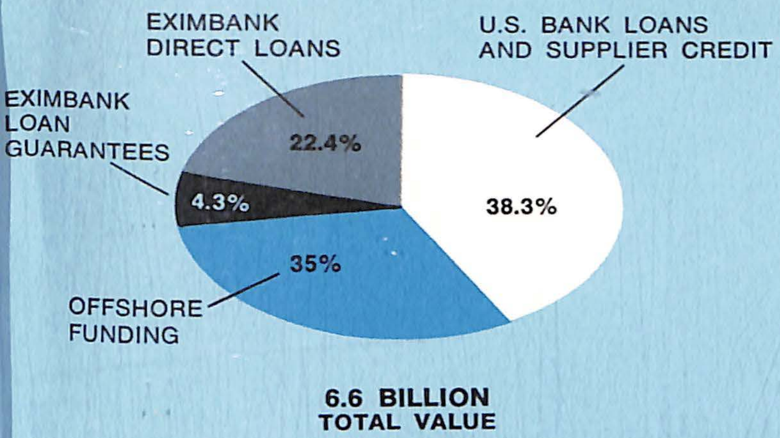
Finally, the private bank can get a preliminary commitment for a discount loan before it even enters the transaction. This gives the banker assurance of immediately available cash should he encounter a liquidity problem.

Extension of repayment terms from seven to ten years, as provided by the participation plan, obviously means smaller repayments to private banks as well as to Eximbank, which in the short run has an adverse effect on the U.S. balance of payments position. Where the participants are U.S. banks, there is an additional negative impact. Eximbank considered this but decided to proceed with the longer-term financing due to the overall importance of aircraft exports to the American economy.

It should be noted that in the long run export financing does *not* affect the U.S. balance of payments adversely. The outflow of capital is fully offset by payments received for the exports. Thus, even without the customary down payment from offshore the net effect on the balance of payments is zero. In fact, as interest is received on the loan, the effect becomes positive. Because in the longer term export financing helps create and hold markets, it improves the balance of payments. For this reason it is of great importance that U.S. aerospace exports be maintained.

On May 25, 1971, the Private Export Funding Corporation (PEFCO) officially began operations, with the goal of increasing the existing financial resources available for U.S. exports, especially aircraft exports, by mobilizing previously untapped private capital.

PEFCO, incorporated in 1970, was capitalized by a large group of U.S. commercial banks and industrial companies. Its initial stock offering by its founders, the Bankers Association for Foreign Trade, was made to "qualified investors," banks and other financial institutions and corporations engaged in foreign trade. The offering was announced last March and was open until May 24.



Initial subscriptions amounting to $12,734,000 came from 46 major banks throughout the nation and from corporations, and Eximbank has extended a $50-million revolving line of credit.

It is hoped that PEFCO will open the way for foreign airlines to utilize the U.S. institutional market, which has been largely unavailable to them because of legislative restrictions on foreign investments.

Its assets will be financial paper, a significant portion of it in the form of airline paper guaranteed by Eximbank which would normally represent the latter maturities of loans in which the commercial banks would have the shorter maturities. In turn, PEFCO will borrow senior funds, both long-term and short-term, from institutional lenders, or will sell its securities in the public market. In either case, PEFCO's borrowings will be secured by its portfolio of Eximbank-guaranteed paper. This will eliminate the legal investment restrictions on foreign loans for institutional lenders.

PEFCO's ability to borrow long-term money against short-term collateral should make the new corporation valuable to Eximbank as a means of laying off its ten-year wide-bodied aircraft paper. These obligations would be too long to discount with commercial banks and too short to discount with institutional lenders.

By discounting such paper with PEFCO, the Eximbank will obtain funds to enable it to increase greatly both its total volume of aircraft export financing and its percentage of participation in such loans, without exceeding its budget limitations.

Tom Lilley, Director of the Export-Import Bank, says: "This activity (PEFCO) has added a whole new dimension to the financing of major projects, particularly those with longer repayment terms."

The Department of Defense (DOD) is actively seeking private participation in its military export sales program (now known as The Security Assistance Program.) this year and next year to the maximum extent feasible. Since Congress has authorized a continuing resolution authority, for the FY 1972 program, it is assumed this means an approved level at the same rate as last year. That included an authorized $340 million of total credit sales, with only $200 million in funding, plus $500 million credit for Israel.

During FY 72 and 73, the House has approved $582 million credit sales, with funding of $510 million. This means about $100 million of private credit is anticipated in FY 72 to be guaranteed by DOD. Credit sales as a whole could amount to about 17 percent of total security assistance program which totals over $5 billion annually. Over 50 percent of total military export sales during the 1970s are expected to be credit financed. These sales will be funded from one of three Government sources if Congress follows last year's pattern:

• *Eximbank credits or guarantees to developed countries.* These must qualify under the Interest Equalization Tax (IET) definition, as well as Eximbank's own criteria for credit worthiness.

• *Special Congressional authority for Israel.* In FY 1971, this method provided $500 million by special amendment to the Defense Procurement Act. This source was unique in DOD's credit sales history, and it is uncertain what precedent it may establish. In fiscal year 1972, this requirement is included in the FMS credit fund.

• *Defense Foreign Military Sales (FMS) Credit.* DOD describes this as a "last resort" source normally reserved for economically less-developed nations. This credit is available only when Eximbank, private, or other sources are *not* available.

Thus, DOD has $300 million available for developed countries through Eximbank, and $582 million for the economically less-developed nations including Israel—and from $200-$340 million for economically less-developed nations for a total estimated credit of close to $1 billion this fiscal year.

• *Procedures for Private Credit Guarantees.* There are four principal steps for concluding private credit guaranty arrangements with DOD.

• Banks and suppliers should advise or notify DOD of their "indications" for private credit participation to the extent possible, specific dates should be provided so that the U.S. Government can evaluate the prospects for the transaction in terms of total requirements, priorities, and other considerations. DOD funds for prospective cases must be earmarked at the earliest time.

• When the private transaction is near consummation, an official request should be submitted by the financial institution, including evidences of approval by the foreign government for the transaction. This request should show definitive credit terms and conditions, funds involved, items, and the final status of negotiations, plus any other justifications considered vital in the request for credit.

• Based upon this request, DOD must then submit an official request to the Departments of State and Treasury for approval of the transaction, The request must show "terms and conditions" in line with the President's Financial Standards and Criteria established as a result of the Foreign Military Sales Act of 1968 (Section 34). DOD, upon approval of this request, then draws up a "Guaranty Agreement" with the private bank or institution. Both DOD and the private source must sign such an agreement.

• The private financial institution must deposit the "guaranty fee" with DOD, prior to the agreement becoming effective.

STRENGTHENING U.S. EXPORTS

Faced with the prospect that the United States will this year record its first negative balance of trade since 1893, U.S. economic planners are formulating a number of programs to strengthen the nation's position as an exporter. This represents something of a departure from the American experience in the post-World War II era.

As the free world nations, with strong U.S. assistance, made their impressive recoveries from World War II, the U.S. monopoly of aerospace technology began to decline. The 1960s brought successful new aerospace efforts by the European nations and by 1970, Japan had become a strong international competitor. As a result, the international marketplace as a whole, and aerospace in particular, has become an arena of intense competition. The effect has been to weaken America's traditionally strong balance of trade position.

The recent and serious decline in the nation's balance of trade and long term losses in our balance of payments have caused grave national and international concern. The stability of the dollar is being severely challenged and the nation's economy is undergoing a serious transition. The course of action the U.S. follows in resolving these crucial issues will certainly determine our national strength and stability in the future.

The aerospace industry has an important role to play in supporting and implementing national policy by virtue of its responsibility as a defense industry and due to the fact that its commercial and military exports have played a direct and dynamic role in the national economy.

If aerospace is to continue fulfilling this role, several points need to be seriously considered.

• Without a viable and progressive national trade policy, industry cannot effectively assist Government in attaining national economic objectives. The creation of the export environment is a national responsibility falling to Congress, the executive branch, industry, and the financial community. In short, both the public and private sectors must cooperate.

• U.S. policies fail to support U.S. producers adequately. And as a result, this nation's manufacturers cannot attain their potential in making military export sales in competition with foreign sellers who receive support and political leverage from their own governments.

• Industry must assume distinct responsibilities in the areas of market analysis, selling and financing sales and service follow-on, under positive government policy.

After World War II and through the 1950s, the

United States, through a variety of programs, furnished to European countries technology, know-how, materials and money to reestablish the technical and manufacturing capability of these countries.

In the 1960s the capability of European countries began to mature, but they still bought military systems from other sources, particularly from U.S. manufacturers. To aid in such sales, the U.S. Government assisted in arranging financing and purchase offsets.

The governments of Great Britain and the European countries have seen the efficacy of governmental assistance to military export sales of their own products.

In recent sales efforts, U.S. aerospace firms have experienced great disadvantages in competing against foreign manufacturers who are supported by efforts of their own governments.

In price and technology, U.S. aerospace manufacturers are equal to the foreign competition, but offset sales—*quid pro quo* arrangements—negotiated by the foreign governments, and lacking from the U.S. Government, give a powerful advantage to foreign firms.

The Department of Defense recently has been following the policy of taking no initiative in foreign military sales, refusing to "pre-empt" sales from foreign competitors, promoting the growth of foreign munitions development and production capability, encouraging local procurement to satisfy foreign military equipment requirements, and refusing to help U.S. suppliers in almost all industry-to-foreign government sales opportunities.

As a result, for example, during Fiscal Year 1970 Latin American countries spent $860 million to buy foreign munitions. Of this, the U.S. share was $46 million, and the rest went mainly to France and the United Kingdom.

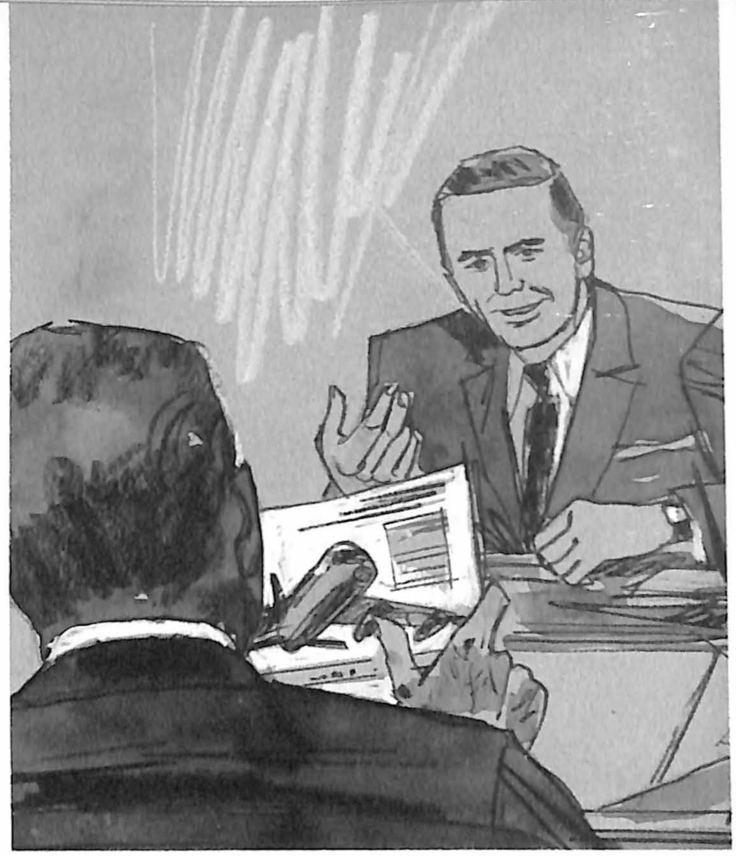
In the foreign marketplace, U.S. suppliers now find themselves competing with foreign governments, nationalized or socialized industries, or industries receiving the full financial, economic and diplomatic support of their governments. Offset arrangements have become an integral part of most foreign military sales. No U.S. corporation has the breadth, depth or variety of offset capability of a foreign government.

Export financing of commercial aerospace products always becomes difficult in periods of high interest rates and tight money. The principal sources of export credit financing are the Export-Import Bank and U.S. commercial banks. The recently activated Private Export Funding Corporation should be very helpful.

The passage of legislation which removes the Eximbank from the unified budget and provides other progressive measures, such as extending its capitalization from $13 billion to $20 billion, is extremely important in expanding U.S. aerospace exports.

Export credit financing of military aerospace products is at times available under the terms of the Military Sales Act in the form of DOD guarantees of commercial loans. This fund of approximately $350 million provided by the Act is available at the pleasure of Congress. The present Act expired on June 30, 1971, and the new law has not been enacted at this time. This is the principal source of export credit financing for military aerospace products.

The U.S. must compete equally with all other trading nations concerning the availability of export credit



financing for all types of U.S. manufactured aerospace products.

The requirement for vastly expanded discount facilities to handle export paper held by U.S. exporters has become a priority issue. The Eximbank should extensively expand its capabilities in this area.

Export business has become an increasingly important market for the aerospace industry and high technology products are in demand on a worldwide basis. National economic priorities require better implementation of the present legislation liberalizing the export control process. Here are some recommendations:

- The Commerce Department should take leadership in the progressive de-control of exports proposed in the Export Administration Act in response to the mandate of Congress.
- The Commerce Department should realistically analyze and modify U.S. unilateral control of commercial products in line with the COCOM (15-nation Coordinating Committee on Strategic Commodity Control) restrictions.
- Positive action should be taken to extend MFN (Most Favored Nation) trading privileges to selected Eastern European nations in addition to Yugoslavia and Poland.
- Relaxation of commercial export controls is a prerequisite to the improvement of the nation's worldwide trading relations and ability to meet foreign competition, and will bring a significant new dimension to our export capability.
- The aerospace industry strongly supports the proposed legislation to provide tax deferral for the Domestic International Sales Corporation (DISC). Its positive effects should be numerous.

The enactment of DISC will stimulate increased foreign sales of goods produced in the United States and will operate as a brake on investments in overseas production facilities. This will produce significant benefits for the U.S. economy by increasing domestic employment and encouraging investments in domestic production facilities. Other industrial countries have adopted similar concepts to protect their own interests.

DISC will improve the U.S. balances of trade and payments by motivating American industry to make extra efforts to expand foreign sales.

DISC should promote increased domestic employment and industrial development.

Now under consideration by various government and industry groups are a number of additional steps designed to enhance the nation's export position.

Priority attention should be given to these areas:

• Establish a trade surplus as a national goal, formally adopted and enunciated by legislation and executive decree.

• Remove restrictive U.S. Government monetary limitations in Latin America concerning the sale of U.S. aerospace equipment.

• Do not invoke U.S. import commodity quotas which may prompt trade retaliations from other trading nations.

• Eliminate R&D recoupment of U.S. sales to foreign governments.

• Promote a unified industry-labor effort to improve management and increase productivity to make U.S. export products more competitive.

• Review carefully the restrictive antitrust laws which limit U.S. firms in their competition with foreign cartels and foreign government-backed combines.

• Support the important proposals concerning the restoration of the investment tax credit, and the establishment of DISC.

• Review the extensive and cumbersome security requirements which govern the exports of high technology products.

• Continue to press for the elimination of non-tariff barriers and other trade restrictions in U.S. international negotiations.

• Develop appropriate national incentives for the expansion of research and development of advanced technology products.

• Strive for a strengthened U.S. dollar as *the medium of exchange* in a free and unencumbered international marketplace.

• Eliminate the temporary import surcharge on imports into the U.S. as soon as practicable.

• Recognize the critical importance of U.S.-manufactured high technology products as a national resource and strategic export commodity, to be further developed in the national interest.

• Emphasize sales from the private sector and continue to phase out foreign grants for economic reasons.

• Continue to resist restrictive controls on foreign travel.

A progressive national trade policy with close effective government-industry cooperation is an urgent priority.

The private sector must be encouraged to compete in foreign markets, undeterred by U.S. Government regulations. America must remain competitive.

In the national interest, a better way must be designed to strengthen America's export position without harming national or international security.

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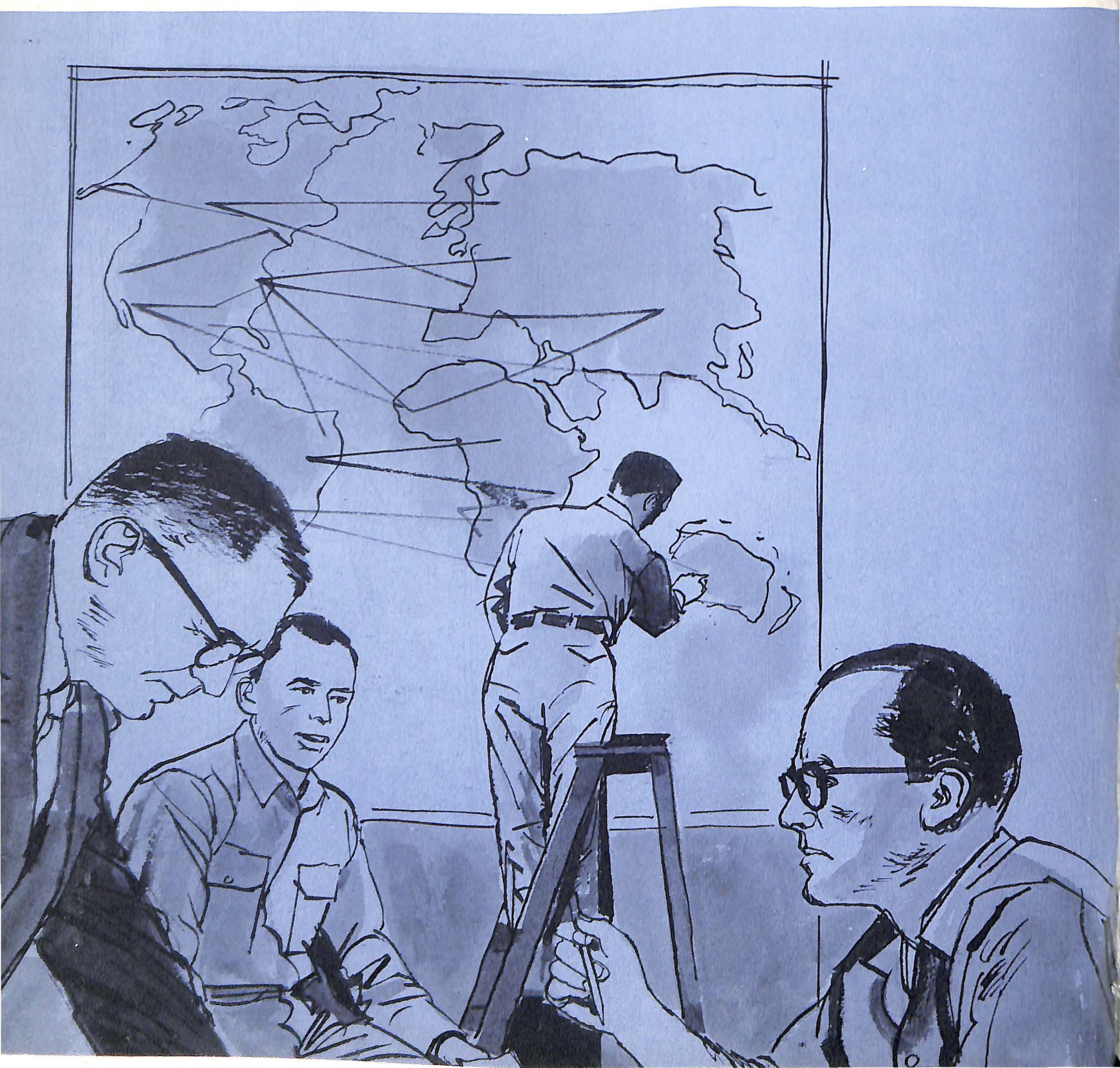

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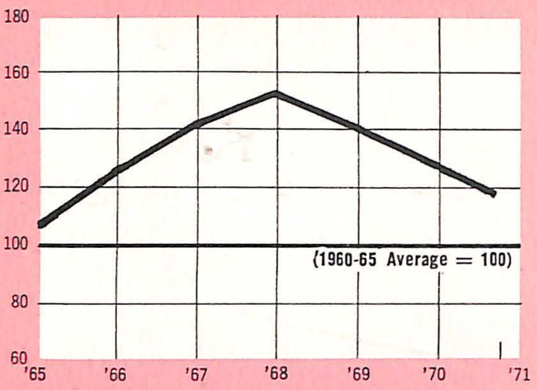
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • JANUARY 1972

AEROSPACE REVIEW AND FORECAST

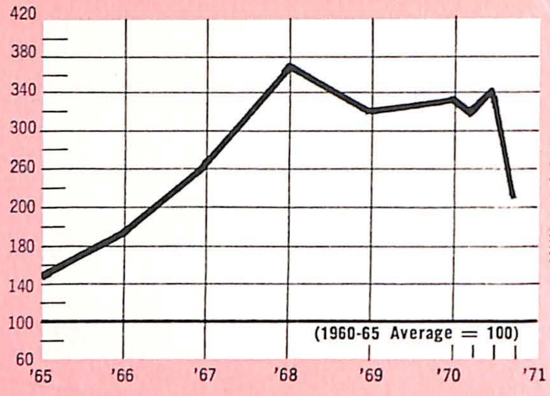
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

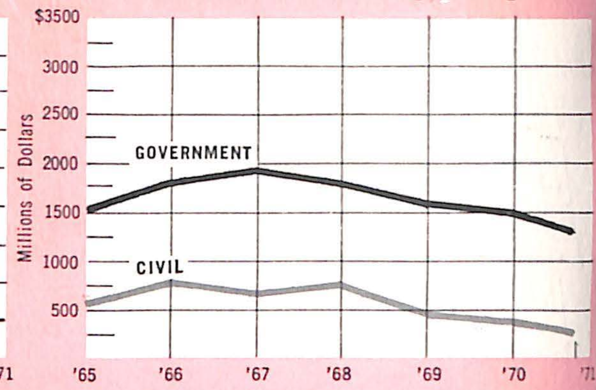


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1960-65 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Third Quarter 1971	25.0	24.1	22.9
	Billion $	Quarterly	4.8		6.0	6.2	4.8
DEPARTMENT OF DEFENSE							
Aerospace Obligations: Total	Million $	Monthly	1,151	June 1971	2,351	782	1,645
Aircraft	Million $	Monthly	601	June 1971	1,500	378	1,169
Missiles & Space	Million $	Monthly	550	June 1971	851	404	476
Aerospace Expenditures: Total	Million $	Monthly	1,067	June 1971	1,340	1,041	1,174
Aircraft	Million $	Monthly	561	June 1971	773	628	675
Missiles & Space	Million $	Monthly	506	June 1971	567	413	499
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920‡	June 1971	1,744	538	1,251
Aircraft	Million $	Monthly	447	June 1971	1,032	339	902
Missiles & Space	Million $	Monthly	473	June 1971	712	199	349
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Nov. 1971	152	284	209
Expenditures	Million $	Monthly	130	Nov. 1971	208	204	232
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3#	Third Quarter 1971	25.5	22.5	23.9
U.S. Government	Billion $	Quarterly	11.6		13.6	11.6	13.0
Nongovernment	Billion $	Quarterly	3.7		11.9	10.9	10.9
EXPORTS							
Total (Including military)	Million $	Monthly	110	Oct. 1971	344	327	307
New Commercial Transports	Million $	Monthly	24	Oct. 1971	87	101	105
PROFITS (After Taxes)							
Aerospace — Based on Sales	Percent	Quarterly	2.3	Third Quarter 1971	1.9	1.9	2.2
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		3.9	4.5	4.1
EMPLOYMENT: Total	Thousands	Monthly	1,132	Sept. 1971	1,114	942	945
Aircraft	Thousands	Monthly	469	Sept. 1971	488	383	385
Missiles & Space	Thousands	Monthly	496	Sept. 1971	453	393	394
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Sept. 1971	4.20	4.33	4.34

R Revised.
E Estimate.
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
# Averages for 1961-65.
‡ Averages for fiscal years 1960-65.

Source: Aerospace Industries Association

BY KARL G. HARR, JR.

President,
Aerospace Industries Association

The end of one year and the beginning of the next is an appropriate time to take stock as to where the aerospace industry, this nation's largest manufacturing employer, has been, where it is now and where it is going.

- In two decades its sales climbed from less than $1.5 billion in 1948 to a peak of nearly $29 billion in 1968.
- Its employment grew from about ¼ of one million to more than 1.4 million during the same period.
- Its exports soared from about $150 million to $3.4 billion—the difference between a positive and negative national trade balance for the U.S. in each of the four years preceding 1971.

Since 1968, reductions in defense and space programs and a soft commercial air travel market have caused a steady decline in the industry.

- One of every three employees in the industry is gone.
- Profits, as a percentage of sales after taxes, are less than half of what they are for all manufacturing industries.
- Foreign competition is growing, particularly in the short-takeoff, airbus, supersonic transport and military aircraft fields.

The negative employment and sales curves should flatten out in 1972; remain relatively level in 1973, and then begin a gradual upward trend that will continue through the last half of the decade.

But there is a much broader and a much more important concern than the economic status of the aerospace industry—a vital concern which merits the full attention of this nation and its leaders.

America's economic strength and its national security have been based in major part on its ability to stay ahead technologically. Today its lead in this respect has dwindled due to its reduced support of research and development. We are at a critical point—a point at which America must make up its mind.

We have to decide as a nation whether or not we will be satisfied to fall back substantially in many fundamental aspects of our national life which we have come to take for granted.

Some who understand the vital importance of technological leadership to the economic health of this nation, to its national security, and to the ultimate solution of the problems that face it in many environmental, personal and ecological fields, are considerably alarmed by a recent significant prejudice against technology as such.

This alarm is well founded. If this nation abandons its traditional technological leadership, if it lags significantly in the research and development that underpins that leadership, we will have set off on a new course that threatens our very capacity to survive.

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

Publication Office: 1725 De Sales Street, N.W., Washington, D. C. 20036

AEROSPACE REVIEW AND FORECAST

Aerospace industry sales continued their anticipated decline in 1971 to $23.3 billion compared with $24.9 billion in 1970, a 6.3 percent decrease.

However, a 7.1 percent increase in commercial aerospace sales, primarily jet transports, was reported in 1971 from sales of $4.903 billion, compared with $4.578 billion in 1970. This increase reflects increased deliveries of wide-bodied jet transports.

Generally, all other areas of aerospace activity continued the decline which started in 1968 when record sales of $29.0 billion were reported.

Major aerospace sales areas include:

- Total aerospace sales to the Department of Defense in 1971 were $13.3 billion compared with $14.6 billion in 1970.
- Military aircraft sales declined to $7.8 billion in 1971 compared with $8.9 billion in 1970. These figures include both procurement and research and development funds.
- Missile sales, which also include research and development, increased slightly from $5.375 billion in 1970 to $5.432 billion in 1971.
- Space sales continued to decline in 1971 to $3.220 billion, compared with $3.580 billion in 1970.

Non-aerospace sales declined, with $2.361 billion in 1971 compared with $2.676 billion in 1970. These sales represent work by aerospace firms in such fields as urban transportation, pollution control, marine sciences and water desalination.

- Utility and executive aircraft sales decreased from $399 million in 1970 to $300 million in 1971, and units delivered showed a drop of 1.3 percent.
- Civilian helicopter sales increased from $49 million in 1970 to $60 million in 1971.

BACKLOG

Total aerospace backlog at the close of the first half of 1971 was $22.5 billion compared with $25.2 billion at the end of 1970. It is anticipated that the backlog at the end of 1971 will be $22.0 billion.

EXPORTS AND IMPORTS

Aerospace exports continued to increase as they have since 1964. They rose from $3.397 billion in 1970 to $4.300 billion in 1971, a 26.6 percent increase. Major reason for the increase was transport aircraft exports, which gained from $1.283 billion in 1970 to $1.722 billion in 1971, a rise of 34.2 percent. Military aerospace exports increased 24.0 percent from $887 million to $1.100 billion in the same period, with exports of military helicopters, fighters and attack bombers accounting for most of the increase.

Imports of aerospace products in 1971 were valued at $355 million, a 15.3 percent increase from $308 million in 1970.

EMPLOYMENT

Employment in the aerospace industry declined from 1,069,000 workers in December 1970 to an estimated 931,000 in December 1971. Despite this continuing drop, the aerospace industry remains the nation's largest manufacturing employer.

Production workers in the aerospace industry dropped from 528,000 in December 1970 to 466,000 in December 1971, a 11.8 percent decrease. Employment of scientists and engineers is expected to continue to decline from the peak of 235,000 in June 1967. It is estimated that employment in this category will be reduced to 147,000 by June 1972.

During 1971, production workers made up 49 percent of total employment, scientists and engineers accounted for 16 percent, technicians 4 percent, and the remainder were in administrative, clerical and maintenance categories.

PROFITS

Aerospace industry profits (as a percentage of sales after taxes) are expected to drop from 2.0 percent in 1970 to 1.9 percent in 1971.

1972 FORECAST

Aerospace industry sales in 1972 are expected to decline to $22.9 billion compared to $23.3 billion in 1971. The anticipated decline is in both space and commercial sales.

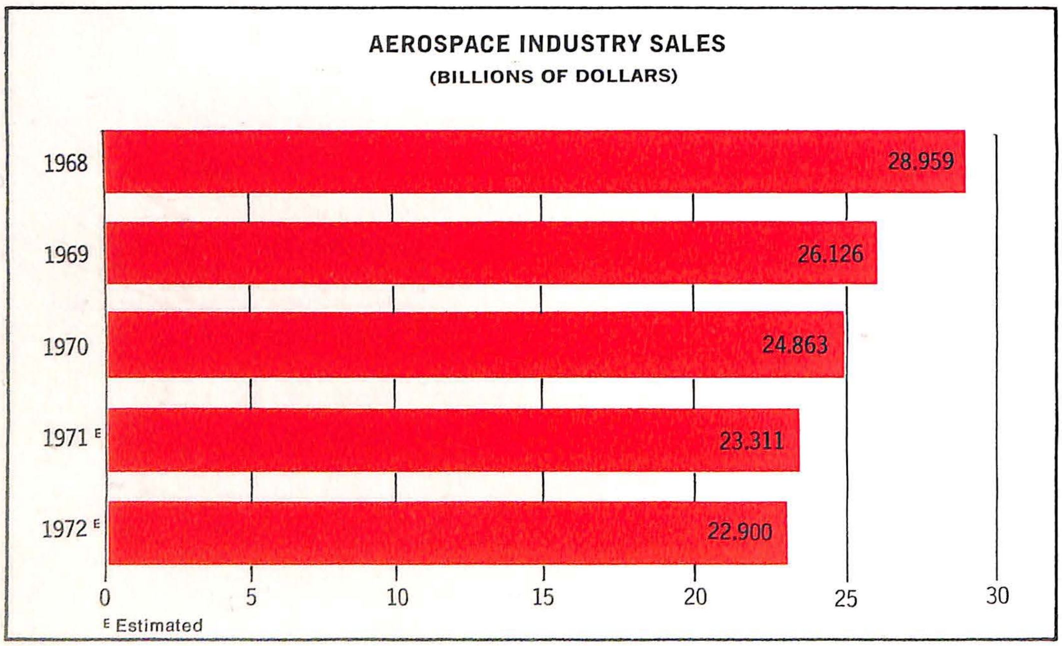
Sales to the Department of Defense are expected to increase to $14.0 billion in 1972 compared with $13.3 billion in 1971.

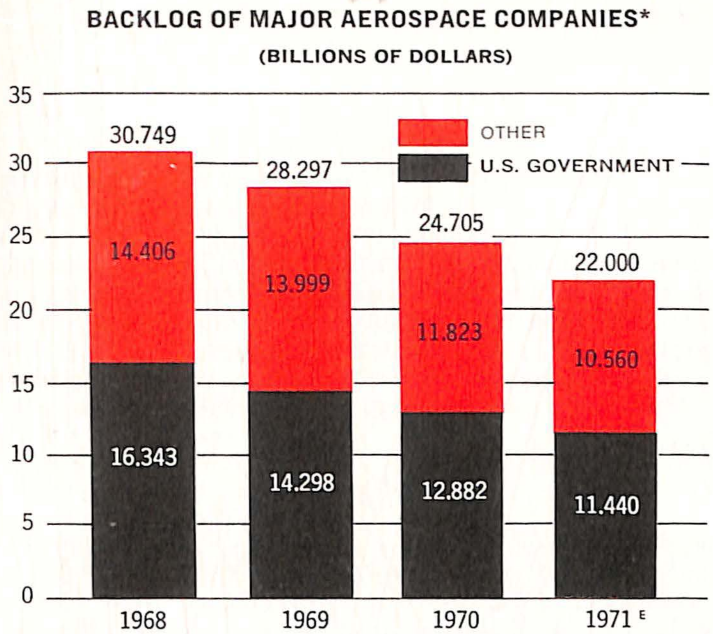
Space sales will decline to $2.900 billion in 1972 from $3.220 billion in 1971.

Commercial aerospace sales are also expected to decline between 1971 and 1972, dropping from $4.903 billion to $4.300 billion. The decline is primarily due to cancellations and a stretch-out of production schedules for jet transport aircraft.

Non-aerospace sales in 1972 are estimated at $2.200 billion, a decline of 6.8 percent from 1971 non-aerospace sales of $2.361 billion.

Employment in the aerospace industry is expected to decline by 8.7 percent between December 1971 and December 1972, from 931,000 to 875,000.

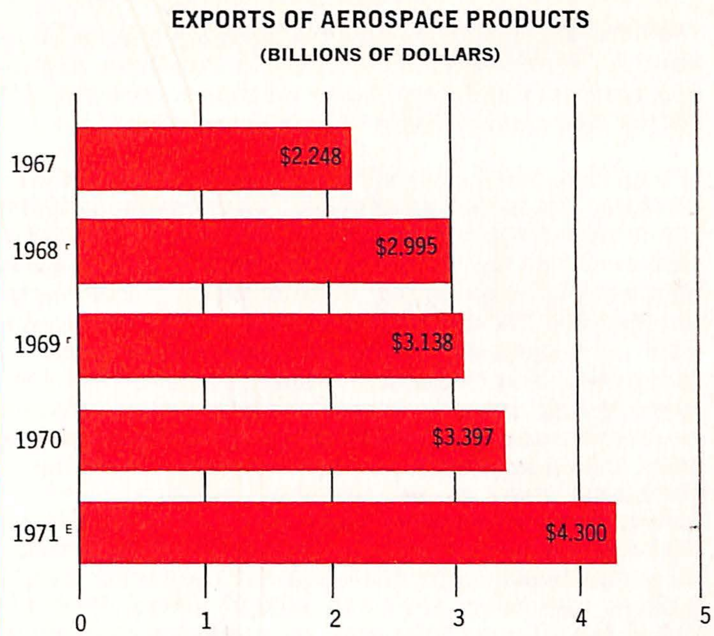




* Backlog reported to the Bureau of Census (includes information furnished by 62 companies). Statistics for years prior to 1968 are not totally comparable because of recent revisions in reporting by the Bureau of the Census on aerospace backlog. Statistics showing the distribution of backlog by government and non-government for prior years are not yet available on a revised basis; therefore, the revised total backlog is shown in parentheses.

E Estimated.

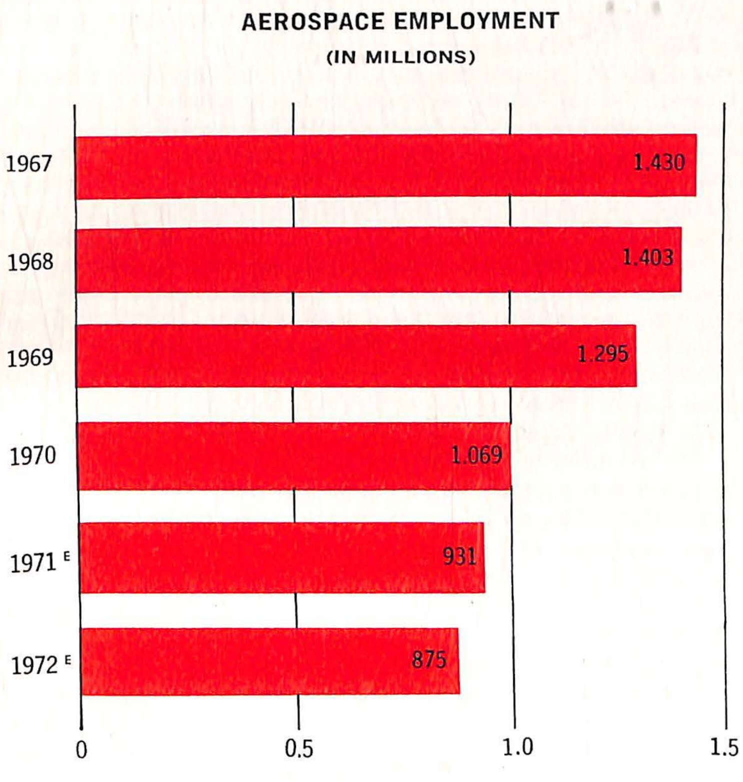
Source: Bureau of the Census, Report M37D.



E Estimated

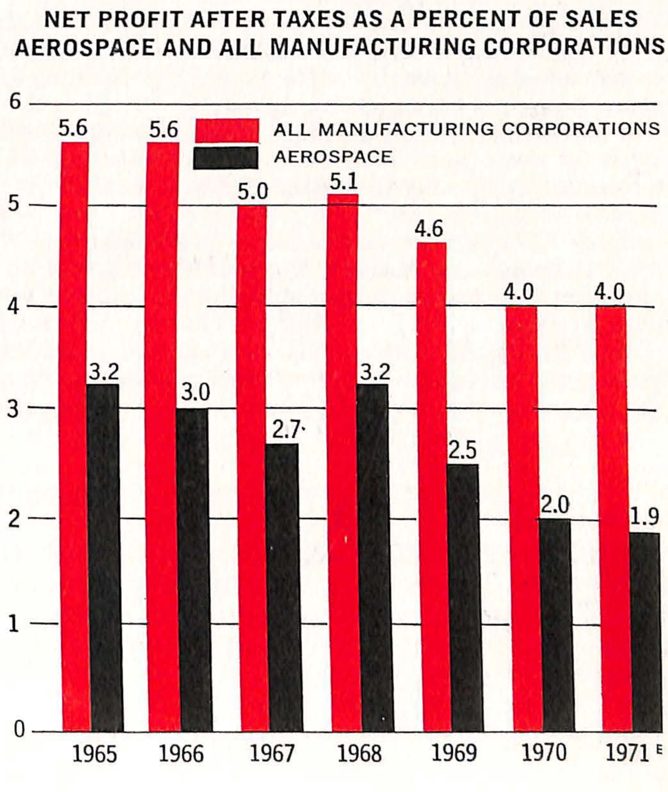
r Revised

Source: Bureau of the Census, Report FT 410.



E Estimated.

Source: Aerospace Industries Association, based on Bureau of Labor Statistics, Bureau of Employment Security data, and Company Reports.



E Estimated on the basis of data for the first six months of 1970.

Source: Securities & Exchange Commission-Federal Trade Commission "Quarterly Financial Report for Manufacturing Corporations."

'The Future Is Now'

The following is excerpted from a speech made by Karl G. Harr, Jr., President of the Aerospace Industries Association, before the Mid-East Region meeting on December 16, 1971 of the Aviation/Space Writers Association.

Forecasting is an imprecise science, indeed it is more art than science. In the aerospace business the problems of forecasting are compounded by the unique relationship of the industry to national and international policy objectives and decisions and by the fact that there are only a very few customers for the bulk of the products we produce. A significant change in the level, nature, or timing in the requirements of those few customers has a profound and dramatic impact on the level of activity in the industry and on its economic and technological viability. This is in sharp contrast with consumer industries which have broad market bases.

This year saw a further decline in aerospace sales to $23.3 billion from $24.9 billion in 1970 and about $29.0 billion in the peak year 1968. For 1972 a further drop is foreseen with sales estimated at $22.9 billion. This level represents the low point and we expect a gradual but steady increase during the balance of the seventies.

Here are other economic highlights:

■ The profit picture, again, is not good. Profits after taxes as a percentage of sales are estimated at 1.9 per cent compared to 2 per cent in 1970, less than one half the level of all manufacturing industries.

■ Employment continues to drop. There were an estimated 931,000 people on the payroll in December 1971, compared to 1,418,000 in 1968, with a further decline to 875,000 projected by December 1972.

■ In the major government market areas military aircraft sales declined by more than a billion dollars, space oriented sales dropped by more than $350 million. Missile sales showed a slight increase.

■ In contrast, on the commercial aircraft side 1971 sales were up more than $300 million to $4.9 billion. This includes an all time high in exports of commercial transports of $1.7 billion.

■ For 1972 an increase in sales to the Defense Department is foreseen; however, this increase will not be sufficient to offset the decline we anticipate in space and commercial sales.

This brief economic profile of the aerospace industry provides a background against which to assess its potential future development and identify some of the problems to be overcome. To make this assessment with any degree of credibility necessitates an examination of political considerations both in the United States and abroad. Here there exists a very vocal, if small, clique who condemn technology and the research and development effort upon which it is based as contributing to some of the domestic problems afflicting our nation. Foreign nations have taken quite the opposite view. They have seen the enormous benefits that the U.S. has derived from its research and

development investments since World War II and have determined that technological advance is the most effective means to enhance their standard of living and their ability to compete in world markets.

However, we are now realizing that technological advance is the primary generator of economic growth which is essential to the solution of the many problems confronting our society. Perhaps the most striking evidence of this new awareness is the comprehensive government-wide new technology opportunities program initiated by the President. Every Department and agency of the government has been requested to identify new programs that could and should be initiated. In addition, the private sector was invited to submit its suggestions and recommendations. All this input is currently being evaluated to identify those programs with the greatest benefits, both near and long term, to establish priorities, and to determine the resources that will be required for their implementation.

It also reflects a growing awareness that the traditional concepts of what activates the U.S. economy may not be adequate in these times. Heretofore, the domestic market was the major factor in reaching economic decisions with exports a sort of fringe benefit. Now, however, with increased competition from abroad, not only for foreign markets, but in our own domestic market, the validity of our historic approach needs a critical reappraisal.

One of the most successful exports over the years has been our commercial jet transports. We have dominated the free world market, producing about 80 per cent of the total airline fleet. However, looking ahead we can see the end of this dominance and, indeed, a reversal of the picture unless we take some immediate actions to develop new transports to compete with those currently being developed abroad. Because of the long development lead-time, as Redskin Coach George Allen says, "The future is now."

The free world jet transport market between 1974 and

"FOR WHETHER WE WISH TO BE OR NOT, WE *ARE* COMMITTED TO THE FUTURE BORN AT KITTY HAWK MORE THAN 50 YEARS AGO. WE HAVE LONG RIDDEN ITS ASCENDING CURVE TO HEIGHTS OF PROGRESS UNDREAMED OF WHEN THE WRIGHT BROTHERS WERE BORN. TO DISENGAGE—TO DROP OUT NOW, TO LIMIT THE ASCENDING TRAJECTORY OF FLIGHT BY CUTTING OFF THE FLOW OF PUBLIC SUPPORT FOR THE RESEARCH AND DEVELOPMENT ON WHICH IT RESTS, SEEMS TO BE AT BEST AN ACT OF SHORT-SIGHTED FOLLY IF NOT A CRIME AGAINST FUTURE GENERATIONS OF AMERICANS. . . ."

—Senator Howard W. Cannon, accepting the Wright Brothers Memorial Award at the annual Wright Brothers Memorial Dinner, Washington, D.C., December 17, 1971.

1985 has been estimated at $148.0 billion, half of which will be purchased by U.S. carriers. This figure is in current dollars and assumes a five per cent annual increase in costs due to inflation and product improvement. There are three general market areas—long range, including the SST; medium range, including the twin engine airbus; and short range, including STOL aircraft.

Now to make some assumptions about the penetrations of this market if the U.S. decides to be competitive in all three categories. It is estimated that the U.S. would capture 90 per cent of the long range market, 80 per cent of the medium range market, and 70 per cent of the short range market.

If we do not compete the potential loss of business has been estimated at $77.0 billion. This translates into 1,479,000 man years of lost employment, a $29.6 billion loss in payroll, and the loss of nearly $10.6 billion in Federal income taxes. The impact on the aircraft balance of trade is equally drastic. By 1976 the positive balance we presently enjoy in aircraft exports will become negative and in 1985 the negative balance will be an estimated $4.5 billion. The cumulative negative balance of trade during the period will reach a total of $18.3 billion.

A fair question would be in view of the magnitude of the potential market and the sweeping economic impact why doesn't the industry do something about it?

Industry would like to. But now and for the next several years it does not have the necessary financial resources. All the major transport manufacturers are experiencing cash flow difficulties on existing programs. This is partly the result of cancellations and the stretch-out of orders from the airlines, partly it results from the decline in space and defense business, and finally it is the result of the low level of profits the industry has been forced to accept on its government business.

Lacking the internal financial resources to initiate these new developments, industry might be expected to turn to the bankers, investment firms and other financial sources for the capital required. A survey of the money market indicates that there is *no* repeat *no* risk capital available for major new commercial aircraft programs at this time. The capital is there, but the financial people believe that the high degree of risk involved cannot be justified by the potential return on the investment.

What options then are there if the U.S. is to compete for this important market? One route is to team up with foreign interests, generally with the capital provided by the foreign government involved. Another alternative would be for the government to develop mechanisms that would generate the necessary resources. Comparing the two, the most attractive and valuable to the U.S. economy by far is some form of cooperative effort with the U.S. Government. This enables us to export products, not technology. With foreign financing and industry participation we are, in effect, selling our technology to obtain a share of the market, primarily domestic, increasing the technical competence of foreign industry, enabling it to compete more effectively for future new programs.

I am fully aware of the fact that government support of private industry in whatever form is not popular in this country. However, in view of changing world economic conditions, and the continued growth of imports, the time has come to reexamine carefully and thoughtfully some of our traditional economic concepts to determine if they are consistent with the realities of the times. I would hope that this is one of the major policy issues that is being examined by the Domestic Council as an element of the new technology opportunities program. I am not making a pitch for special treatment for the aerospace industry. If any new form or mechanism is developed for a more effective relationship between the government and the nation's industry in meeting national challenges and/or in foreign competition, this new arrangement should be available to all segments of the industrial sector. In addition, before being used the program or undertaking should meet two criteria:

- It must be in the public interest.
- The financial magnitude or risk must be beyond the capacity of private capital sources.

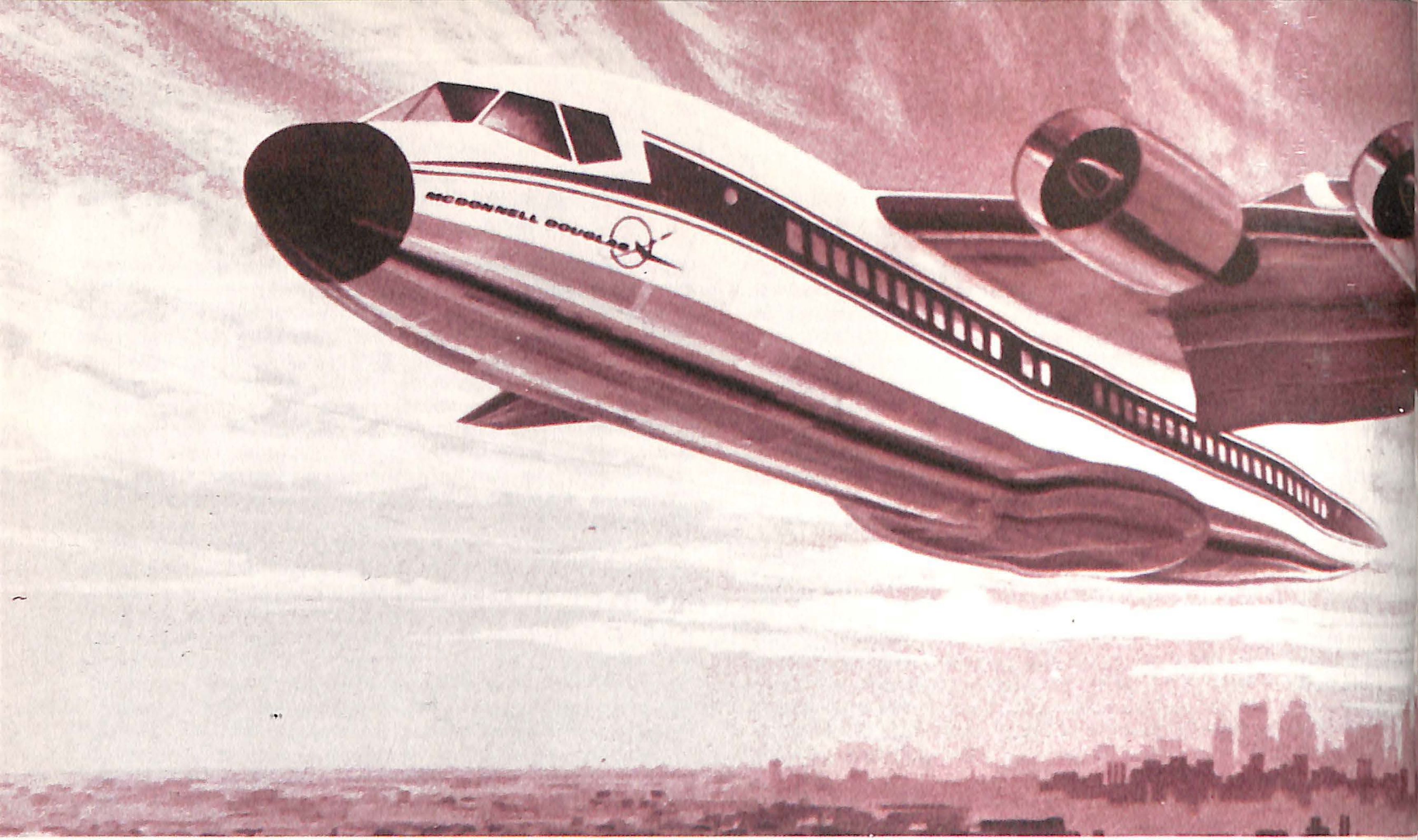
If these criteria are met there are a number of alternatives that merit consideration, either as individual options or in combination. Indeed, it is quite possible that different options or combinations would be used depending on the nature and scope of the specific program or project.

The possible alternatives include:

- Research and development tax incentives.
- Loan guarantees with or without reimbursement of interest.
- Government development funding with or without recoupment.
- Accelerated depreciation allowances.
- Government purchases and lease.
- Establishment of a technology development bank.
- Liberalization of the anti-trust laws.

While, on the surface, these might appear to be radical departures from the norm, similar mechanisms are widely used abroad and there has been a precedent for their use in U.S. history. Our companies would prefer to go it alone without government involvement, but the realities of the financial situation within the industry often preclude their ability to do so.

The decisions that will determine our national course for decades to come now rest on the table—of the President, of the Congress, and of the American people. In a somewhat different context than George Allen had in mind when he coined the phrase it has never been more true that for the industry, for the American people and for the nation as a whole, the future is now.



McDonnell Douglas turbofan-powered STOL aircraft

SHORT-HAUL TRAN
Problems and Promises

The need for more effective short-haul transportation is not new.

It is a need that once was filled by horse-carts and wagons—by bicycles—by trolley cars—by small trucks.

But during this century population growth, technological advances, galloping industrialization and almost unbelievable advances in communications have multiplied the need for short-haul transportation over ever increasing distances.

The farm-to-market wagon of 1900 won't do in 1972 when the housewife, no matter where she lives, expects to find a full selection of fruits, meat, vegetables and canned goods in her supermarket each day.

And the trolley won't do when a businessman's home office is not in the same town, or his wife's parents are not down the block and his parents are not in a neighboring suburb.

WHAT IS THE PROBLEM?

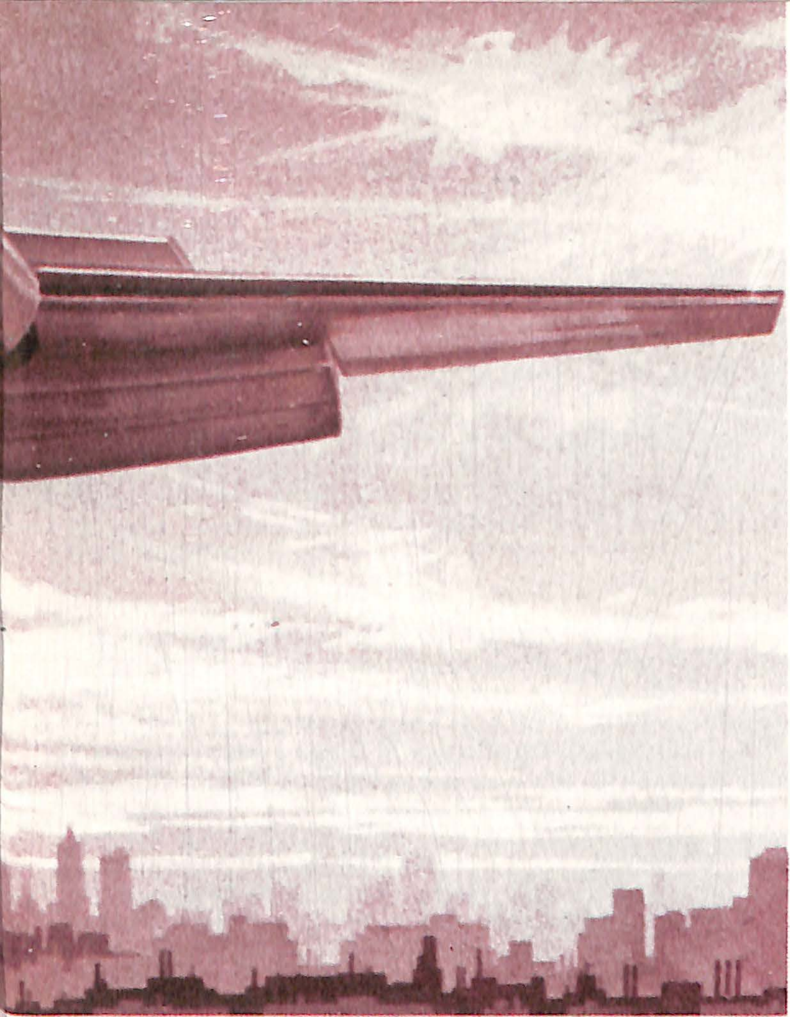
The requirement to move lots of people and lots of things over distances of 50 to 500 miles has grown by leaps and bounds. Various types of transportation have improved constantly under the pressure to meet various segments of the nation's transportation needs. The problem is that there have been only a few efforts toward coordinating the various transportation modes—automobile, truck, bus, boat or ship, train, aircraft—each with its unique capabilities.

Short-haul transportation is essential to a complete national transportation system, and although short-haul travel distances of up to 500 miles comprise the major portion of the air travel market, the air transportation system is not oriented in this direction.

Seventy percent of all passenger flights are for 500 miles or less, and 50 percent of all air passengers travel such short distances. Surveys show that in the U.S. 30 percent of all air passengers travel less than 300 miles. In the New York area, for instance, 50 percent travel less than 300 miles. In Europe almost 85 percent of all air passengers travel less than 300 miles per trip.

Airlines carry about 70 percent of the non-highway passengers traveling between New York and Washington. The other 30 percent go by train. There is more than enough room for both rail and air short-haul systems, and highway users would welcome any decrease in the congestion that they must battle daily.

The Northeast Corridor, which extends from Washington, D.C., to Boston, is a prime example of a congested transportation situation. Here the high-speed Metroliner trains between New York and Washington, and the National Railroad Passenger Corporation (AMTRACK) are beginning to serve an increasing segment of an overall short-haul transportation system. But there still is a network of cities that isn't being served adequately, and the requirement for efficient and convenient short-haul transportation promises to grow faster than bus, rail and air together can provide that transportation.



PORTATION -

Today the private automobile is the major short-haul vehicle for trips of from less than 50 to 500 miles. And for family travel the private auto may continue to be the short-haul transport for some time to come.

However, Dr. Rene Miller, Massachusetts Institute of Technology Professor of Flight Transportation, believes that the driving public is becoming aware of the hidden costs of the automobile—community disruption, pollution, traffic congestion and land loss to more and more, wider and wider ribbons of concrete and complicated highway interchanges.

What, then, are the problems to be solved in developing the short-haul transportation system needed to serve these expanding markets now and in the immediate future.

Traffic congestion on the ground and in the air is one of the acute problems. While many airports today are operating at near capacity, the interconnecting air traffic control network is overloaded. Congestion delays caused by this lack of greater capacity are costing the airlines $180 million each year, and it is estimated that this cost will increase to $1 billion by 1981.

Congestion on the ground, both within and outside the airport boundaries, is causing additional delay and inconvenience to air travelers. New airports must be located farther out from the centers of population and the central business districts. Thus, the already congested route to the airport is extended. Often the short-haul traveler spends more time on the ground going to and from the airport than he does enroute in the air.

In other words, no matter how much short-haul air transportation can reduce travel time, there is the possibility that this advantage will be offset by increased ground travel time before departure and after travel, and service to the traveler on short-haul inter-city routes will not be as efficient, fast and convenient as it could and should be.

At the same time, all segments of aviation—long and short-haul airlines, business and private aircraft—frequently must circle and wait for a turn to land, or stand on taxiways waiting their turn to take off at increasingly congested airports.

WHAT IS NEEDED?

The technological tools and techniques necessary to solve such problems are available. What is needed is the courage, imagination and organization to utilize them for the overall benefit of the public.

There is no single answer to meet the demand for short-haul transportation. All available modes—ground (bus, truck and car), surface effects vehicles, hydrofoils, ferries, high speed rail, tracked air cushion vehicles and aircraft—will be required to provide an integrated short-haul transportation system.

A prompt solution to the short-haul traffic congestion problem can be achieved only by Federal, state and local governments working in close coordination with all segments of the transportation industry.

But no solution will be adequate unless the use of land for landing facilities and the areas surrounding them are considered carefully. There is increasing concern about the ecological and safety problems facing this country. In terms of all modes of transportation this means mastering noise and air pollution and the dangers of crowded highways and congested air space. These solutions are not out of reach, including a new, better and more widespread air traffic control system.

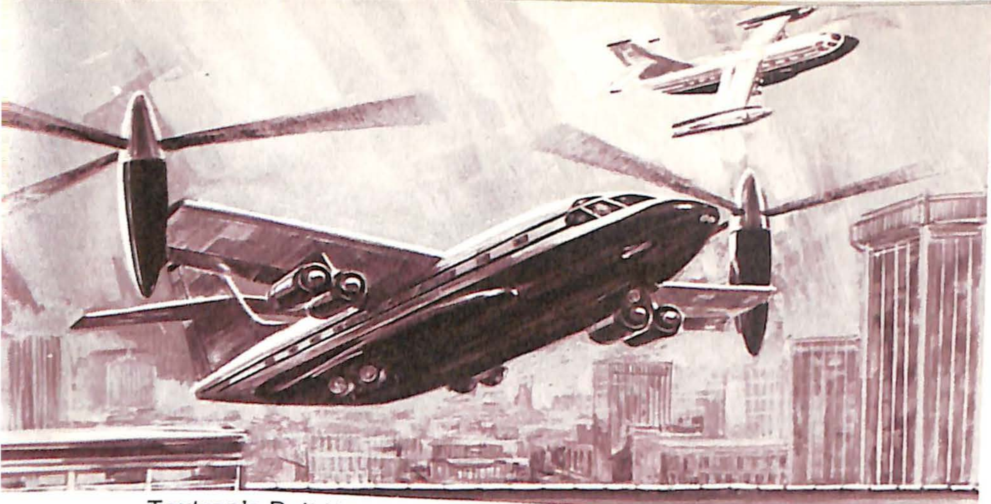
The noise of our rail systems and our highway systems have moved the suburban dweller farther and farther from the rights-of-way and have had a significant impact on property values. In some areas air traffic is drawing criticism from communities adjacent to major airports. On the other hand, a study on behalf of the American Institute of Real Estate Appraisers reports that helicopter landing facilities do not, and will not, have a negative effect on real estate values.

The pollution from our automobiles and buses is at times overwhelming, particularly in our major city centers. But new emission standards for gasoline engines have been set and turbine engines have helped decrease pollution in both our rail and air systems.

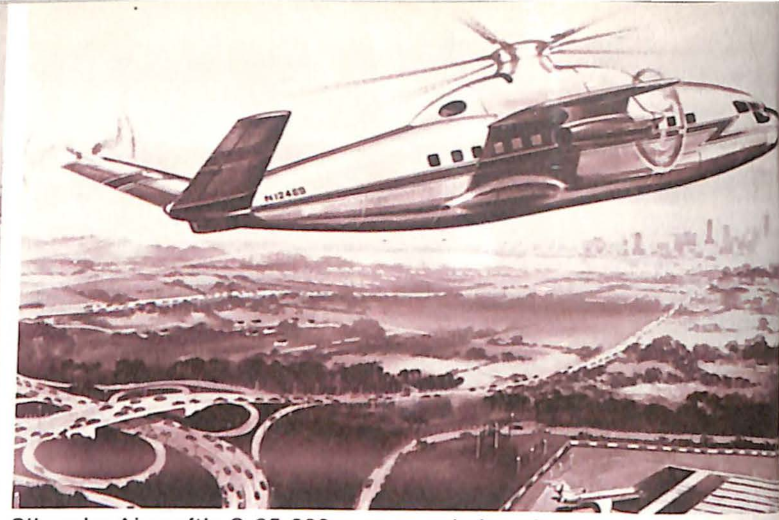
In recent years the greatest integrated transportation advances have been made in the business of moving "things." Efficient short-haul tractor-trailer truck transportation has been wedded to trains and ships for economical long-haul "piggyback" or containerized "seatrain" transportation. AutoTrains that carry the family and its car between Florida and northern points along the east coast are another promising experiment.

In the business of moving people, however, there are gaps in the rapid, efficient and convenient short-haul system. The gaps are between major airports and ultimate ground destinations, and from city-center to city-center. In this area buses can help and modern trains can fill some of the need, but only where there are rights-of-way, roadbeds and tracks.

Eastern Airlines has completed a study of airport capacity needs for 24 of the cities that it serves. The airline estimates that if the additional airport capacity required to handle the anticipated air travel growth could be accommodated by separate airports serving



Textron's Bell Helicopter Company aircraft with folding proprotor



Sikorsky Aircraft's S-65-200 compound aircraft

vertical/short takeoff and landing aircraft (V/STOL) the savings in construction costs would amount to more than $6 billion. The cost of landing facilities are considerably less for a V/STOL system than for a conventional system of the same capacity.

A V/STOL segment for the needed short-haul transportation system promises many advantages in coping with frustrating congestion. Heliports or small airports located close to or within urban population centers would reduce arrival and departure times and would drain off the short-haul air traffic to the relief of major terminals. Such a system also would reduce ground traffic congestion between urban centers and their major airports.

Writing in the October 1971 issue of *Astronautics & Aeronautics,* Professor Miller of MIT says that vertical and short-takeoff and landing aircraft have reached the point of challenging the automobile, and could well fill the ultra-short-haul intracity travel requirement—moving people between suburban areas and city centers and taking them from one urban center to another. He predicts that the new breed of V/STOL aircraft can be quieter than ambient city noises, can cut air pollution, and will only need to use small parcels of land anywhere they operate. He recommends that live demonstration programs be initiated to determine the true needs of the traveling public and their preferences. In other words, we must clarify the questions that must be answered if we are to operate efficient, ultra-short-haul service within the actual transportation system that exists today.

WHAT IS BEING DONE?

In April 1967 the President of the United States established the U.S. Department of Transportation. This act officially recognized the need for the development of a balanced, coordinated inter-modal transportation system for this country.

Under the 1970 Airports and Airways Development Act, Federal funds are available for the development and expansion of a modern air transportation system in the 1970s.

For the first time in history Government funds are available for new airports, an automated air navigation system, improvements at existing airports and for public-use heliports and STOLports. A special provision of this Act permits communities that are considering expanding their airports or building new facilities to buy land now for well-planned later use. This provision can prove particularly helpful to planners of city-center landing facilities. Proximity to the business and hotel district is important to the passenger who needs to go from city-center to city-center. It will become increasingly difficult in the future to find available landing sites in these traffic-clogged areas unless surface and rooftop sites are planned now.

The National Aeronautics and Space Administration (NASA) recently announced a $100 million program to develop a short take-off and landing airliner. This is welcome recognition of the urgent requirement for more effective and more convenient short-haul air service.

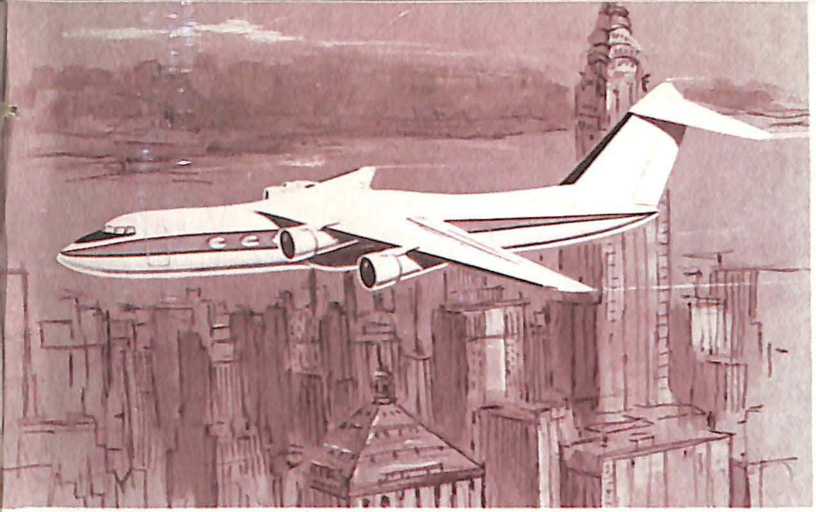
Initially NASA has awarded three $1.5 million contracts to cover the six-month design phase of the QUESTOL (Quiet Experimental STOL) program. The three firms working on this project are the Douglas Aircraft Company of Long Beach, Calif. (a division of McDonnell Douglas Corporation), Grumman Aerospace Corporation of Bethpage, N.Y. (teamed with the Boeing Company of Seattle, Wash.), and the Lockheed-Georgia Company of Marietta, Ga. (teamed with North American Rockwell Corporation of El Segundo, Calif., Bell Aerospace Corporation of Buffalo, N.Y., and Cornell Aeronautical Laboratories, also of Buffalo, N.Y.). This design competition will develop technology that can be used to build fleets of 75 to 125-passenger STOL airliners.

Since the late 1950s, individual manufacturers have poured millions of dollars into V/STOL research and development, knowing that there would some day be a recognized need to serve the short-haul market.

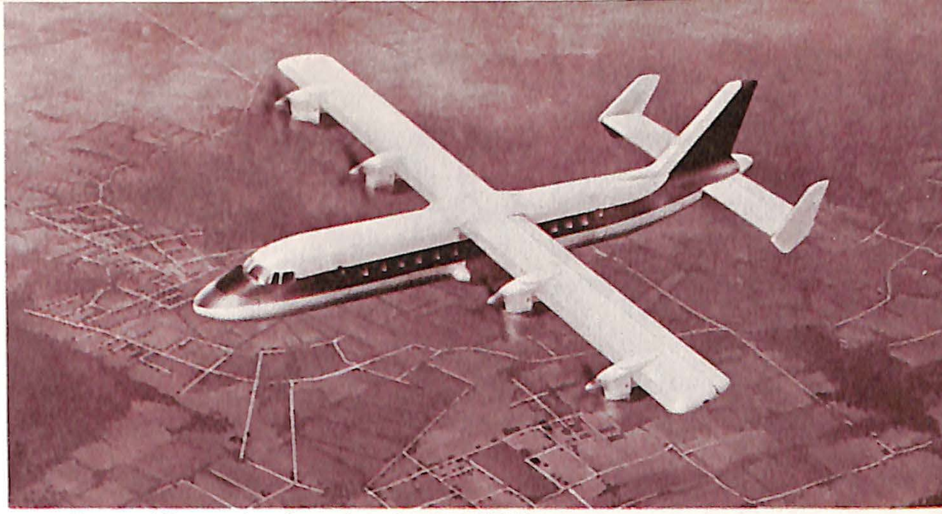
Many options for short-haul air transport should be considered. A number of these options have been explored to one degree or another during the last decade, most often under programs funded by individual companies. Here again the problem has been one of trying to meet undefined requirements in the absence of a national transportation plan.

Among the options already under exploration are: Tilt-wing aircraft that have achieved 100 percent in-flight conversion from vertical to horizontal flight, a helicopter with four-bladed tandem rotors and a wing, a "propulsive wing" aircraft that uses air flow to achieve vertical lift and then forward movement, and an aircraft with tilt proprotors.

Civilian applications of tilt proprotors would focus on city-center to city-center flights. For vertical take-offs the aircraft would use its rotors in helicopter fashion. This has the benefits of allowing flight out of confined areas with low noise characteristics, minimum downwash and steep approach paths, all of which are desirable in high-density population areas. Once in flight the aircraft would tilt its rotors forward to serve as propellers. In this mode, it would fly at 275 to 300 miles per hour, a speed envelope that could be used for short-to-medium distance flights.



Grumman Aerospace Corp (teamed with the Boeing Co.) QUESTOL (quiet STOL) airline transport



General Dynamics Canadair CL-246 STOL transport

Today the Department of Transportation is sponsoring the Metroliner and TurboTrain experiments to test high-speed, short-haul, inter-city rail service. And the Federal Aviation Administration of the Department of Transportation is studying the development of a STOL system, including the aircraft, air traffic control systems and terminal centers. NASA is funding STOL experimental aircraft developments, but there is yet no formalized program to confirm the feasibility of STOL in an integrated transportation system. Similarly there is not yet any Federal program to demonstrate the capabilities of vertical takeoff and landing aircraft to serve the transportation needs from city-center to city-center and between the city-center and outlying airports. This could be a logical forerunner to a sophisticated V/STOL transportation service of the future.

There is need now for low-cost, low-risk solutions to the short-haul transportation problem.

The recently released study "A Short Haul Air Transportation Study," completed for the Aviation Advisory Commission by the Mitre Corporation, concludes that both STOL and VTOL operations could be successful in at least three areas after 1975—the Northeast Corridor, the West Coast Corridor and the Great Lakes region. The report further states that a VTOL system operating from new city-center vertiports could be profitable and could attract about 60 percent higher demand than would suburban STOL airports.

For the short-haul transportation system that is needed now all modes must be exploited. All should be developed, tested and integrated into an overall system as soon as possible.

VTOL systems could come before STOL in short-haul operations, not only because the technology of these versatile aircraft has been widely demonstrated but also because many ground facilities either exist or can be established in our major cities at low cost.

A VTOL segment of an overall transportation system could be put into operation quickly in two steps:

First, a 45-passenger modification of a military helicopter operating at 150 knots could be used for an experimental service in the Northeast Corridor to develop the necessary air traffic control and instrument flight rules, equipments and procedures. Such helicopters could be introduced into passenger service at relatively low cost and service could start soon from new, well-located, low-cost heliports, or from existing city-center heliports.

Second, a 100-passenger, 260-knot short-haul transport helicopter could be brought into service from a present-day development program.

It is estimated that by 1980, VTOL downtown service could eliminate 40 to 60 flights per hour during the peak period at New York City's long-haul airports. This traffic drain-off would be equivalent to constructing a new major airport in that area.

The initial costs of this proposed two-step system would require Government direction and support, and cities now suffering from severe transportation problems would need to plan for downtown public-use heliports.

Aerospace manufacturers also are applyling their technological expertise to the problems of surface transportation.

The Boeing Company is system manager for the radical new Personal Rapid Transit (PRT) system under construction in Morgantown, West Virginia. The Sikorsky (United Aircraft) TurboTrain recently completed a successful 12,000 mile trip through 28 states. The trip, sponsored by the U.S. Department of Transportation, was designed to test the durability and ride qualities of the equipment under short, intermediate and long distance operating conditions.

The Rohr Corporation is producing the vehicles for the San Francisco Bay Area Rapid Transit (BART) system, and Bell, Boeing, LTV, Aerojet-General and others are working on various segments of the total transportation system of the future—higher speed rail transportation, surface effects vehicles, hydrofoils and people-movers for intracity applications.

In summary, some 80 percent of all aircraft used by free world commercial airlines are U.S.-made. This takes care of the medium and long-range travel requirement—until foreign SSTs come on the market, as they will soon.

Airbuses to cover a segment of the short-haul market are being built in Europe but none are under development in the U.S.

The new generation of trains will take care of one segment of the short-haul requirement, where there are rights-of-way and tracks.

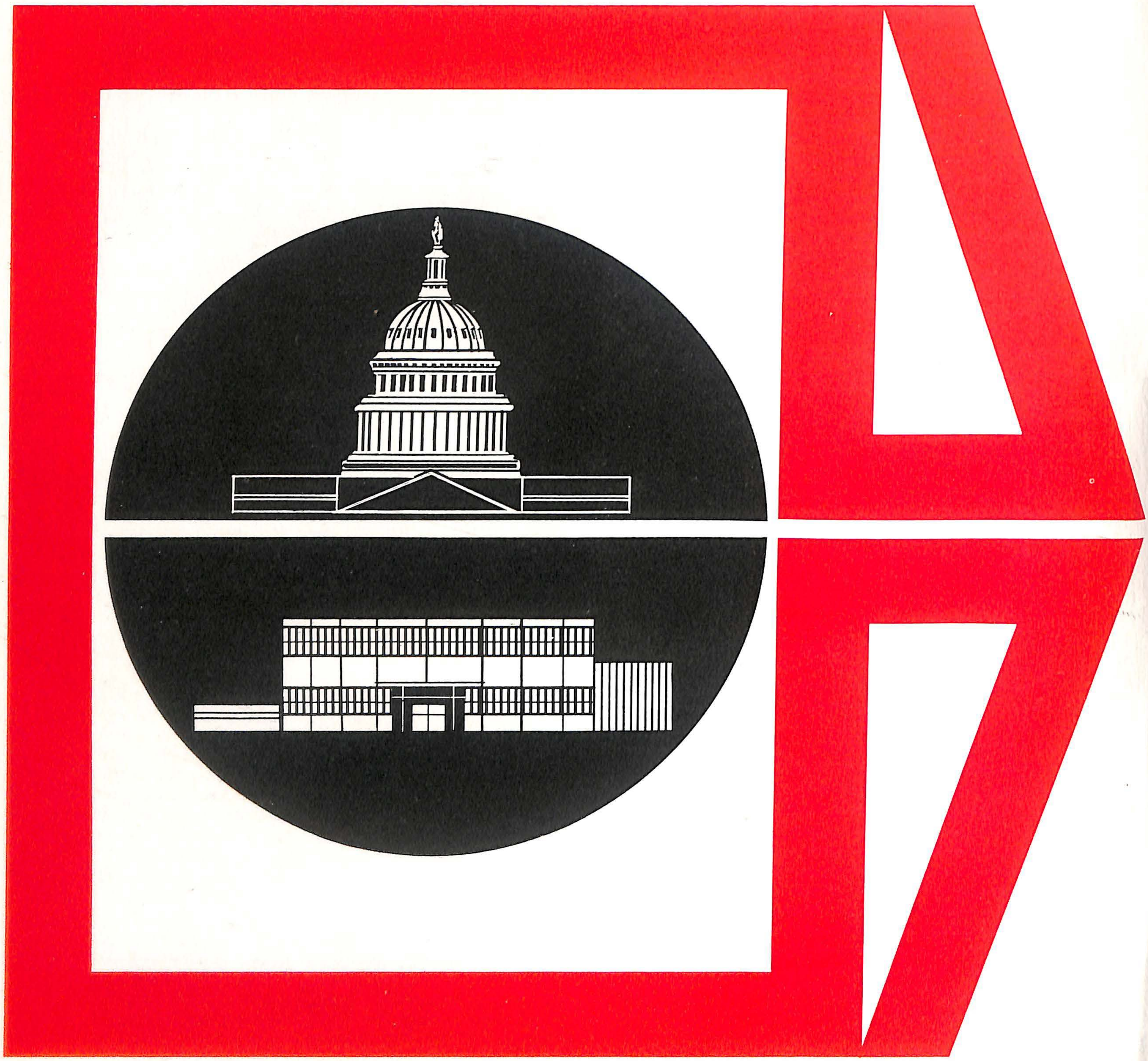
Buses and trucks are doing an efficient job for the segment of the transportation market that they serve.

But we are not doing enough about the short-haul commuter traffic—from city-center to city-center and between city-centers and outlying airports.

This is the market in which imaginative U.S. administration and innovative U.S. industry can benefit travelers most and can reduce congestion in other segments of the overall transportation system by providing the vertical takeoff and landing and the short takeoff and landing vehicles, the routes, and the heliports and STOLports from which they can operate.

A Proposal—

FEDERAL PROCURE



MENT PRINCIPLES

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A proposal—

FEDERAL PROCUREMENT PRINCIPLES

The procurement of goods and services by Federal agencies from private enterprise is a significant factor in the national economy and contributes substantially to the economic growth and world leadership position of the United States. To foster the continued growth and strength of the nation, it is declared in the public and national interest that certain principles be set forth defining the fundamental relationships between the public and private sectors of our society in all Federal procurement actions. These principles shall have precedence unless otherwise barred by law:

- The Government favors the use of and will procure to the maximum extent from private enterprise to fulfill its needs for goods and services.
- All Government procurement actions, including those resulting from actions of sovereignty, shall be based on a doctrine of fairness and equity.
- The Government shall abide by the same business principles that govern others in the field of commerce.
- The Government, when its procurements comprise the sole or dominant share of a market, shall recognize and avoid the use of its monopsonistic leverage to exact unfair or inequitable contractual arrangements or conditions.
- The opportunity to earn a reasonable profit shall be fostered in Government procurement commensurate with the risks assumed and comparable to similar commercial endeavors.
- Government procurement shall acquire the benefits of competition through the use of either formal advertising or negotiation.
- The Government shall pay fair prices for goods and services by accepting all ordinary and necessary costs, consistent with accepted commercial practices.
- The Government shall issue procurement regulations as required to establish equities and protect the public interest while at the same time assuring that regulations are not excessive, conflicting or imposing undue costs.
- Formal criteria for the content, development and approval of all procurement policies, regulations and procedures shall be established by each agency, be common among agencies where possible, and be consistent with these Federal Procurement Principles.
- The Government recognizes and shall protect the rights of affected parties to participate in the procurement regulatory process and to seek independent review of such regulations for amendment or repeal based on these Federal Procurement Principles.

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The Aerospace Research Center of the Aerospace Industries Association recently proposed a set of Federal Procurement Principles aimed at establishing by legislation the basic framework for governing, with fairness and equity, the fundamental contracting relationships between the Federal Government and the private sector.

No such set of explicit principles currently exists. This void is believed to be an underlying reason for many of the troublesome problems being experienced in government contracting and for serious inefficiencies in the economy which, in the national interest, should be corrected.

Government contracting with private enterprise has been called the world's largest business. This may well be. Federal expenditures for goods and services currently amount to about $100 billion per year, which is three times greater than the entire budget for Great Britain and comprises almost one-half of the U.S. national budget. Such expenditures have become a towering force and a major element of our economy. By way of further comparison, such expenditures today are 5½ times higher than in 1950. They have doubled in just the last ten years and by 1975 will probably exceed the equivalent of the entire federal budget of only five years ago. Yet no clearly defined set of principles exists to provide guidance and long-term national direction for such an overwhelming economic undertaking.

What does exist are over 4,000 statutes which directly or indirectly affect such transactions; scores of Executive Orders and Circulars; hundreds of Board and Court decisions; thousands of policies spread among the various agencies; and innumerable procurement regulations, procedures, management systems, and reporting requirements—all developed and administered largely in piecemeal fashion and often conflicting and duplicative.

Within this mass of paper, initiated by and residing in offices throughout all levels of Government, some principles can indeed be found. But more often than not they are only implicitly stated and were generated from different viewpoints for different needs at different times. This is not an indictment but rather recognition that government contracting has grown fitfully and rapidly, and without benefit of a strong and explicit foundation.

Stresses and problems associated with government procurement are legion and appear to be growing even more rapidly than expenditures. The symptoms of cost growth and cost overruns, growing numbers of Court cases, more and more red tape, and charges of waste and inefficiency, clearly indicate that national policy on government procurement has become an increasingly critical public issue.

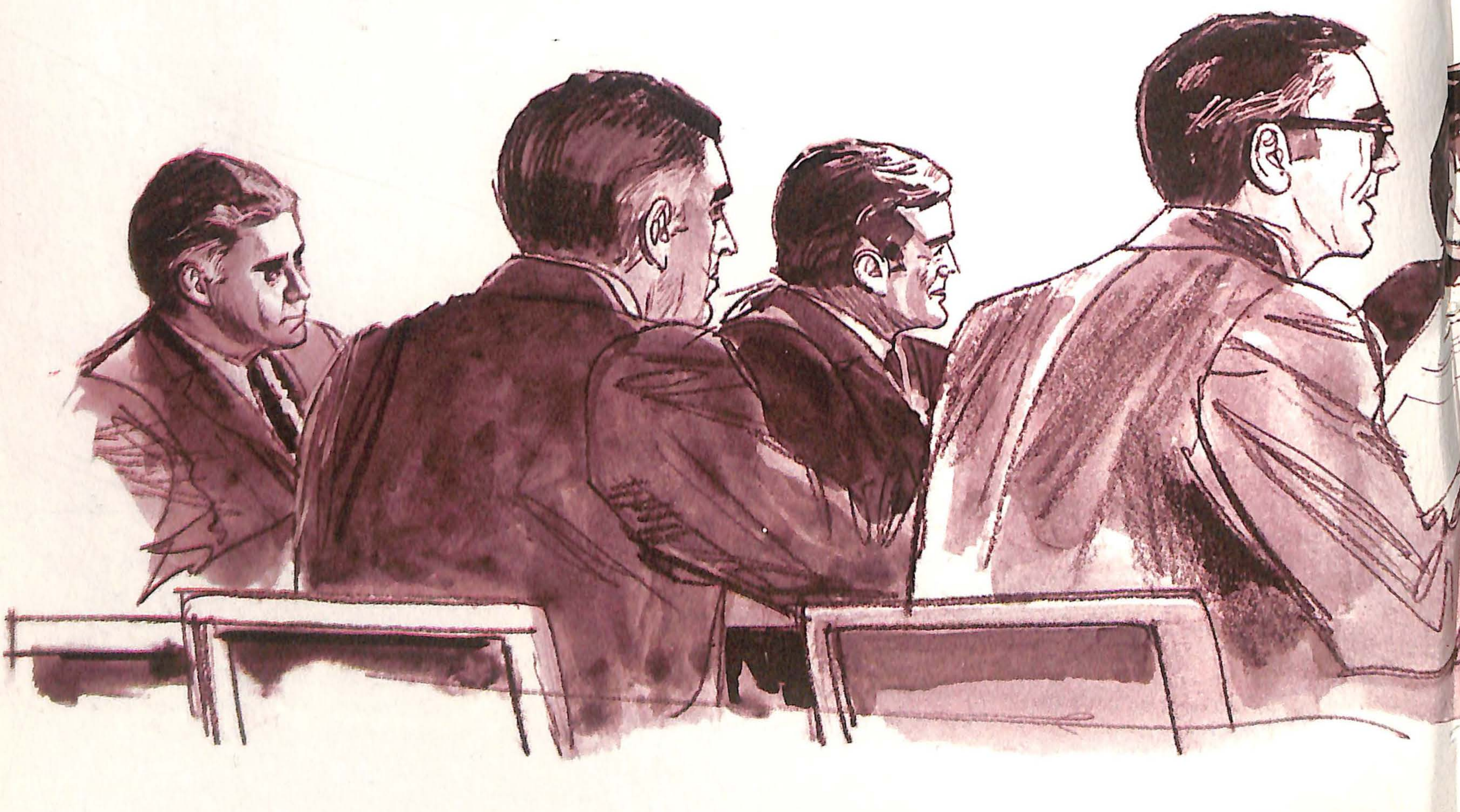
Recognition of the growing importance and complexity of procurement problems, and broad public concern about them, led the Congress to establish in 1969 the Commission on Government Procurement to review all aspects of Federal contracting. Such recognition is also the reason this proposal is being offered at this time. It appears that the nation is in a period where such fundamental guidelines *can be* established based on broad experience and *should be* established based on obvious need. The future form, efficiency and well-being of the national economy will in many ways be dependent upon whether this need is met and how well it is met.

As important as developing and installing such a sound foundation for the future may be, the task will not be easy. Widely acceptable Federal Procurement Principles will have to take into account not only the best of the past but also the realistic requirements of today and the needs of tomorrow.

They will have to be forged with recognition of our traditional concepts, institutions and values and with understanding of the underlying nature of current social, economic and political trends. They will have to take into account the complex factors of conflicting goals and objectives and such issues as public interest vs. private independence, political exigencies vs. national long-term needs, and sovereign powers vs. equity, among many others.

The challenge to both government and private enterprise will be considerable, but it is earnestly believed that this proposal will provide a good starting point for the job to be done. Its validity is believed to be substantial on at least two counts. First, it addresses fundamentals which, by their very nature, exclude subjective bias or selfish interest. Second, it represents a set of standards comprising the essentials of sound and enduring business relationships, developed over the long history of commercial jurisprudence.

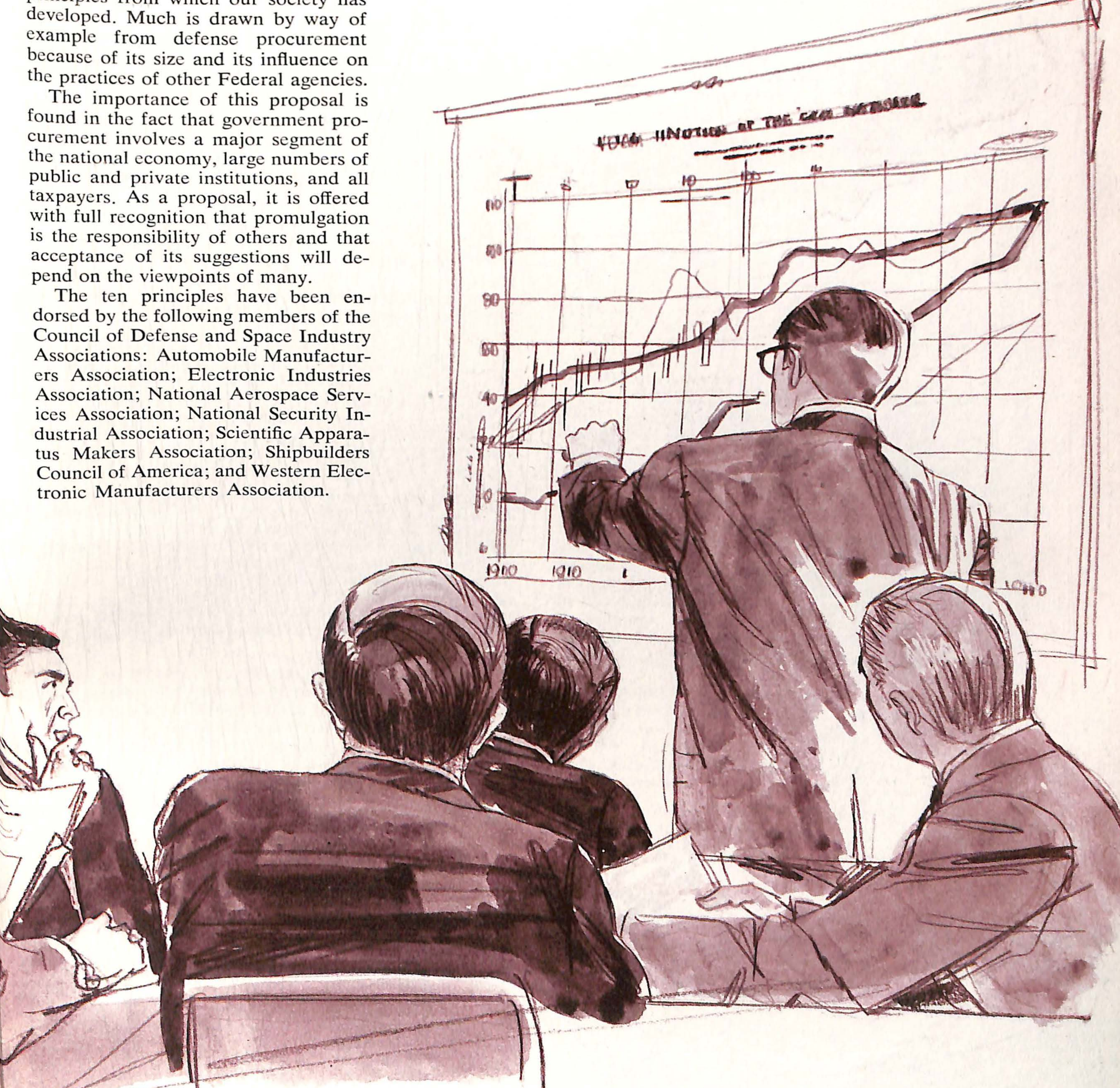
The full report prepared by the Aerospace Research Center identifies such key factors as statutory, economic,



legal and philosophical and related principles from which our society has developed. Much is drawn by way of example from defense procurement because of its size and its influence on the practices of other Federal agencies.

The importance of this proposal is found in the fact that government procurement involves a major segment of the national economy, large numbers of public and private institutions, and all taxpayers. As a proposal, it is offered with full recognition that promulgation is the responsibility of others and that acceptance of its suggestions will depend on the viewpoints of many.

The ten principles have been endorsed by the following members of the Council of Defense and Space Industry Associations: Automobile Manufacturers Association; Electronic Industries Association; National Aerospace Services Association; National Security Industrial Association; Scientific Apparatus Makers Association; Shipbuilders Council of America; and Western Electronic Manufacturers Association.



transpo '72

For as long as man has been flying the United States has thrilled to national and local air shows and air races.

Old-timers can recall the thrill of lying on their backs in a daisy-covered field next to a dirt-runway "airport" and watching Army Air Corps B-6 bombers wheel into view and staggered-wing WACO 10s loop and roll above them.

Never, however, has the United States sponsored an international exposition like the biannual Paris Air Show or an industry showcase like England's Farnborough air spectacular.

This year things will be different.

Today program planning and actual construction for the world's first international transportation exposition—not just air, but all transportation—is under way near Washington, D.C., at the world's finest major air facility—Dulles International Airport with its soaring Sarrinen-designed terminal building. The exposition will be presented from May 27th through June 4th this year.

When first conceived in the mid-60's the United States International Transportation Exposition—*Transpo '72*—was to be a purely aerospace fair. Later, planners decided that rather than being limited to aeronautics and space the format should be expanded to encompass the entire spectrum of transportation—air, space, ground and water—and how these various transportation requirements and the modes to satisfy them can be integrated.

Now work is proceeding seven days a week at a 10 to 14-hour-a-day clip in an effort to make up for any delays caused by adverse weather and by changes in concept and scope. The Honorable John A. Volpe, U.S. Secretary of Transportation, is personally involved in the project, and other departments and agencies of the Government have pitched in to help. Officials express confidence that the show will meet its opening-day target date.

Total attendance is expected to range between 925,000 and 1,300,000 visitors, according to exposition officials, with some 250,000 people expected on each of the final weekend days (June 3 and 4). Among the visitors will be approximately 357,000 businessmen, of whom 50,000 are expected to come from overseas.

Purposes—*Transpo '72* has several basic objectives:

- To explore new overseas markets for U.S. products, and thus help improve the U.S. balance of trade position.
- To make the using public more aware of the great importance of the total transportation industry to economic, social and cultural progress.
- To bring together in one place for the first time the products, equipment, technologies and concepts needed to solve today's transportation crisis—and the people who have created them and will create further advanced systems in the future.
- To emphasize the importance of integrated transportation systems.

In meeting these goals *Transpo '72* planners recognize a dual responsibility to the U.S. taxpayer who is helping to finance the show, and to the businessmen who attend and those who exhibit.

Financing—Original estimate of the total cost of the exposition was approximately $6.5 million. After further planning, and cost increases, the figure rose somewhat. Congress has so far appropriated $2.8 million, and probably will approve additional Federal funding. An additional $3.8 million is expected in revenues from exhibitor registrations, indoor and outdoor display space rental fees, ticket sales, parking fees, returns from concessionaires, program sales and other sources.

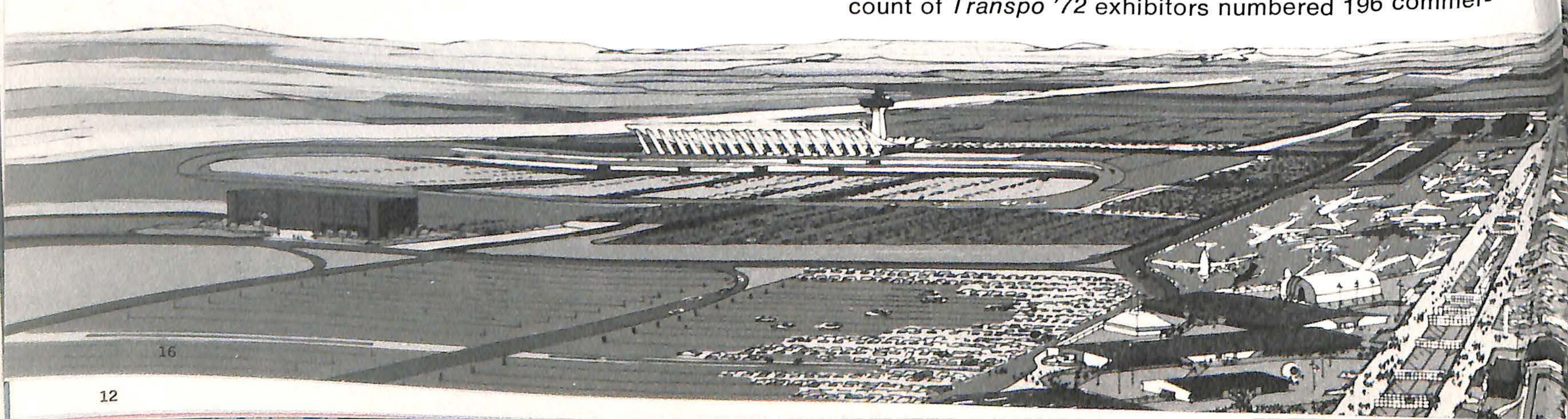
Any funds remaining after expenses have been paid will be delivered to the General Receipts fund of the United States Treasury.

By way of cost comparison, it is believed that the 1971 Paris Air Show, though its facilities were built in earlier years, cost considerably more than will *Transpo.*

A side benefit of this national undertaking is the fact that site preparation, new road construction and other activities will add to progress under the long-range master plan for Dulles International Airport development.

Layout—The ground plan for the exposition calls for a "spine" adjacent to existing Dulles facilities. This spine will be about one and one-quarter miles long—approximately the distance between the U.S. Capitol building and the Lincoln Memorial. Total area of the indoor and outdoor exhibition areas along the spine, and the adjacent demonstration areas, roads and surfaced or sod parking areas, will cover some 360 acres—or 40 times the area encompassed by the Los Angeles Coliseum.

Exhibitors—about evenly divided among air, water and ground transportation modes—will use about 320,000 square feet of covered exhibit space in four huge prefabricated steel exposition halls and more than one million additional square feet in separate exhibit chalets and outdoor areas. As of late December more than 50 percent of the interior exhibit space had been contracted for, more than 222,000 square feet of outdoor display space had been reserved and only eight of 102 planned chalets still were available. A December count of *Transpo '72* exhibitors numbered 196 commer-



cial firms and 14 government agencies for a total of 210.

A number of firms and governments of other nations—including Brazil, Great Britain, Canada, France, Italy, Japan, Mexico, and West Germany—have scheduled exhibits, and negotiations are continuing with other potential foreign exhibitors.

By mid-December 27 manufacturing members of the Aerospace Industries Association had registered as *Transpo '72* exhibitors. Executive officers of five member companies or their parent corporations are serving on the Secretary of Transportation's Exposition committee: William M. Allen, Chairman of the Board of The Boeing Company; William P. Gwinn, Chairman and Chief Executive Officer of United Aircraft Corporation; Jack S. Parker, Vice Chairman of the Board of General Electric Company; Simon Ramo, Vice Chairman of TRW, Inc., and James M. Roche, Chairman of the Board of General Motors Corporation. Karl G. Harr, Jr., President of AIA, represents the aerospace industry on the exposition's Transportation Associations Coordinating Group.

A major feature of the exposition, from the standpoint of advanced ground transportation, will be four Personal Rapid Transit (PRT) systems. These "people mover" systems will move visitors along or across much of the spine to provide coordinated, connecting intrafair transportation.

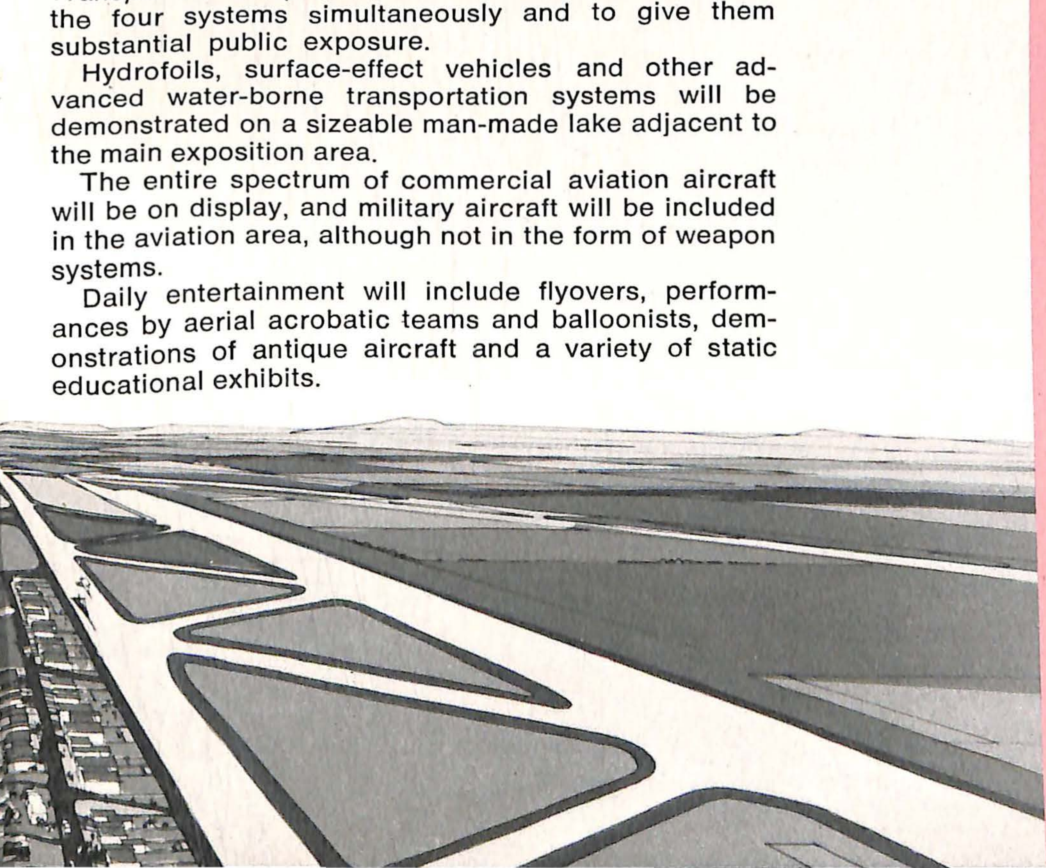
The systems will be built, installed and demonstrated under four $1.5 million contracts issued by the Department of Transportation's Urban Mass Transportation Administration to the Dashaveyor Company of Los Angeles; the Ford Motor Company of Dearborn, Michigan; Transportation Technology, Inc., of Denver; and the Varo Corporation of Garland, Texas, affiliated with Rohr Corporation of Chula Vista, California.

"People movers" are believed by many to be one solution for the mounting problems of getting people from one place to another in crowded urban areas. Characteristically the PRT vehicles are small, independently powered, and move at relatively low speeds on exclusive guideways under automatic control. Thus, *Transpo '72* will provide a unique opportunity to test the four systems simultaneously and to give them substantial public exposure.

Hydrofoils, surface-effect vehicles and other advanced water-borne transportation systems will be demonstrated on a sizeable man-made lake adjacent to the main exposition area.

The entire spectrum of commercial aviation aircraft will be on display, and military aircraft will be included in the aviation area, although not in the form of weapon systems.

Daily entertainment will include flyovers, performances by aerial acrobatic teams and balloonists, demonstrations of antique aircraft and a variety of static educational exhibits.



AIA

MANUFACTURING MEMBERS

Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Amphenol SAMS Division
  The Bunker-Ramo Corp.
Avco Corporation
The Bendix Corporation
The Boeing Company
CCI Corporation
  Murdock Machine & Engineering
  The Marquardt Company
Chandler Evans, Inc.
  Control Systems Division of
  Colt Industries
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Aerospace Group
  Aircraft Engine Group
General Motors Corporation
  Detroit Diesel Allison Division
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  ITT Aerospace/Optical Division
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  Aerospace and Marine Systems Group
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  Harvester Co.
Sperry Rand Corporation
Sundstrand Corporation
  Sundstrand Aviation Division
Teledyne CAE
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Textron Inc.
  Bell Aerospace Company
  Bell Helicopter Company
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Thiokol Chemical Corporation
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TRW Inc.
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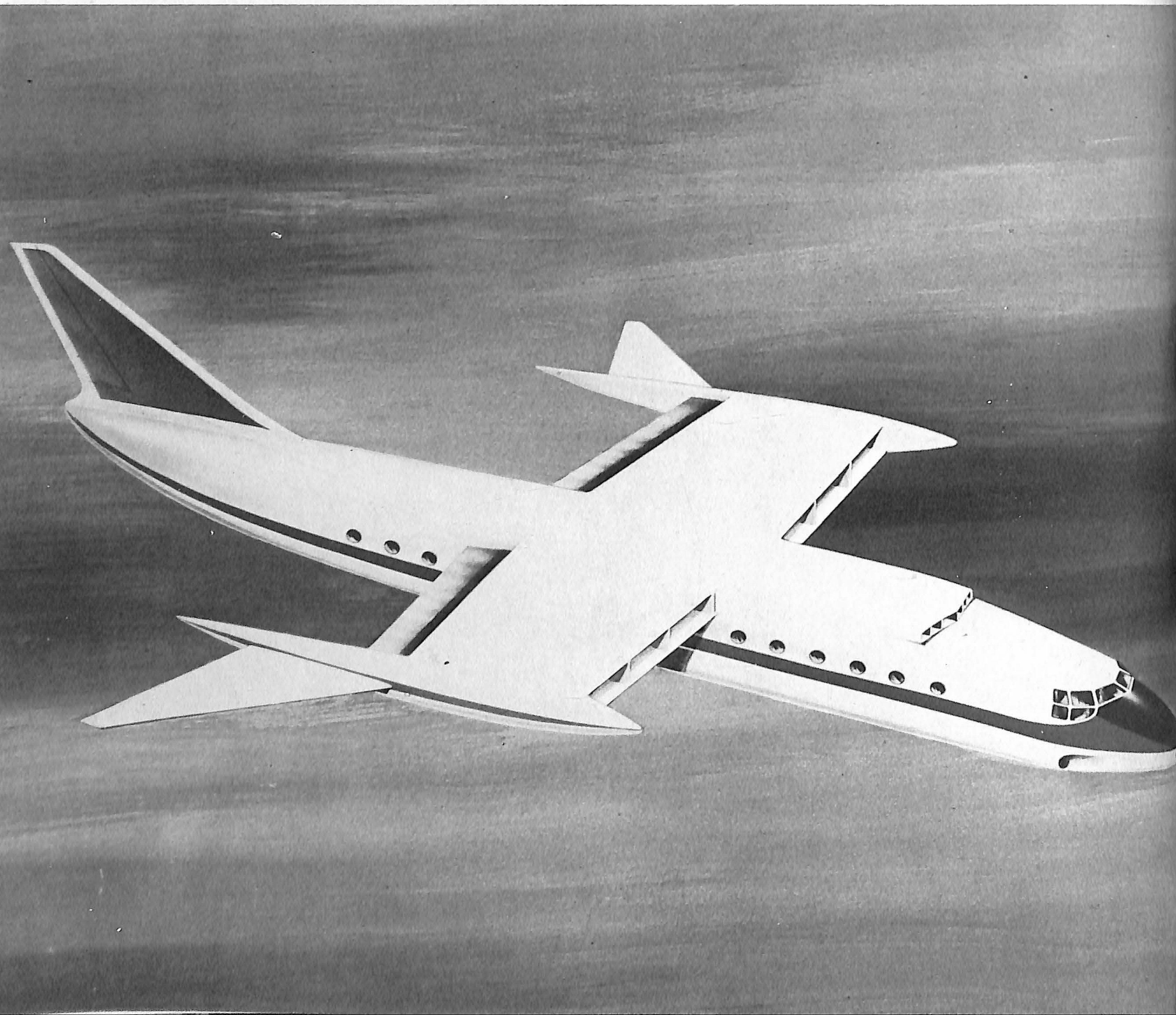
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory

AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St., N.W., Washington, D. C. 20036

RETURN REQUESTED

LTV Aerospace Corp. design of a vertical takeoff and landing transport aircraft incorporating the air deflection and modulation concept. (See *Short-Haul Transportation—Problems and Promises,* Page 8).



aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • APRIL 1972

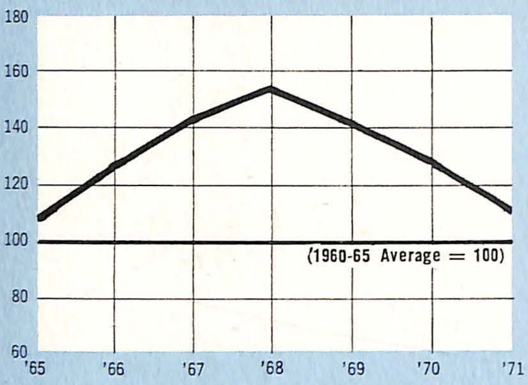
SPACE SHUTTLE
Investment in the Future

BY REPRESENTATIVE OLIN E. TEAGUE
Chairman, House Manned Space Flight Subcommittee

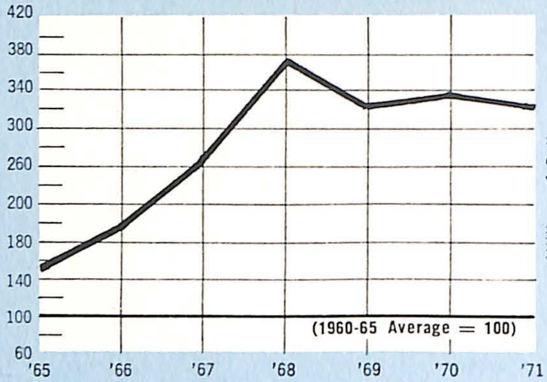
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

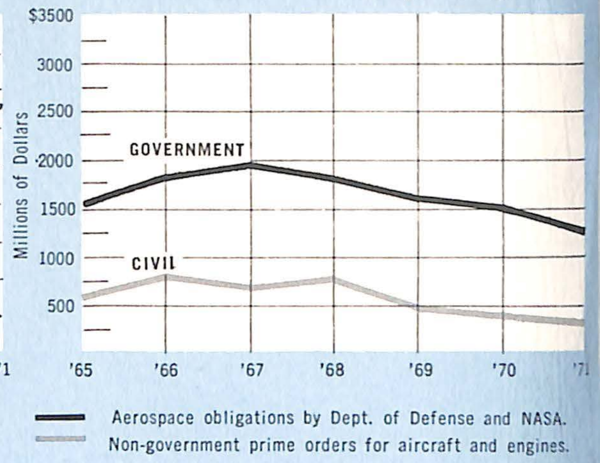


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1960-65 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	4th Quarter 1971	24.8	22.7	21.6
	Billion $	Quarterly	4.8		6.3	4.8	5.2
DEPARTMENT OF DEFENSE							
Aerospace Obligations: Total	Million $	Monthly	1,151	Dec. 1971	1,570	937	1,565
Aircraft	Million $	Monthly	601	Dec. 1971	730	541	900
Missiles & Space	Million $	Monthly	550	Dec. 1971	841	397	665
Aerospace Expenditures: Total	Million $	Monthly	1,067	June 1971	1,340	1,041	1,174
Aircraft	Million $	Monthly	561	June 1971	773	628	675
Missiles & Space	Million $	Monthly	506	June 1971	567	413	499
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920-╬-	Dec. 1971	1,255	876	1,036
Aircraft	Million $	Monthly	447	Dec. 1971	533	597	564
Missiles & Space	Million $	Monthly	473	Dec. 1971	722	279	472
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Feb. 1972	201	185	161
Expenditures	Million $	Monthly	130	Feb. 1972	236	190	208
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3#	4th Quarter 1971	24.7	24.0	21.8
U.S. Government	Billion $	Quarterly	11.6		12.9	13.1	13.3
Nongovernment	Billion $	Quarterly	3.7		11.8	10.9	8.5
EXPORTS							
Total (Including military)	Million $	Monthly	110	Dec. 1971	277	293	384
New Commercial Transports	Million $	Monthly	24	Dec. 1971	92	80	153
PROFITS (After Taxes)							
Aerospace — Based on Sales	Percent	Quarterly	2.3	3rd Quarter 1971	1.9	1.9	2.2
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		3.9	4.5	4.1
EMPLOYMENT: Total	Thousands	Monthly	1,132	Dec. 1971	1,070	937	929
Aircraft	Thousands	Monthly	469	Dec. 1971	465	380	375
Missiles & Space	Thousands	Monthly	496	Dec. 1971	438	391	388
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Dec. 1971	4.30	4.35	4.41

R Revised.
E Estimate.
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
\# Averages for 1961-65.
╬ Averages for fiscal years 1960-65.

Source: Aerospace Industries Association

MAN DIDN'T MOVE FORWARD BY LOOKING BACKWARD

BY KARL G. HARR, JR.
President,
Aerospace Industries Association

In 1915 for the first time it became possible to make a long distance telephone call between New York and San Francisco. When you could get through you paid $20.70 for a three-minute conversation.

Today you can pick up the telephone in New York and dial the number you want in San Francisco. Your immediate three-minute conversation will cost 70¢ on a weekend, 85¢ any evening, or $1.35 during week-days.

Just 45 years ago Charles A. Lindbergh became the first man to fly the Atlantic ocean from America to Europe alone.

It took him 33½ hours of totally dedicated effort.

Yesterday, if it was a typical day, hundreds of commercial jet aircraft flights carried thousands of people from continent to continent in a few hours of comfortable travel.

Some 14 years ago the Russians launched the first Earth satellite, and a few months later the United States put its first small satellite into orbit.

Today scores of satellites orbit Earth and eight United States astronauts have walked on the moon and returned with material that will be invaluable to world scientists for years.

A few years ago tropical storms took hundreds — even thousands — of lives each year. Today the terror of such storms is reduced immeasurably by much more precise warning provided well in advance by weather satellites.

Recently millions of people around the world had ring-side seats for the 1972 Winter Olympics at Sapporo, Japan, and were absorbed in following the historical visit of the President of the United States to mainland China — all live and in color.

Soon a satellite will be bringing educational TV to millions of people who live in areas of India where no land lines of communication exist.

The list of benefits man has realized from space is almost endless. Today he stands on the threshold of great things not even imagined a few years ago — medical advances, clean power sources, adequate fresh water supplies, the protection and intelligent management of natural resources, to name a few.

There is increasing evidence that more and more people are convinced that they "are getting their two cents worth" from our space program. And further evidence is at hand that from now on they will be getting even more for their money as manned and unmanned programs are blended together in new projects such as Skylab and the space shuttle.

In these efforts, NASA is concentrating on how best to conduct each element of the total space program in a less expensive manner. The result of this new objective is reflected in the proposed 1973 fiscal year budget wherein the U.S. space program will account for about 1¢ out of every dollar the Federal government spends.

This includes some $200 million in development funds for the space shuttle, about which President Nixon has said: "It will take the astronomical costs out of astronautics. In short, it will go a long way toward delivering the rich benefits of practical utilization and the valuable spinoffs from space efforts into the daily lives of Americans and all people."

AIA

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Official Publication of the
Aerospace Industries Association of America, Inc.

PRESIDENT • Karl G. Harr, Jr.
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ASSOCIATE EDITOR • David Reed Bundy
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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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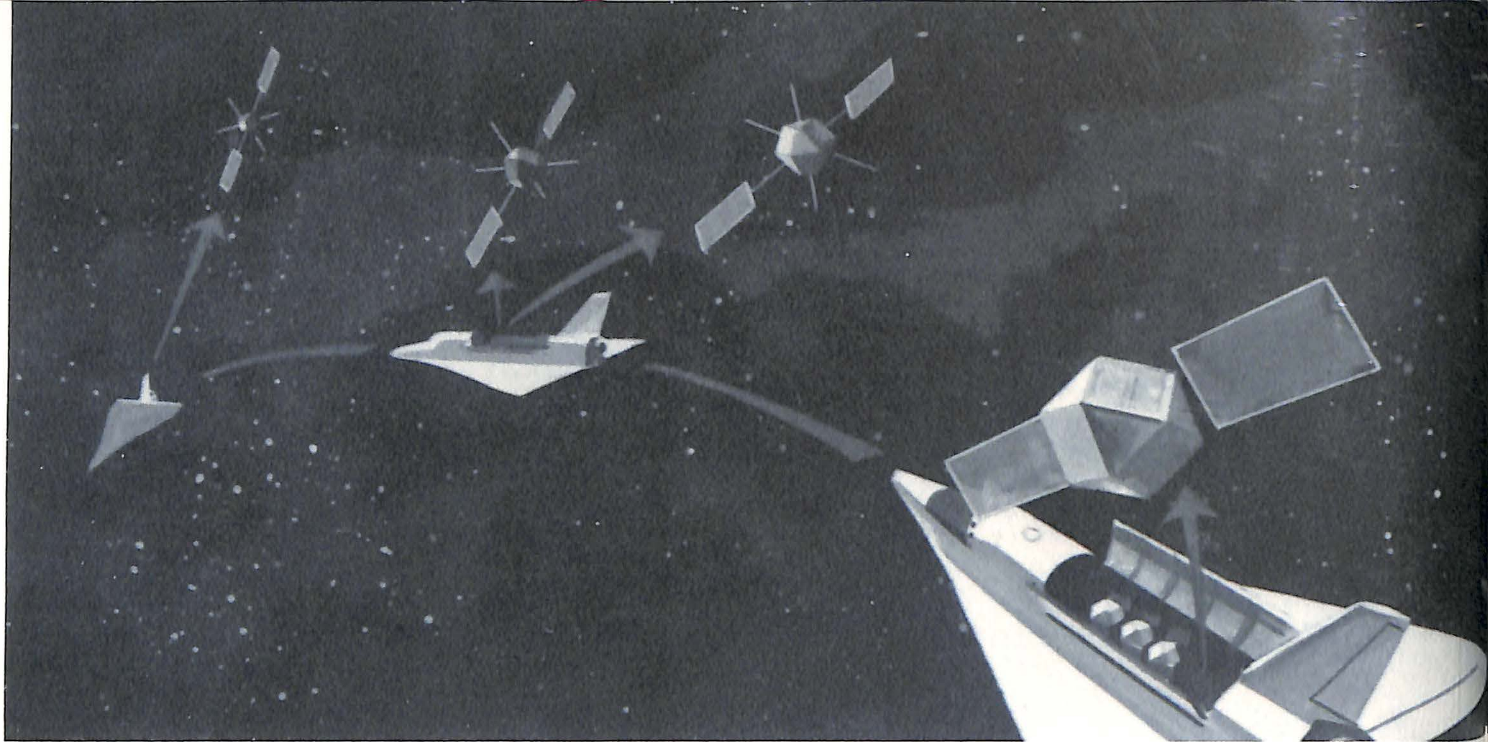

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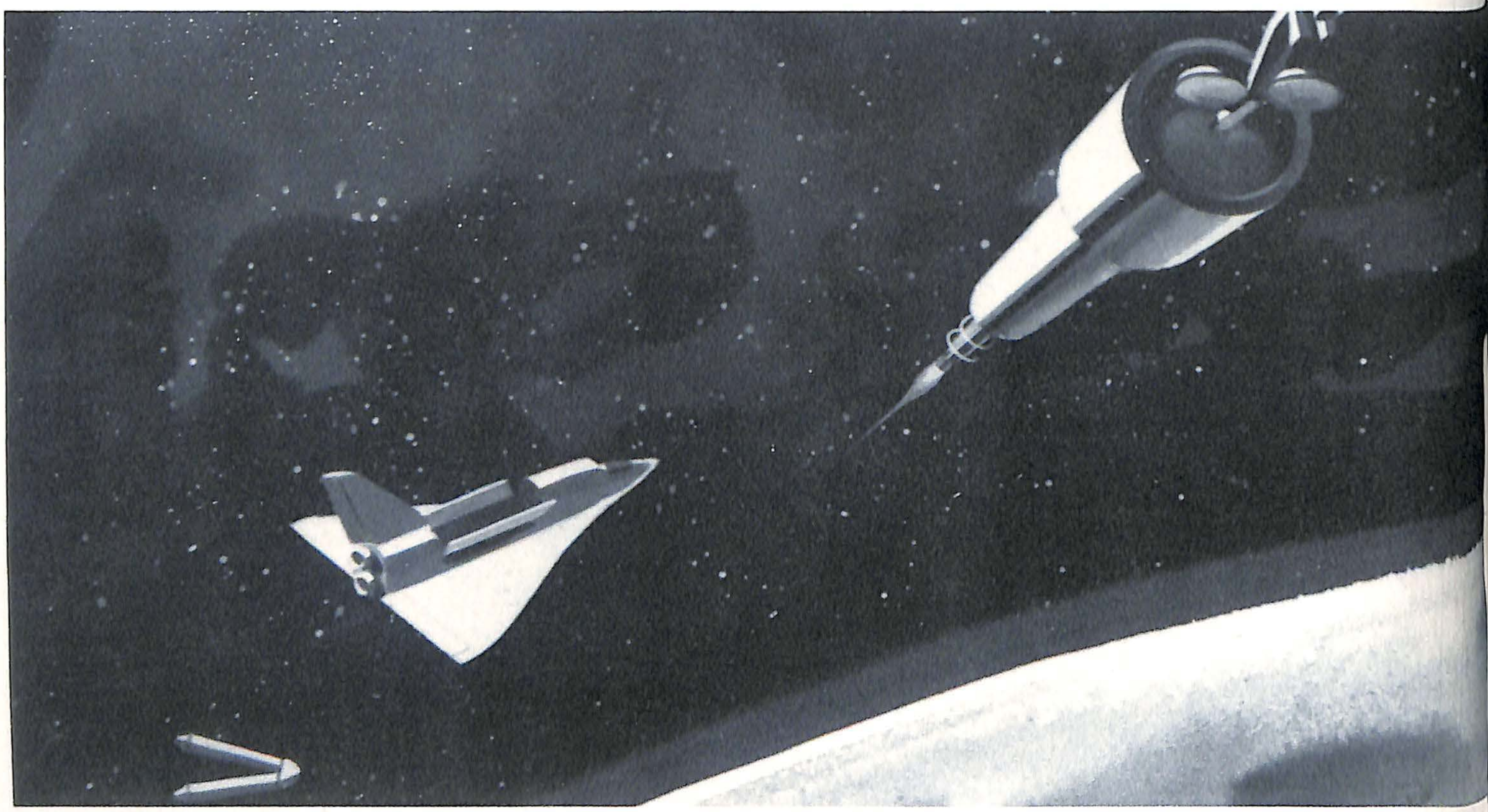


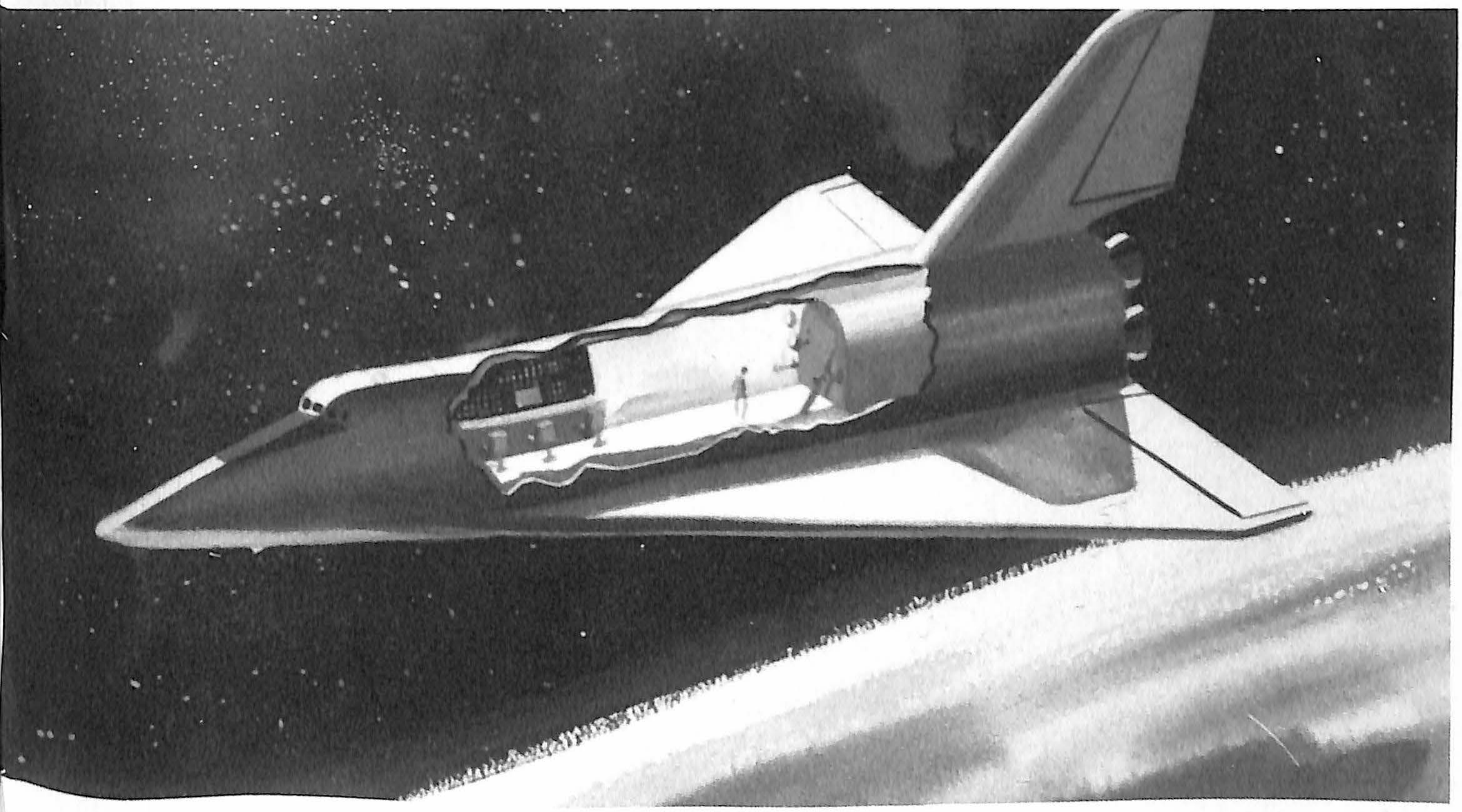
The primary uses of the shuttle system are: A, delivery of unmanr ed paloads to orbit; B, repair or retrieval of satellites; C, adjustment of a payload's orbit by use of a space tug; D, manned experiments or operations in space.

SPACE SHUTTLE

Investment in the Future

B

D



BY REPRESENTATIVE OLIN E. TEAGUE
Chairman, Manned Space Flight Subcommittee
House Committee on Science and Astronautics

Ever since the first man-made satellite was thrust into orbit almost 15 years ago, there has been a continuing argument as to whether manned or unmanned systems can most effectively accomplish operations in space.

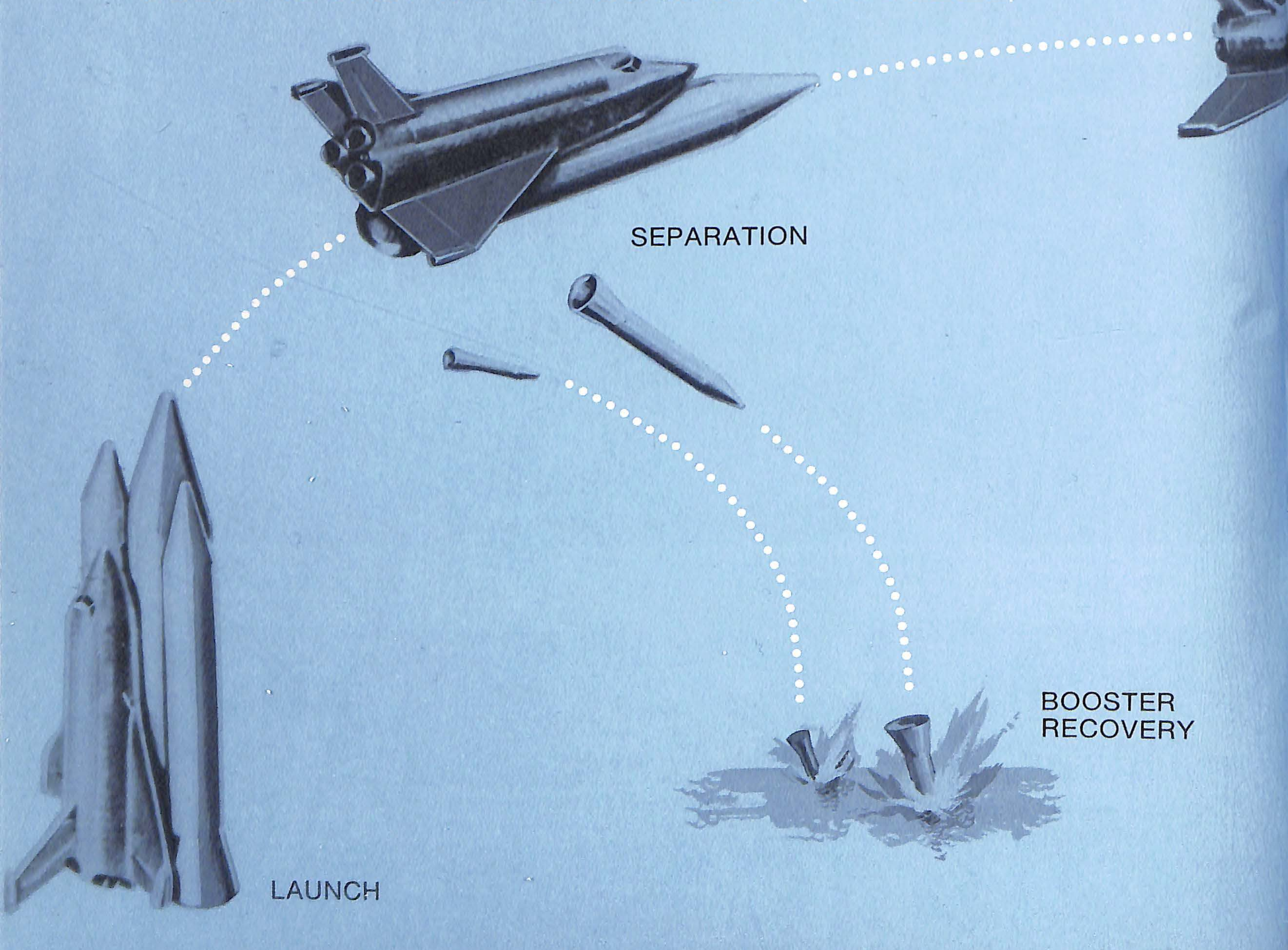
Advocates of robot spacecraft contend that modern, supersophisticated automated equipment is capable of performing most space tasks at a fraction of the cost of a manned system. The opposing school of thought responds that the admittedly greater costs of protecting humans in space are more than justified by man's ability to judge, observe and forestall failures by corrective action.

I do not propose to rekindle the argument. Rather I suggest that advancing technology has negated it by providing an entirely new approach to space operations which combines the advantages of man in the cycle with a degree of economy hitherto unobtainable. It is the reusable space shuttle, which makes possible manned delivery, repair and retrieval of unmanned satellites and which, alternatively, can serve as a manned laboratory in which investigators may conduct those experiments or operations best managed by manned monitorship.

This system, approved by the Administration and now pending Congressional sanction, offers a number of advantages, among them:

- ***Economy of delivery.*** Because the shuttle system can be used over and over again, it will replace practically all of the one-shot-only launch vehicles currently in use, offering substantial reduction in the cost of delivering a payload to orbit.
- ***Payload economy.*** The availability of a large-capacity, reusable "delivery truck" would influence areas other than delivery, such as simplification of payload design, extension of satellite life and reduction in failure frequency, each contributing significantly to overall savings.
- ***Flexibility.*** The carrier vehicle can accommodate almost any type of payload contemplated — human researchers with their equipment and experiments, scientific satellites or probes, and applications satellites. It can serve the needs of NASA, the Department of Defense, commercial users and foreign governments.
- ***Routine access to space.*** One constraint on space operations has been the need for elaborate pre-launch preparations, in some cases as much as five months of repetitive systems checks to insure reliability. This is principally due to the fact that the spacecraft's onboard equipment has never before been used. The

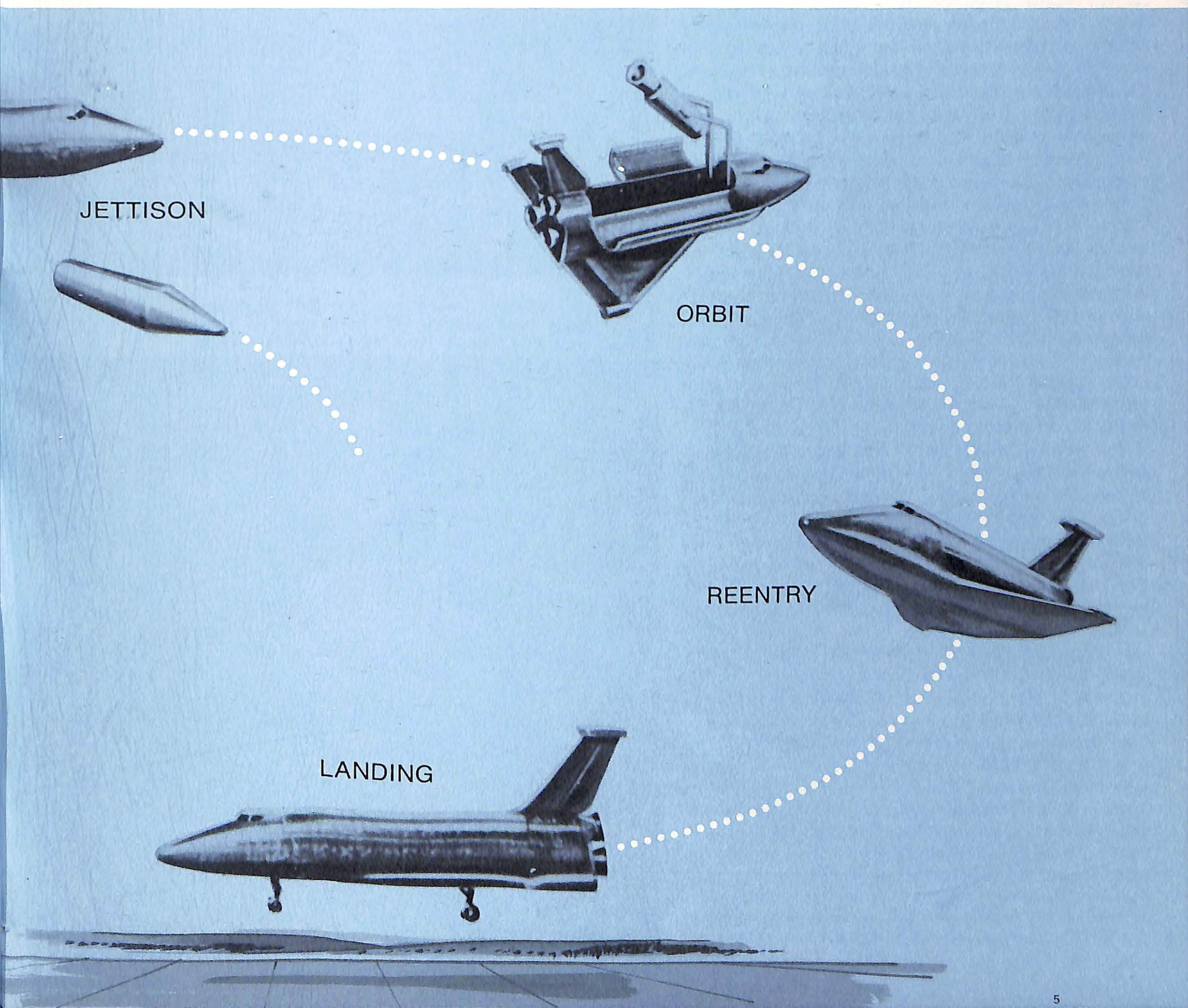
SPACE SHUTTLE MISSION PROFILE
SOLID ROCKET MOTOR BOOSTER (PARALLEL)



reusable carrier vehicle will be serviced and maintained more like an airplane, reducing launch complexity and trimming turnaround time to about two weeks.

- ***Stimulus to maximum benefit from space.*** Routine access to space, lower mission costs and the new latitude the shuttle will provide payload designers, all combine to permit vast improvement in the capabilities of applications satellites, such as weather, communications and survey systems. The shuttle offers added promise to the possibility of better managing our natural resources by means of space monitoring. Similarly, it may speed the day of the global environment-monitoring system.
- ***Manned space flight continuity.*** After Apollo and its 1973 follow-on, Skylab, the U.S. will have no manned space program other than the shuttle. The continued presence of American man in space is essential, not only for the broader research capability manned operations permit, but additionally to maintain continuity and keep our options open for the future. With the shuttle, we can keep man in space without reverting to the heavy expenditures of earlier years. NASA has stated positively that the shuttle system can be developed within a budget plan approximating that of the current year, which represents one of the lowest levels of the past decade. Development costs, spread over six fiscal years, amount to about $5.15 billion for two test spacecraft and their boosters. If Congress approves the plan, flight testing will begin in 1976 and the shuttle can be available for operational use in 1979.

The space shuttle is a two-element system composed of a booster and a spacecraft. The recoverable booster stage, consisting of two large solid-propellant rocket motors mounted in parallel, has a thrust output of more than 5,000,000 pounds. More powerful than any launch vehicle in the U.S. inventory except the mammoth Sat-



urn V moonbooster the twin booster allows the spacecraft to carry as much as 65,000 pounds of payload per flight.

The spacecraft, called the Orbiter, is essentially an "aerospace plane," a hybrid spacecraft/airplane. In appearance it resembles a delta-wing aircraft and dimensionally it corresponds closely to the McDonnell Douglas DC-9 jetliner. Weighing some 70 tons, it is heavier than any spacecraft yet flown, including Apollo.

In operation, the shuttle is launched vertically by the combined energy of the solid booster stage and the Orbiter's three liquid-propellant engines with a total thrust of 1,400,000 pounds. At an altitude of about 25 miles, the booster stage separates to descend by parachute for recovery in the ocean. The Orbiter, manned by two pilots and two flight engineers, flies into space under its own power. The Orbiter's rear-mounted engines draw their propellants from a large external tank which is jettisoned when the craft attains orbit.

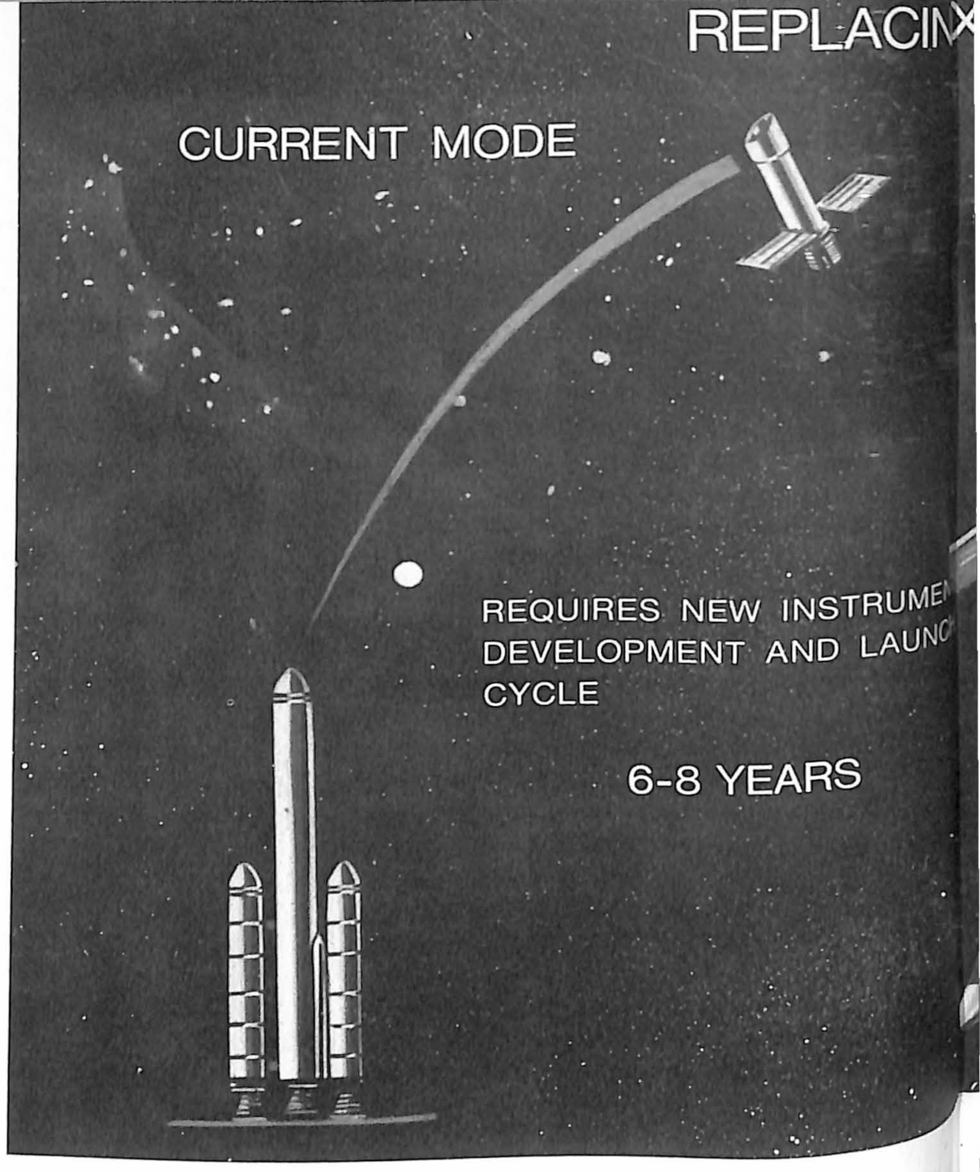
In space, the Orbiter maneuvers by means of two smaller engines, also mounted in the rear propulsion cluster, whose aggregate thrust is roughly comparable to that of the main Apollo engine which has performed so impressively on the lunar missions. For minor course corrections and adjustments of attitude, the Orbiter has a series of small thrusters located at the tips of the delta wing and atop the vertical tailplane. Normal mission duration will be seven days or less, but orbital stay-time can be extended for manned operations to 30 days, by the addition of expendables such as water, food and oxygen.

Upon conclusion of its mission, the Orbiter flies back into the atmosphere toward its land base, protected during re-entry by a new form of heat shielding which will last 100 missions, unlike the insulation on earlier recoverable spacecraft, which burned off during re-entry. Once through the re-entry phase, the Orbiter becomes an airplane, gliding as much as 1100 miles to its base, guided by aerodynamic controls. During the final phase of the flight, jet engines permit adjustments to the approach path.

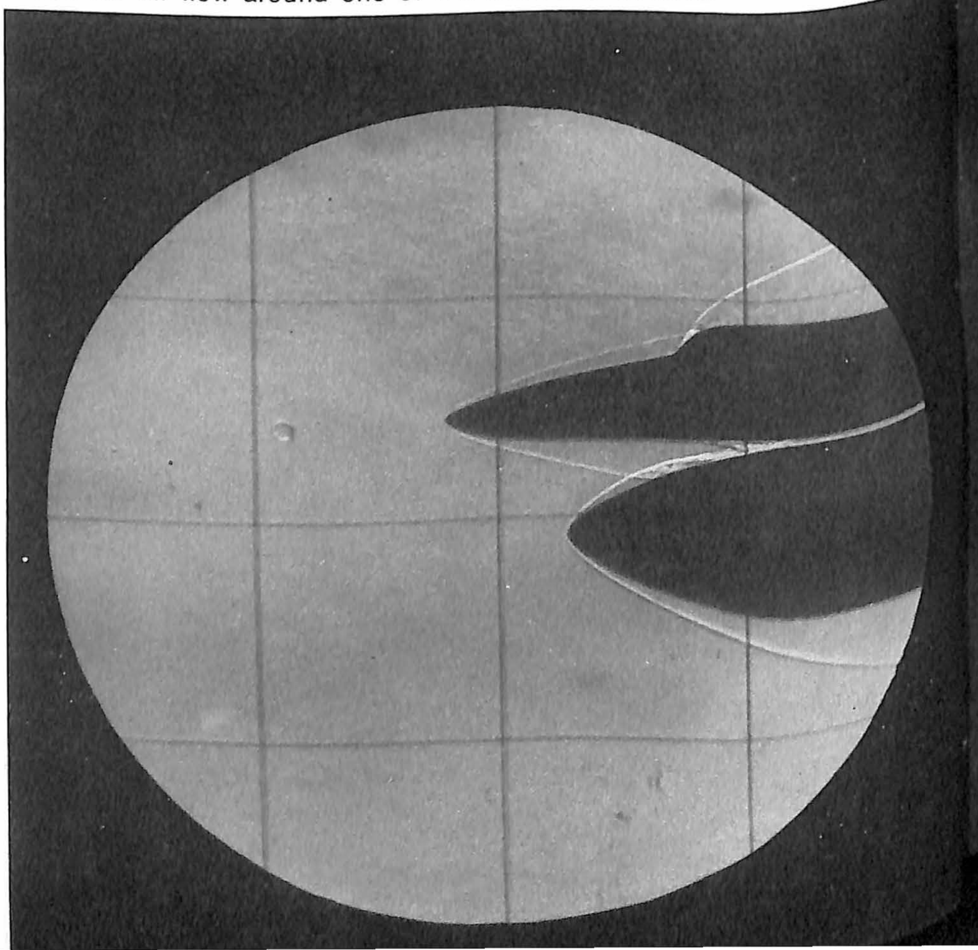
The Orbiter's entire center section, corresponding to the passenger cabin of a jetliner, is occupied by a large cargo compartment, or payload bay. For delivery of unmanned satellites, the payload bay is unpressurized; its "roof" consists of a pair of clamshell doors which open outward to permit deployment of the satellites. For manned laboratory-type missions, a special pressurized "sortie module" can be fitted into the payload bay.

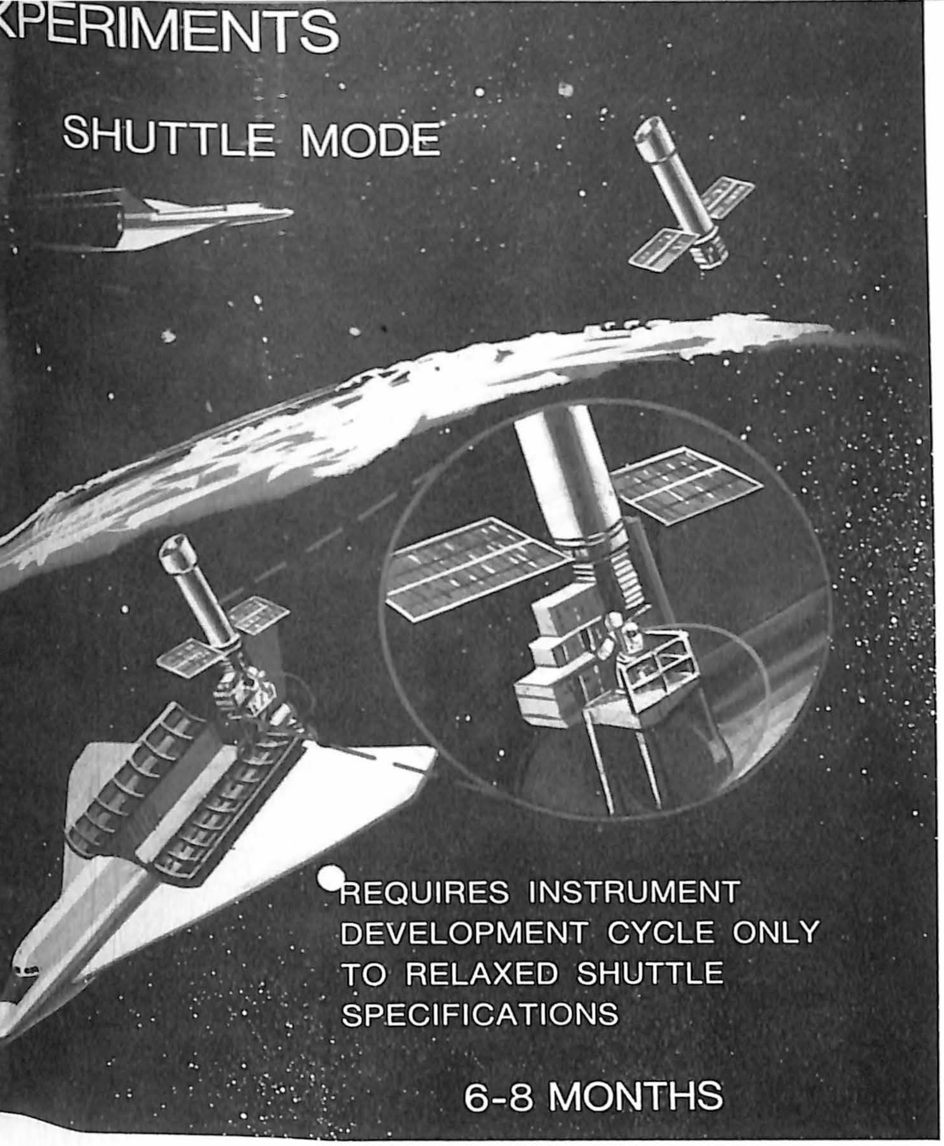
Here are some examples of how the remarkably versatile Orbiter will function:

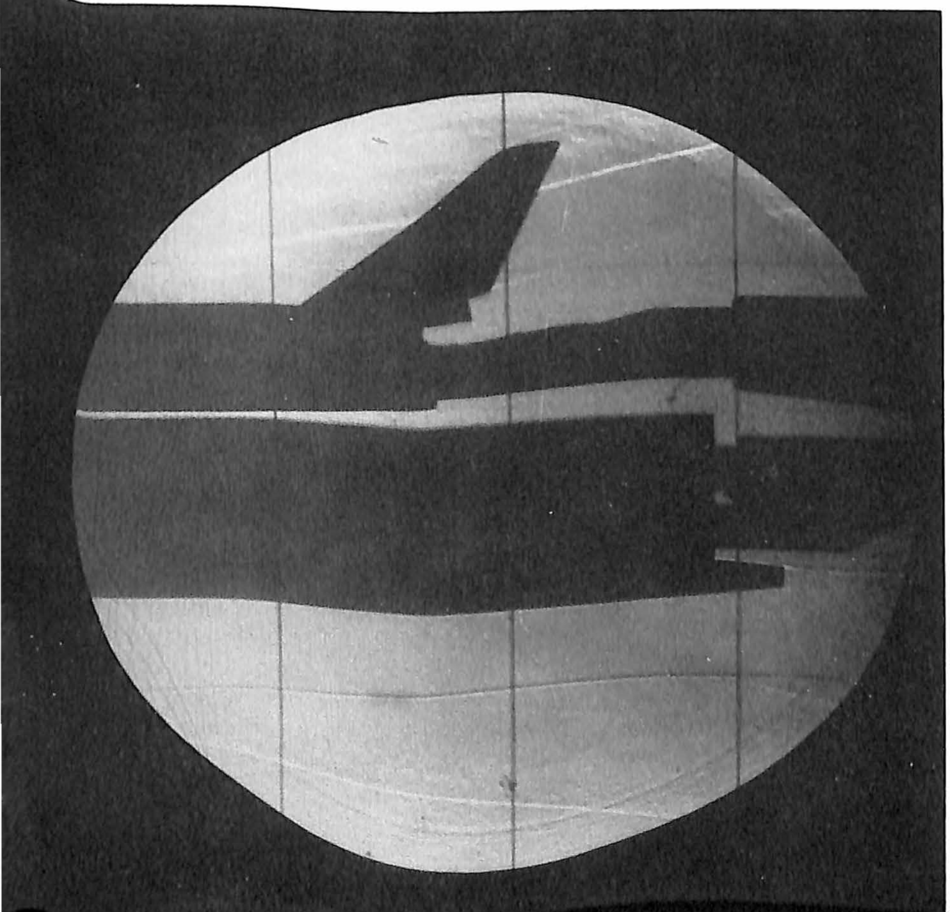
In injecting satellites into orbit, which is expected to constitute the primary workload of the carrier vehicle, the Orbiter can accommodate a very large satellite or a number of smaller payloads in the cylindrical bay, 15 feet in diameter and 45-60 feet long. Working in the unpressurized bay, space-suited flight engineers will give the payloads a final checkout before deploying them at preselected points in space. The ejected payload, of course, assumes the same velocity as its carrier and it is this velocity which counterbalances the pull of earth's gravity so that the satellite remains in the orbit in which it was injected. The Orbiter's weight-lifting capability, together with the generous dimen-



Extensive aerodynamic testing has been done on various space shuttle configurations. This photographic study shows the air flow around one of the candidate models.







sions of its bay, permit delivery of any type of civil payload currently contemplated, including general-purpose scientific spacecraft, special-purpose observatories, interplanetary probes, and communications, weather, earth resources, geodetic, navigational and air traffic control satellites. In addition, the shuttle is being designed with careful attention to the special requirements of the military services. We do not hear a great deal about military employment of satellites because of the classified nature of many of the payloads, but the Department of Defense launches space systems with greater frequency than does NASA, a factor which additionally underlines the need for shuttle development.

In another mode, the Orbiter has utility as a repair/retrieval vehicle for satellites already in orbit which have malfunctioned. The crew maneuvers the Orbiter to a close rendezvous with the satellite; the flight engineers, in extravehicular garb, exit through the open clamshell doors, "capture" the satellite by attaching lines, and haul it into the payload bay for examination. If the trouble is minor, it may be possible to repair the satellite on the spot and redeposit it on station. Otherwise, it can be stowed in the bay and returned to earth for rework, then redelivered to orbit on a later flight.

Still another area of shuttle utility in handling unmanned spacecraft is the employment of the space tug, essentially a propulsion stage which can be used to jockey a satellite from one orbit to another. An example of the need for this service is the synchronous-orbit satellite, one whose path in space is synchronized with earth's orbit so that the satellite remains in a fixed position relative to earth. Synchronization requires that the satellite operate at an altitude approximately 22,300 miles from earth, a high-altitude orbit that demands additional launch energy. In practice, the satellite is usually injected first into a low altitude orbit still affixed to an upper stage of the launch vehicle. At a given time, the stage's engine is fired to propel the satellite to its synchronous orbit.

The reusable space tug serves as substitute for the "kick" stage. The Orbiter delivers the joined space tug/satellite to a point in low altitude orbit. Operated by command signals from the Orbiter, the tug fires its engine, moves the satellite to its new orbit, disengages itself and returns to the lower altitude for pick-up by the Orbiter. Initially, the tug will probably be an unmanned system, but a manned version compatible with the dimensions of the Orbiter's bay is feasible should expanding space operations dictate its need.

With the addition of the pressurized sortie module, the Orbiter becomes a manned space laboratory where scientists and engineers can work in shirtsleeve environment for as long as 30 days. The module can accommodate up to 12 persons along with their experiments and other equipment. Since they play no part in the operation of the Orbiter and since the shuttle is being designed for low acceleration forces during launch and re-entry, the passengers need not be trained astronauts. For the first time, investigators will be able to accompany their experiments into space and contribute to the greater research efficiency that man-monitorship enables.

Here again, there is military potential. For some time the Department of Defense has sought to evaluate, in actual space flight, the role of military man in space. The shuttle can make possible such an evaluation.

Finally, ever since man first ventured into space in 1961, there has been a never-filled need for a space rescue vehicle. A major reason has been the time required to mount and check out a manned spacecraft. With a fleet of five Orbiters, which is what NASA contemplates for the inventory of the 1980s, and the inherent quick reaction of the shuttle, the system can be adapted to fill this long-standing requirement.

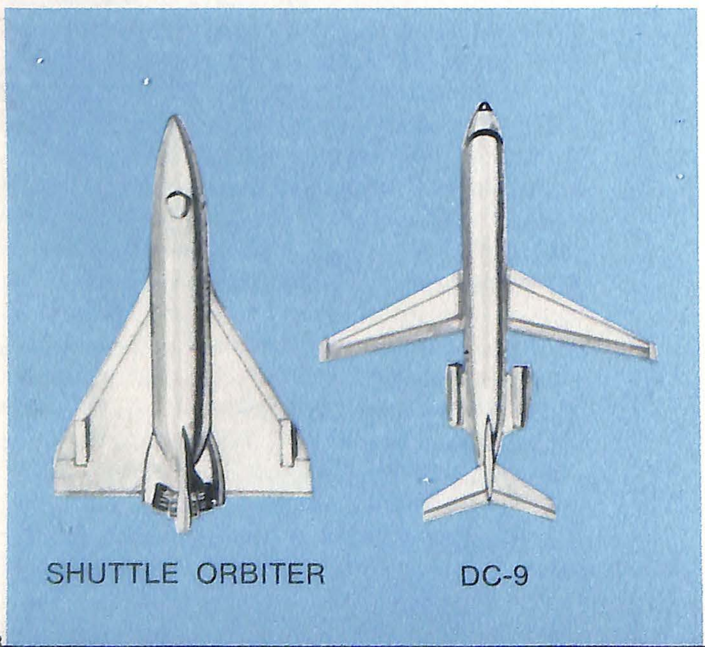
The economic advantages of the shuttle system are as broad as the operational gains. Clearly, the employment of a reusable launch vehicle affords savings of substantial order. But although this is the most obvious area of economy, it is not the greatest. NASA estimates that 80 percent of the savings promised in delivery and operation of unmanned spacecraft will stem from the shuttle's influence on satellite design and reuse.

One factor is freedom of design. Today, as in the past, satellite design is pegged to a particular launch vehicle on a cost-effectiveness basis. The launch vehicle's weight-to-orbit capability, therefore, imposes restrictions as to the overall size and weight of the satellite and consequently to the design of each individual component. To meet specifications without sacrificing performance, it is necessary to miniaturize instruments and equipment at considerable developmental cost.

The Orbiter's large bay allows a relaxation of weight and dimensional constraints, permitting designers to use off-the-shelf equipment in some cases or, alternatively, to develop new equipment at substantially lower cost. "We can," says one NASA official, "put the satellite together like an alarm clock rather than a Swiss watch."

Additional savings are possible in the extension of a satellite's operating lifetime by repair in orbit or by retrieval for overhaul at an earth base. There is

The Orbiter is shown in a dimension comparison with the DC-9 commercial airliner. Wingspan of the Orbiter is 75 feet compared with 94.3 feet for the DC-9. Length is almost the same (120 feet), but the operational weight (empty) is 140,000 pounds for the Orbiter and 57,210 pounds for the DC-9.



related economy in the matter of "updating" unmanned spacecraft, improving the capability of a particular type of satellite by incorporating advanced equipment which was not available at the time the basic version was being fabricated. Currently, the only way to update is to build a new satellite which frequently requires six to eight years to develop, test and launch. With the shuttle, a replacement instrument or experiment can be developed within six to eight months, because of the relaxed design specifications; it can be installed in orbit or the satellite can be retrieved for updating at the earth base.

Further payload economies are anticipated in the use of the Orbiter as a test bed for instrument development. For example, consider the development requirements for a major spacecraft such as NASA's Large Space Telescope, to be flown in the 1980s to give the astronomer the capability to analyze the spectrum of stellar objects free of the distorting effect of earth's atmosphere. This system requires a large array of instruments, which must be designed, built and tested. The testing is a lengthy and expensive procedure requiring a variety of special facilities, because the instruments must be examined under conditions approximating as closely as possible those under which they later will operate. The shuttle can be used to fly prototype instrument systems to orbit, reducing ground-test operations and facilities requirements and contributing to greater test effectiveness, because the systems will be checked out in the actual space environment rather than by simulation.

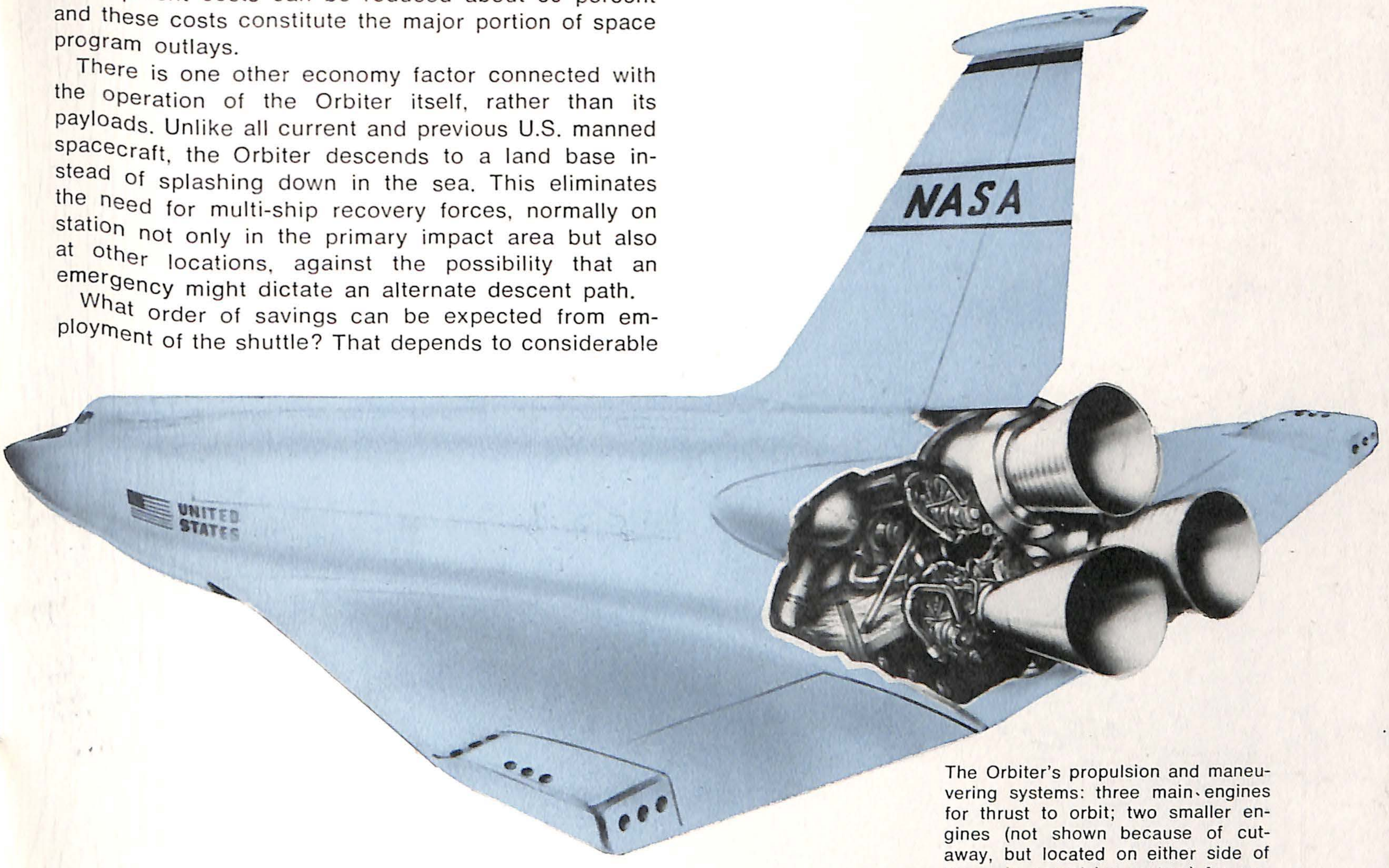
Additionally, there is the important consideration of the costs of failures, which continue to occur despite the most elaborate precautions to prevent them. A prime example of the risk-reduction utility the shuttle offers is the Orbiting Astronomical Observatory program, one of the most costly of all unmanned spacecraft projects and also one of the most important from the scientific standpoint. Three OAO's were launched; one performed perfectly but the other two experienced failures. In one case, a shroud jettison problem prevented the valuable OAO from attaining orbit; this would not have happened in the shuttle-delivery mode. In the other instance, the observatory's battery charger failed, rendering the experiments inoperable. Had the shuttle existed at the time, the OAO could have been returned to earth for repair and quickly restationed. Even the successful OAO, which operated as expected for its planned lifetime, could have been provided additional months or years of life by the shuttle; the problems which eventually cropped up were of such a nature that the satellite could have been repaired in orbit.

A NASA study of 131 space failures shows that 78 of them were related to the launch phase and therefore could not have occurred if the shuttle had been operational. In the remaining cases, where the satellites became inoperable or erratic after deployment, the payloads could have been saved by in-orbit repair or retrieval. Thus, the shuttle promises virtual elimination of total failure. Even should the shuttle itself malfunction the Orbiter's crew could abort the mission and return to base with the payload intact.

Collectively, these influences of the shuttle on payload design and operation offer potential savings of a very large order. It is estimated that payload development costs can be reduced about 50 percent and these costs constitute the major portion of space program outlays.

There is one other economy factor connected with the operation of the Orbiter itself, rather than its payloads. Unlike all current and previous U.S. manned spacecraft, the Orbiter descends to a land base instead of splashing down in the sea. This eliminates the need for multi-ship recovery forces, normally on station not only in the primary impact area but also at other locations, against the possibility that an emergency might dictate an alternate descent path.

What order of savings can be expected from employment of the shuttle? That depends to considerable



The Orbiter's propulsion and maneuvering systems: three main engines for thrust to orbit; two smaller engines (not shown because of cutaway, but located on either side of the main propulsion system) for maneuvering in orbit; thrusters at wing tips and on vertical tail for minor adjustments.

extent on the frequency of shuttle missions, or the number of launches annually. In the first 12 years of space flight (1958-69), the U.S. sent into orbit an average of more than 50 spacecraft a year, including civil and military payloads together with launches for foreign nations and international consortiums. In the past two years, with American space activity at low ebb, the average has declined to 30 a year. The schedule for this year contemplates an increase to about 40 launches.

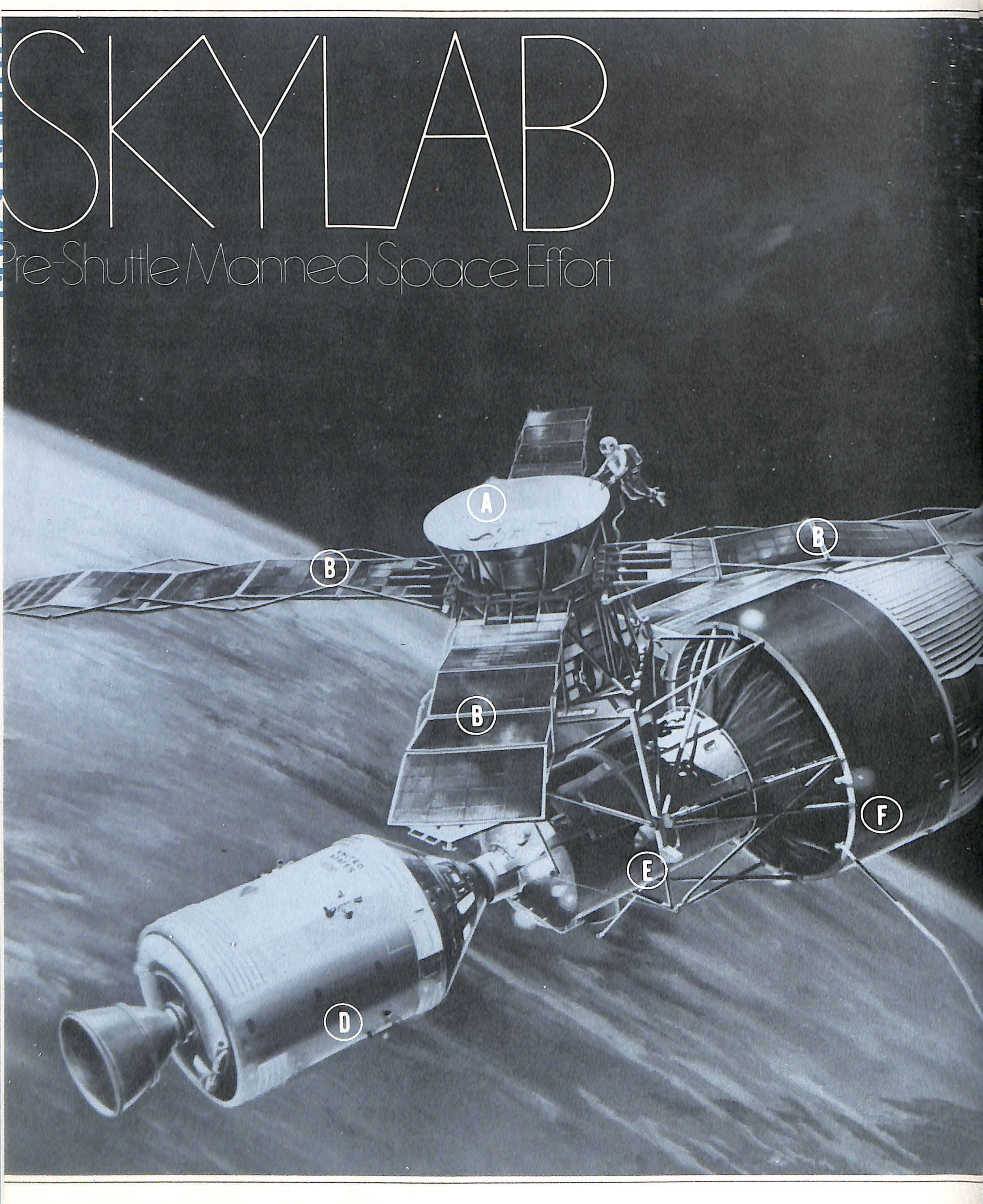
NASA has conducted a study of anticipated shuttle economies based on a "mission model" that assumes shuttle usage on 580 missions over a 12-year period from 1979, the first operational year according to the development plan, through 1990. That comes to an average of about 48 flights annually. NASA terms the mission model "realistic." It may even be conservative, because of the potentially greater opportunities for deriving concrete benefit from space operations and because of the likelihood of increased foreign use of U.S. launch services with the shuttle's lower costs. At any rate, the study concluded that the combined factors of a reusable delivery system, reusable payloads, design simplification and sharply reduced risk of failure add up to a saving averaging more than $1 billion a year.

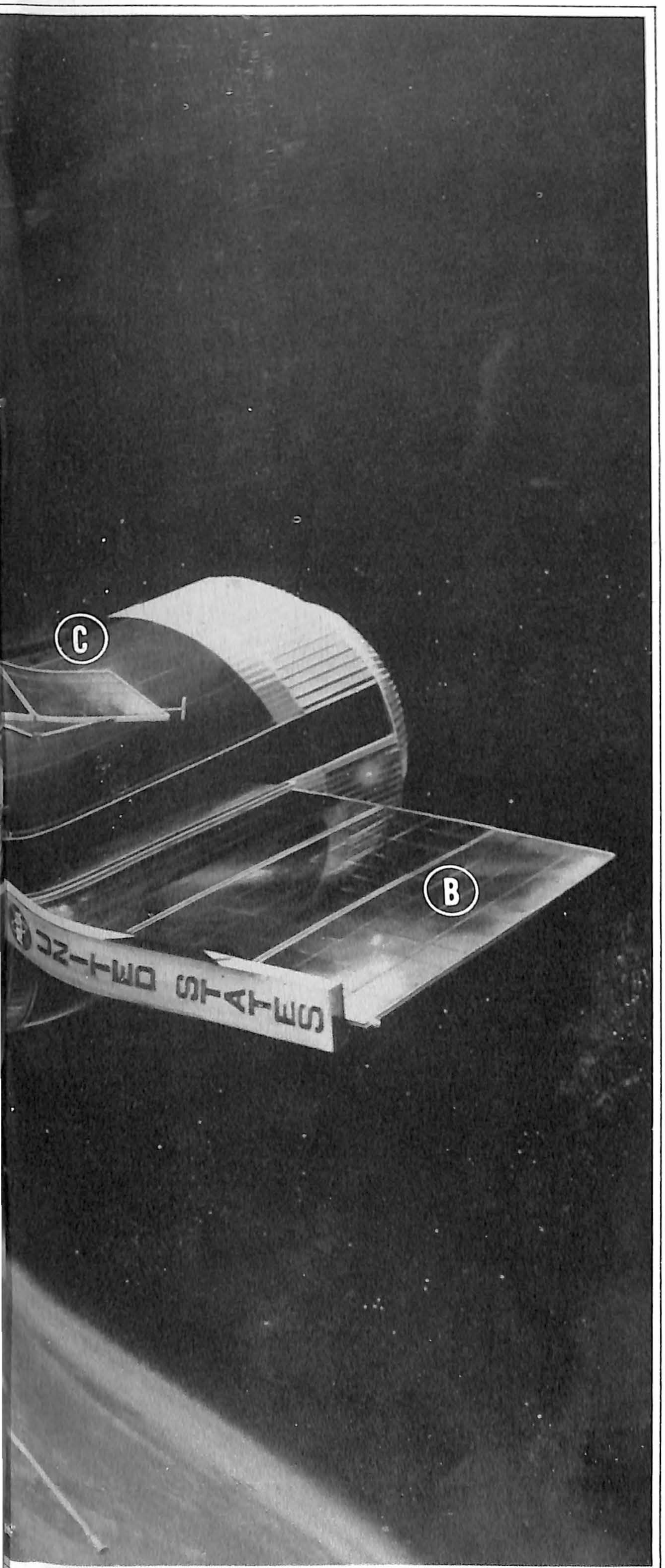
The economic features of the program are important, particularly to a legislator, but I do not suggest that cost reduction is the sole, or even the primary justification for developing this system. The fundamental reason for carrying out the program is to make available a means for routine access to space, to remove the constraints imposed by an earlier level of technology, to progress from space adolescence to full maturity.

The shuttle can be the instrument for maintaining American pre-eminence in space and for realizing the broad range of benefits that advancing technology promises — those that are already visible and those that we cannot yet envision.

SKYLAB

Pre-Shuttle Manned Space Effort





The Apollo program is drawing to a close. The next step in manned space flight — and the last planned prior to the space shuttle — is Skylab.

Skylab is a series of Earth-orbiting missions using the first U.S. vehicle developed specifically so that men can live and work in space for prolonged periods of time.

OBJECTIVES

The objectives of the Skylab program are:

- *Advancement of the Sciences* — To increase knowledge of medicine, astronomy, weather and physics. A prime goal is to collect previously unobtainable information on the Sun-Earth relationship and its effects on our environment here on Earth.
- *Practical Applications* — To perfect Earth-looking camera and sensor systems, and their related data systems, to benefit mankind's agriculture, forestry, oceanography, geography, geology, water and land management, communications, and ecology and pollution control. Skylab also will open up a dramatic new field — the development of manufacturing techniques in gravity-free conditions, a field that has the potential for yielding such products as higher quality vaccines and machined parts, such as ball bearings, with a degree of near perfection that cannot be achieved on Earth, where gravity is a factor.
- *Human and Materiel Endurance* — To determine the ability of both human beings and Earth materials and systems to maintain their qualities and capabilities during long absence from gravity. (The longest-duration manned space flight to date, the USSR Soyuz 9, lasted 18 days. The longest U.S. flight, Gemini 7, permitted Frank Borman and James A. Lovell, Jr., to stay in space nearly 14 days.)

SCHEDULE

The first Skylab is scheduled to be launched from Cape Kennedy early in 1973.

This Skylab will double the two weeks duration of Gemini 7 in space and will utilize the unique environment of space to add to knowledge of the Earth, and of the effect that mankind has on the delicate balance between living things, the environment and natural resources.

The second and third Skylab visits will redouble the time of Gemini 7's two weeks in space — to 56 days.

These Skylab missions will serve as a bridge between our earlier space flight experience and the longer-duration missions of the future, and it will do so largely with equipment developed in the Apollo program.

The Skylab, which will approximate the size of a five-room house, will function in space for about eight months, during which there will be three manned missions and two periods of unmanned operation.

The first Skylab mission from Kennedy Space Center will launch a system consisting of the Orbital Workshop, Airlock Module, Multiple Docking Adapter, Apollo Telescope Mount, and an Instrument Unit. All of these will be covered by a shroud during ascent to

Major components of the Skylab are shown in Earth orbit. They are: A, Apollo Telescope Mount; B, Solar Arrays; C, Workshop; D, Command and Service Modules; E, Multiple Docking Adapter; F, Airlock.

a near-circular Earth orbit some 235 miles high. The launch will utilize a Saturn V booster developed during the Apollo program.

On the next day, a Saturn IB booster will be launched from the same complex to take the Command/Service Module and its crew of three astronauts into an interim orbit from which it will then use the Service Module propulsion system to transfer to Skylab's orbit for rendezvous and docking. The crew will enter and activate Skylab for habitation.

For 28 days the crew will conduct experiments and evaluate the habitability of Skylab. Then they will prepare the station for unmanned operation, transfer themselves to the Apollo spacecraft and separate from Skylab.

The Service Module propulsion system will be used to take the Apollo out of orbit and to separate the Command Module from the Service Module. Finally the Command Module will re-enter the atmosphere and descend by parachutes to a splashdown and recovery in the western Atlantic ocean.

The second manned mission will be launched by a Saturn IB approximately 60 days after the first crew has returned to Earth. Orbit insertion, rendezvous and docking procedures will be similar to those of the first flight.

The second crew will continue to carry out scientific investigations with the on-board experiments, this time for 56 days. Recovery again will be made in the western Atlantic.

About 30 days after the second crew returns a third mission will be launched. This mission, also of 56 days' duration, will complete the experiment program. In this case the Module and crew will be recovered in the mid-Pacific.

MAJOR ELEMENTS OF THE SKYLAB

Orbital Workshop — The Workshop, manufactured by McDonnell Douglas Aerospace Corporation, Huntington Beach, Calif., is made from the structure of a Saturn V booster's third (S-IVB) stage.

The larger of its two compartments forms a two-level habitable area:

- The lower level provides accommodations for sleeping, preparing and eating food, hygiene, waste processing and disposal, and performance of some experiments.
- The upper level is a large work/activity area housing water storage tanks, food freezers, storage for film, the scientific airlocks, the mobility and stability experiment equipment, and equipment for other experiments. Below the crew quarters is a container for liquid and solid waste and trash accumulated during the mission.

Solar Arrays — Two wings, covered on one side with solar cells, are mounted outside the Workshop to generate electrical power to augment the power generated by another set of solar arrays mounted on the Telescope Mount. Thrusters are provided at one end of the Workshop to be used when needed in changing the orientation of the cluster. A shield envelops the Workshop some five inches from the outer surface to protect against micrometeorite damage.

Multiple Docking Adapter — The Adapter provides alternate docking ports for the arriving and departing manned spacecraft, and is the control center for the Telescope Mount and the Earth Resources Experiment Package. Mounted on the forward end of the Airlock Module, the Multiple Docking Adapter is a cylinder 10 feet in diameter and slightly more than 17 feet long.

- Cameras and Earth Resources Sensors are located within the cylinder. Some look through a window in the wall; others actually protrude through the wall. Vaults for the cameras and film for the Telescope Mount experiments provide protection against the radiation found at Skylab's orbital altitude.
- The control and display console for the Telescope Mount is located at the rear of the module and contains the controls and instruments required for operation of the solar astronomy experiments. Two television screens are provided to enable astronauts to monitor solar activities.
- The Adapter was assembled, equipment integrated into the module, and testing performed by Martin Marietta Corporation's Denver, Colo., plant last year. Now at McDonnell Douglas, St. Louis, it is being joined to the Airlock Module for combined testing.

Airlock Module — This is the environmental and electrical control center for Skylab. It is attached to the forward end of the Workshop and provides structural support to all modules mounted forward of the Workshop. It also contains the exit port to be used by astronauts engaging in extravehicular activity.

- The Airlock Module consists of two concentric cylinders joined by truss structures. The outer cylinder, or Fixed Airlock Shroud, has the same 22-foot diameter as the Workshop, and is attached to the forward end of the Workshop. The inner cylinder, or tunnel, is the passageway for crewmen moving between the Docking Adapter and the Workshop.
- The Airlock has two hatches that close off each end of the central cylinder and a third hatch located in the outer wall that is the door through which the crew can pass to perform tasks in space. The tunnel section also houses the controls for cluster pressurization and atmosphere purification, electrical power and communications, and the cluster malfunction alarm system.
- The Module, manufactured by McDonnell Douglas, has completed the first phase of test and checkout, and will be joined to the Docking Adapter for combined testing.

Apollo Telescope Mount — The Mount houses a sophisticated solar observatory. It also provides attitude control for the cluster, and its solar arrays supply about half of Skylab's electrical power. Its outer element, the rack, is an octagonal structure 11 feet wide and 12 feet high. Supported within the rack is the solar experiment canister, about 7 feet in diameter and 10 feet long.

- The rack also supports the four solar arrays and contains the attitude control system, the communications system, and the thermal control system that maintains the temperature of the Telescope Mount equipment within required limits.
- The canister is mounted in the rack on gimbals, which allow it to rock two degrees about two mutually perpendicular axes, and by a roll ring that allows it to rotate about its axis. Thus the experiments can be pointed at their targets with great precision.
- The support structure, which connects the rack to the forward end of the Fixed Airlock Shroud on the Airlock Module, incorporates a mechanism that rotates

the Telescope Mount 90 degrees from its parallel launch position in front of the Docking Adapter to its operating position in orbit.

• The Mount, designed and manufactured by NASA's Marshall Space Flight Center at Huntsville, Ala., has been completed and is being checked out.

Payload Shroud — The Payload Shroud protects the Telescope Mount, the Docking Adapter, and part of the Airlock Module during launch and boost to orbit. Before launch it protects the enclosed modules from the weather. It is built in four sections so that it can be jettisoned easily after Skylab is in orbit.

• Testing has been completed by the manufacturer, McDonnell Douglas, Huntington Beach, and the shroud will be shipped to the Cape Kennedy Center in the latter part of 1972.

Command and Service Module — The crew ascent and descent spacecraft consists of the Command Module and the Service Module. These basically are the same as the familiar combination used in Apollo moon missions, but have been modified for Skylab. Whereas Apollo required them to be fully operating and self-sustaining for up to 14 days, Skylab requires this support only during ascent to docking and descent to Earth. For the balance of the 28- or 56-day Skylab missions they will be "powered down" because both modules will be sustained by Skylab.

• The modules are manufactured by the North American Rockwell Corporation in Downey, California. The first two spacecraft have been assembled and testing of the first has been completed. Systems installation is well along on the remaining two units. All four spacecraft will be delivered to Cape Kennedy by the spring of 1973.

Saturn V Launch Vehicle — First stage of the two-stage Saturn V Skylab booster is the S-IC, manufactured by The Boeing Company. Modifications for Skylab have been completed at NASA's Michoud, La., Assembly Facility, and it will be delivered to Cape Kennedy in mid-1972.

• Second stage, the S-II, was manufactured by North American Rockwell at Seal Beach, Calif., and is awaiting assembly with the S-IC.

Instrument Unit — The launch vehicle's control center is a cylindrical structure 22 feet in diameter and three feet high containing the equipment that will guide the launch vehicle from lift-off through the separation of Skylab from the second stage of the vehicle. Then the unit provides power and sends commands to various systems which in turn rotate Skylab 180 degrees, turn on refrigeration systems, jettison the Payload Shroud, and roll the cluster so that the Telescope Mount will be pointed toward the Sun. Now being tested at IBM's plant in Huntsville, Ala., the unit will be delivered to Kennedy Space Center in mid-1972.

Saturn IB Launch Vehicle — Vehicles were completed several years ago and placed in storage. The four S-IB stages are at the Michoud Assembly Facility near New Orleans. The stage for the first manned Skylab launch is being modified to Skylab requirements and is being checked out in preparation for delivery this summer. Delivery of the remaining vehicles will be completed during the summer of 1973.

• All S-IVB second stages have been delivered to Cape Kennedy, and prelaunch processing will begin this summer.

HOW FAR WE HAVE COME

If we mark time from some point in history — say the birth of Christ — it took man more than 1900 years to achieve his first flight in a heavier-than-air machine.

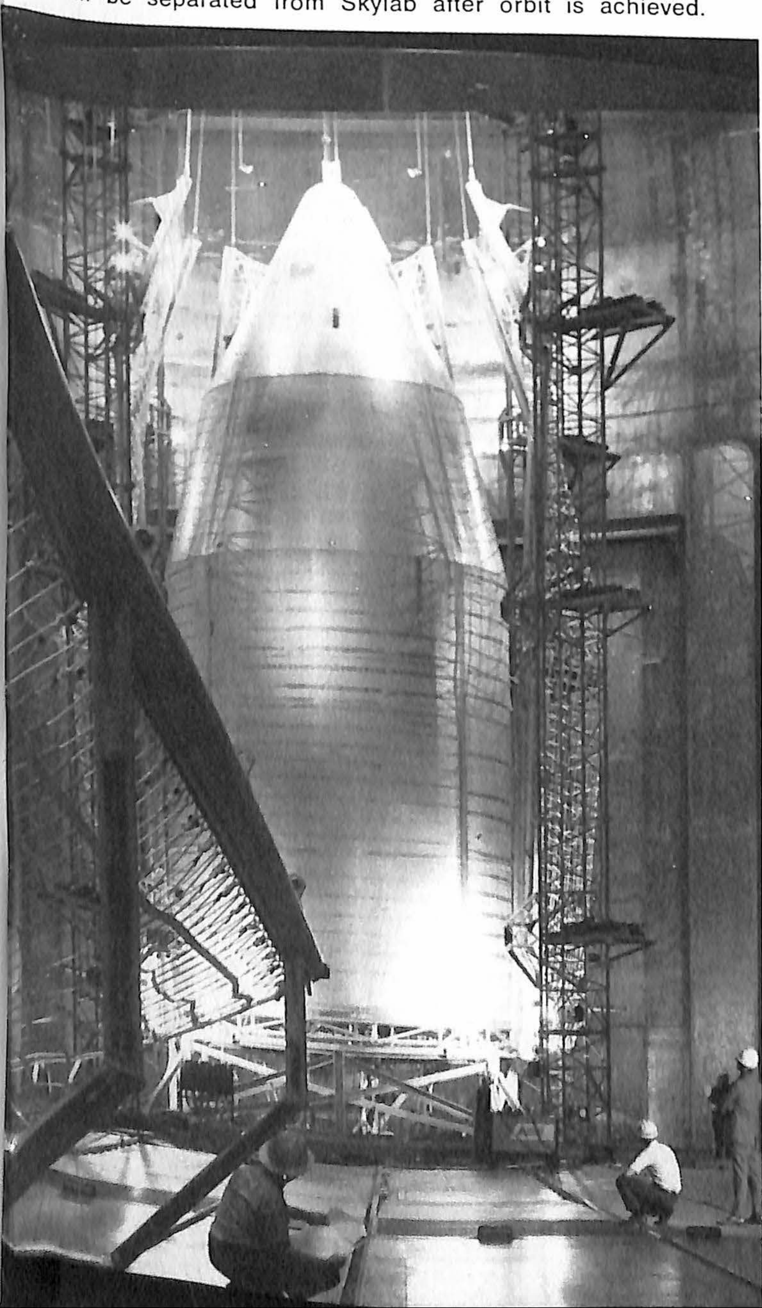
It only took him 54 years more to put his first small satellite in space orbit.

The first U.S. satellite — the size of a basketball — achieved orbit only 14 years ago, in early 1958.

Today we have sent eight astronauts to walk on the Moon and return home, and now we are assembling a space station laboratory the size of a five-room house for launch next year — 15 years after our first tiny space success.

Considering what we have learned from our unmanned and manned space programs, and the thousands of benefits mankind already has realized, the Skylab is an exciting promise of giving man the capability of making his world a better place in which to live.

A shroud will cover the Apollo Telescope Mount, Docking Adapter and part of the Airlock of the Skylab. The shroud will be separated from Skylab after orbit is achieved.



Scientific Satellites

From its inception America's space program has been a planned mix of manned and unmanned projects. Each type of mission has complemented the other—nowhere more than in scientific research from Earth orbit.

This productive situation will be enhanced significantly when the space shuttle becomes operational.

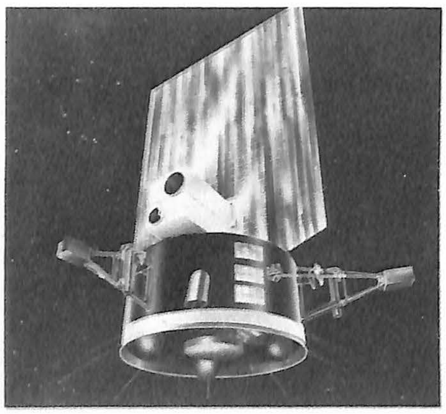
Our view of our solar system has already been revised through satellite discoveries of Earth's radiation belts, the solar wind, the magnetosphere (the magnetic envelope that shields the planet from most space radiation), the X-ray stars, and many other phenomena. More unexpected discoveries can be expected.

NASA lists these general objectives of Earth-orbital science:

- Understand better the nature of the space environment and the hazards it may pose to men and machines.
- Identify the forces that shape the Earth's environment.
- Understand better the origin and evolution of the cosmic environment.
- Carry out experiments that cannot be done on Earth; that is, use space as a new laboratory environment.

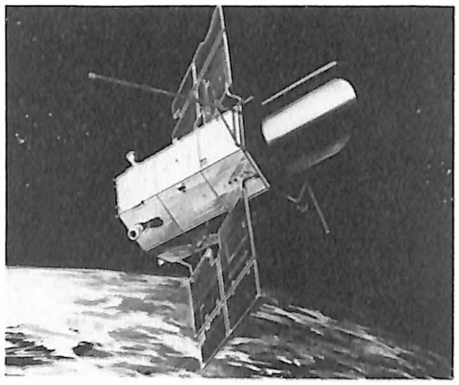
Ultimately we may discover the physical laws that control the cosmos — and within our own infinitessimally small corner of the cosmos, the future of the human race.

The major U.S. Earth-orbit scientific satellite programs are:



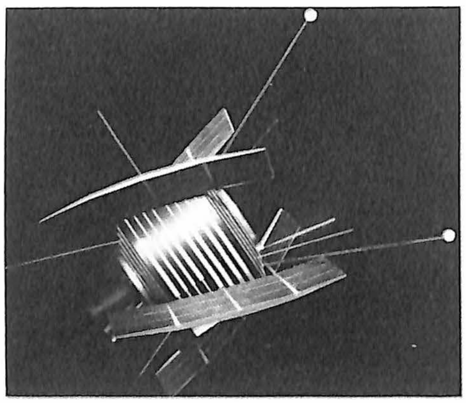
Orbiting Solar Observatory (OSO) Designed primarily as stabilized platforms for Sun-oriented scientific instruments, the OSOs have made possible the first extended study of the Sun from above the Earth's filtering atmosphere. Satellite experiments study Sun flares and other solar activity, X-rays, gamma rays and ultraviolet radiation, and radiation from other than solar sources. The lower—or "wheel"—section of the two-part satellite spins as a gyroscope at a near-constant 30 revolutions per minute to stabilize the observatory. The upper, fan-shaped section—the "sail"—is joined to the wheel by a connecting shaft and remains pointed toward the sun during the OSO "daytime" in space.

With OSO much already has been learned about the Sun and its effect on Earth communications and weather. Much more remains to be learned, however, and Skylab, which will permit scientists to observe from space for extended periods of time, together with unmanned satellites, should provide many answers.



Orbiting Astronomical Observatory (OAO) The 4600-pound OAO—largest U.S. scientific satellite—is capable of lifting a number of telescopes and astronomical experiments above the Earth's atmosphere, which filters cosmic radiations. Solar paddles provide up to 1800 watts of power for the satellite.

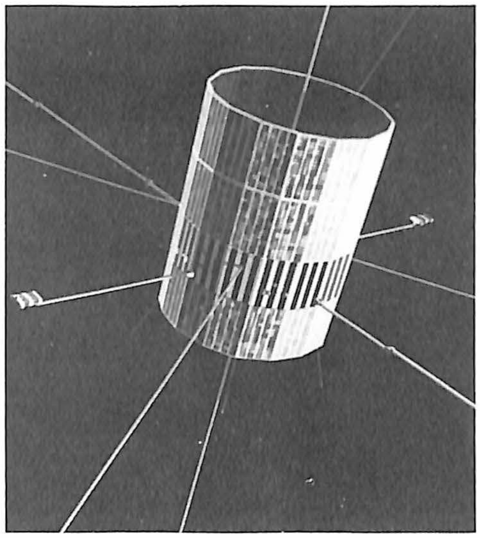
Responding to commands radioed from Earth, the satellite can search and then precisely point itself and its contained instruments at any single star among the millions it can track. Although it obeys hundreds of different commands, once it receives instructions it carries out most of its computations and attitude adjustments on its own.



Radio Astronomy Explorer (RAE) The RAEs are a new tool in man's decades-long effort to interpret the vast amount of radio noise in outer space, such as pulsars and quasars in far-distant space, and other radiation signals within our own solar system. Satellites can take radio antennas and receivers high above Earth's atmosphere so that they can pick up cosmic radio waves not discernible at the surface of Earth. Beyond this, the last RAE will travel into lunar orbit. This will take it far beyond a second barrier—the magnetosphere—most of the time, and will isolate it from confusing radio noise from terrestrial sources.

Small Astronomy Satellite (SAS) One of NASA's Explorer-class programs, the SAS was designed to provide, at relatively low cost, much basic, previously unavailable information on low- and high-energy radiation from sources both inside and outside of our galaxy. These satellites study the celestial sphere above the Earth's atmosphere and search for sources radiating energy in the X-ray, gamma ray, ultraviolet, visible, and infrared regions of the spectrum.

All SAS spacecraft are launched aboard Scout rockets from the San Marco launch platform near Kenya on the east African shore of the Indian Ocean. This launch location makes it easier to achieve equatorial orbits of about 33 miles altitude.

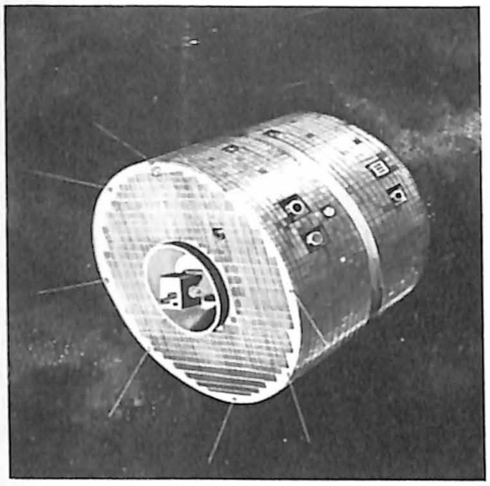


Interplanetary Monitoring Platforms (IMPs) A highly successful family of spacecraft, the IMPs (officially part of the lengthy Explorer series) are relatively small, spin-stabilized, solar-cell-powered satellites sent into either highly eccentric Earth orbits or into lunar orbits. Many of them repeatedly venture past the magnetosphere to sample conditions within and beyond. They measure both the interplanetary medium and the environment captured by Earth's gravitational and magnetic fields.

IMP cargoes usually include magnetometers, radiation detectors and plasma probes. They can be thought of as "particles and fields" specialists.

Small Scientific Satellite (SSS) The SSS is comparatively inexpensive, easily transportable, and small enough to be launched by the Scout, NASA's smallest satellite launch vehicle, from either Cape Kennedy or from smaller sites. The SSS is highly versatile. Although its basic objective is to continue earlier surveys of the Earth's radiation belts, it is a general-purpose instrument platform with interchangeable parts, and it can be used for a variety of missions.

Its flexibility can be maintained through the use of the same flight-proven modules over and over again.



Atmosphere Explorers (AEs) New models of the AE are unique among scientific satellites in that they are cylindrical, with a rocket nozzle protruding from one end. When the AE plunges into the denser regions of the upper Earth atmosphere this engine is fired to overcome drag, so that the spacecraft can continue its job of relaying back to Earth information on the composition, density and temperature at the outer fringe of Earth's gaseous envelope.

Earlier versions of the AE were limited in their missions by lack of this ability to return to higher orbits repeatedly.

High-Energy Astronomical Observatory (HEAO) A newer program is HEAO, aimed at broadening our knowledge of celestial X-rays, gamma rays and cosmic ray flux. The SAS payloads are adequate for initial investigations of low-energy X-rays and gamma rays, but later work in those areas, and on the subject of higher-energy cosmic rays, will require the much larger and heavier instruments that will be carried aboard the HEAO.

The first two of four planned HEAO missions are scheduled for 1975 and 1976. The spacecraft, which probably will be launched by the Titan III vehicle, will be big enough to carry several tons of instruments.

Earth-orbital scientific efforts are important basically because they make it possible to study and to measure the forces and the energies surrounding our own planet and our universe. At the same time they can observe other parts of the universe that we cannot study effectively from Earth because of the obscuring effects of our atmosphere, the ionosphere and the magnetosphere.

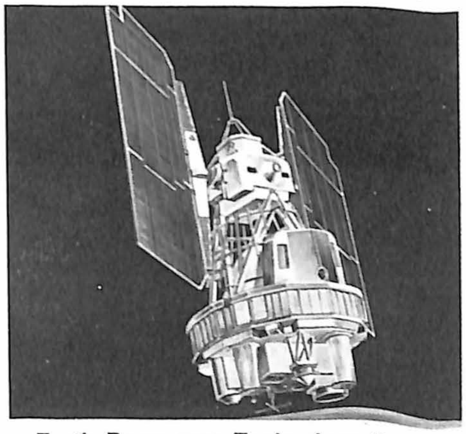
The yield of new knowledge already gained from a single decade of exploration promises new stores of knowledge in the immediate future—and in the years ahead, as the programs progress.

This can only mean a better life and a brighter future for all mankind on Earth.

Applications Satellites

During the years since the first launchings of test spacecraft in the early 1960s, Earth-orbiting applications satellites have demonstrated their usefulness in locating resources, weather-watching, relaying communications, navigation, mapping and monitoring pollution. With our planet's known supplies of raw materials dwindling, and waste-recycling problems increasing, a great challenge during the next decade will be to develop space systems to help solve our many existing problems and others which we can foresee.

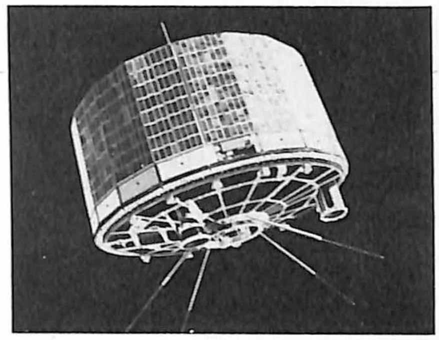
There are numerous satellite programs aimed at meeting the challenges. Some of the principal efforts are:



Earth Resources Technology Satellite (ERTS) — NASA is currently developing two satellites (ERTSA/B), the first to be launched soon this year and the second in 1973. Principal purpose of the program is to move ahead in developing our ability to more efficiently manage our globe's resources. Traveling in a polar orbit 500 miles above Earth, the ERTS will gather information from cameras and other sensors and return it to ground stations.

Manned space flights in the Gemini and Apollo programs have shown that we can gain even more useful information from satellites than that already obtained from high-flying aircraft. Eventually, the ERTS program should help in increasing crop yields, spotting forest fires, following the movement of sea life, keeping track of air and water pollution, and providing us with greater knowledge of our geography, geology, and hydrology.

Intelsat. This was the first truly global communications satellite. First of the series of Intelsat satellites providing international service was launched in December 1968. These satellites are stationed in geostationary orbits above the Atlantic, Pacific and Indian Oceans, providing thousands of new intercontinental communications links. Intelsat carried the Winter Olympic games from Japan. The Intelsats form the Global International Telecommunications Consortium which consists of more than 70 member countries. The U. S. is represented by the Communications Satellite Corporation (Comsat). Next advance in communications satellite technology is the Applications Technology Satellite (ATS) program. These satellites will have substantially larger capabilities and will pioneer the educational television, air traffic control and information transmission systems of the future.



Improved Tiros Operational Satellite (ITOS) — Latest in a long and highly successful series of meteorological satellites, the ITOS unlike its predecessors can take cloud-cover pictures *at night* with a scanning infrared radiometer. Thus, there is more complete photographic coverage of both the day and night sides of Earth. This is a major step toward moving from weather *watching* to weather *predicting* — as much as two weeks in advance of its occurrence, obviously a major objective of meteorologists.

Some idea of the potential gain from such predicting (apart from its effects on such fields as agriculture and construction) is shown by the fact that in August 1969 warnings from earlier types of weather satellites were estimated to have saved thousands of human lives when the massive Hurricane Camille hit the southeast U.S. coast. By any means of calculation, it is apparent that the investment in rockets and spacecraft paid off many fold.

There are other valuable uses for satellites in addition to earth resources, weather and communications described previously. Satellites can be used for air and surface navigation and geodosy (mapping). Principal objective of the geodosy satellite series is to establish a single, common worldwide geodetic reference system that will improve global maps to an accuracy of ten meters.

The navigation satellite, in effect, is a known landmark; the only one visible on the broad oceans. Stars play the same role in stellar navigations, but they are not always visible and fixes are too slow for an aircraft flying near the speed of sound. Navigation satelites have the advantage that the signals can be received automatically and analyzed by computers, providing positions rapidly and continuously for ships and aircraft.

Benefits Unlimited

The civil utilization of aerospace-generated technology offers immense opportunities—in fact, it makes up a primary source of our national economic progress.

A full listing of the many civil applications of aerospace technology already benefitting mankind would require volumes, and more and greater benefits are on the way.

Space permits only the use of a single example in several fields where aerospace advances are benefitting more and more people on Earth.

Medicine. This field, because of its high technology requirements, has been a major beneficiary of space research, development and production programs.

A technique used in the production of spacecraft for germ-control and dust-purging is helping to lower the risk of infection in surgical procedures. The technique uses portable equipment designed for the continuous removal of dust and germs from the surgical area. Equipment includes helmets that resemble those worn by astronauts and specially treated surgical garments that bacteria cannot penetrate.

The equipment is used during hip-joint replacements and similar procedures in which large incisions must remain open for several hours. A 10-foot by 10-foot plexiglass and aluminum enclosure fits inside a conventional surgical room. Air-circulating units force the air through a wall of filters that trap dust and bacteria. The air then moves in a gentle flow from the rear of the enclosure to the front. Clear plastic helmets are worn by surgeons and nurses. Air flows into the helmet from an opening in the top of each helmet. Vacuum lines remove exhaled breath, and communication is provided by headsets worn by members of the surgical team.

The entire concept is based on techniques developed for sterile spacecraft assembly and self-contained life support systems.

Structural Engineering. A computer program, developed by the National Aeronautics and Space Administration, today has more than 185 applications ranging from suspension units and steering linkages on automobiles to the design of power plants and skyscrapers.

NASA's Structural Analysis Computer Program (NASTRAN) is a general purpose digital computer program originally designed to analyze the behavior of elastic structures. A major use was in the design of the space shuttle.

The engineering division of a major automobile manufacturer, using NASTRAN in the design of its 1973 line of light trucks, reports a 60 percent improvement in predicting the behavior of components under stress and a time saving of two-thirds in achieving such calculations.

Other examples of the applications of NASTRAN to design and analysis include:

- Aircraft fuselages, wings and tail assemblies.
- High-speed railroad tracks.
- Turbine engines.
- Space vehicles and launch facilities.

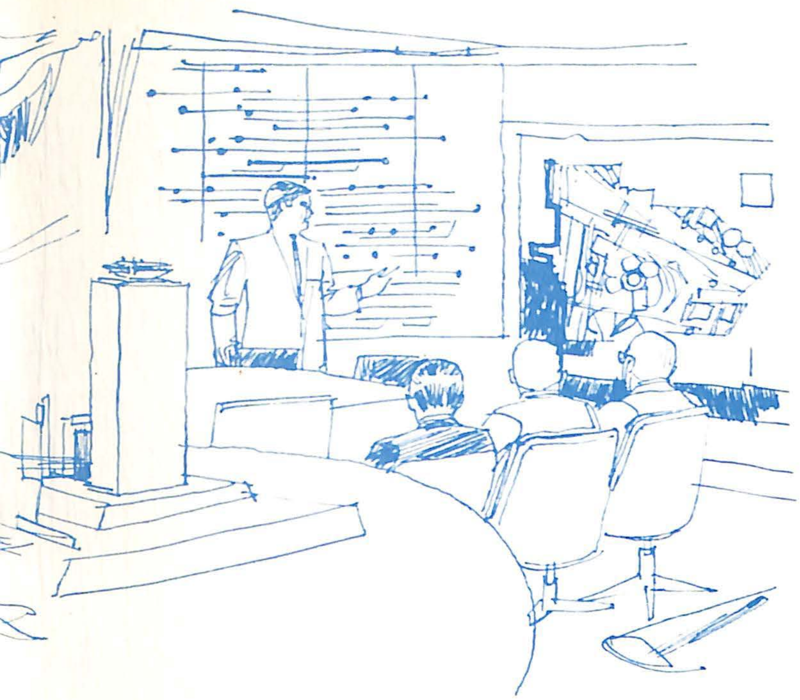
Safety. This is another broad field for new technology applications, ranging from fire resistant materials and paints, to better safety testing of new automobile tires.

This device, originally designed by the Raytheon Company to test miniaturized electronics circuits, for the first time permits effective non-destructive testing of automobile and aircraft tires by the B. F. Goodrich Company. The equipment produces a cathode ray tube picture of the heat in tires as they spin rapidly in the testing device at speeds up to 200 mph, in the case of automobile tires, and 400 mph for aircraft tires. The infrared camera is capable of reading the heat from 600,000 points on a tire every second, presenting a view as if the spinning tire were stopped. Hot spots in a tire are viewed as bright areas in the picture, indicating design or construction flaws needing correction.

Previous camera equipment that could "stop" a spinning tire were too cumbersome. The new evaluation tool weighs less than 40 pounds and can be used to test automobiles with power from the auto's electrical system.

A B. F. Goodrich official says: "We anticipate that this highly accurate method of heat analysis will help us improve many of our products by testing them nondestructively. Heat shortens the life of V-belts, shock mounts, brakes, rubber bearings and many other items besides tires."

Construction Management. Kansas City, Missouri, is



using a system developed for the Apollo manned space flight program to build its $200 million international airport.

The idea was obtained from a briefing room built for NASA for the exchange of ideas and information on the Apollo missions. The Kansas City adaptation is used for briefings on airport progress and problems for the mayor, city manager and city council.

Every two weeks a video tape progress report on airport construction is printed, followed by a computer printout of the latest airport financial status and cash flow requirement.

Typical decisions made during the presentations involve specific problems and improving construction procedures. The system serves as a repository for data on the airport project, permits decisions to be based on current information, and keeps the management of the project in a single location.

Materials. The Houston, Texas, Fire Department today is using new fireproof materials, developed for the space program, for their firefighting suits. The new clothing includes thermal underwear, a coverall chaps, two types of trousers, two jackets and proximity suits which permit the firemen to move closer to the fire or even enter the flames if necessary.

The Mobile Quarantine Facility, formerly used by Apollo crew members, was provided with maximum fire safety furnishings that were developed for space applications. Floor, panels and drapes were sprayed with a non-inflammable fluorel, and the seats were covered with a fireproof synthetic material. These fire-resistant materials are now being commercially sold by several manufacturers.

These are but a few samples. Add to them, and to the hundreds of other benefits already realized, the revolutionary advances soon to come in such fields as weather monitoring, communications, education, agriculture, mapping, navigation, transportation and the surveying, monitoring and management of natural resources world wide.

There can be no question but that generations of mankind now and in the future will be rich beneficiaries of the U.S. manned and unmanned space programs and our technology-oriented industries.

AIA

MANUFACTURING MEMBERS

Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Amphenol SAMS Division
  The Bunker-Ramo Corp.
Avco Corporation
The Bendix Corporation
The Boeing Company
CCI Corporation
  Murdock Machine & Engineering
  The Marquardt Company
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  Colt Industries
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Aerospace Group
  Aircraft Engine Group
General Motors Corporation
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Goodyear Aerospace Corporation
Grumman Aerospace Corporation
Gyrodyne Company of America, Inc.
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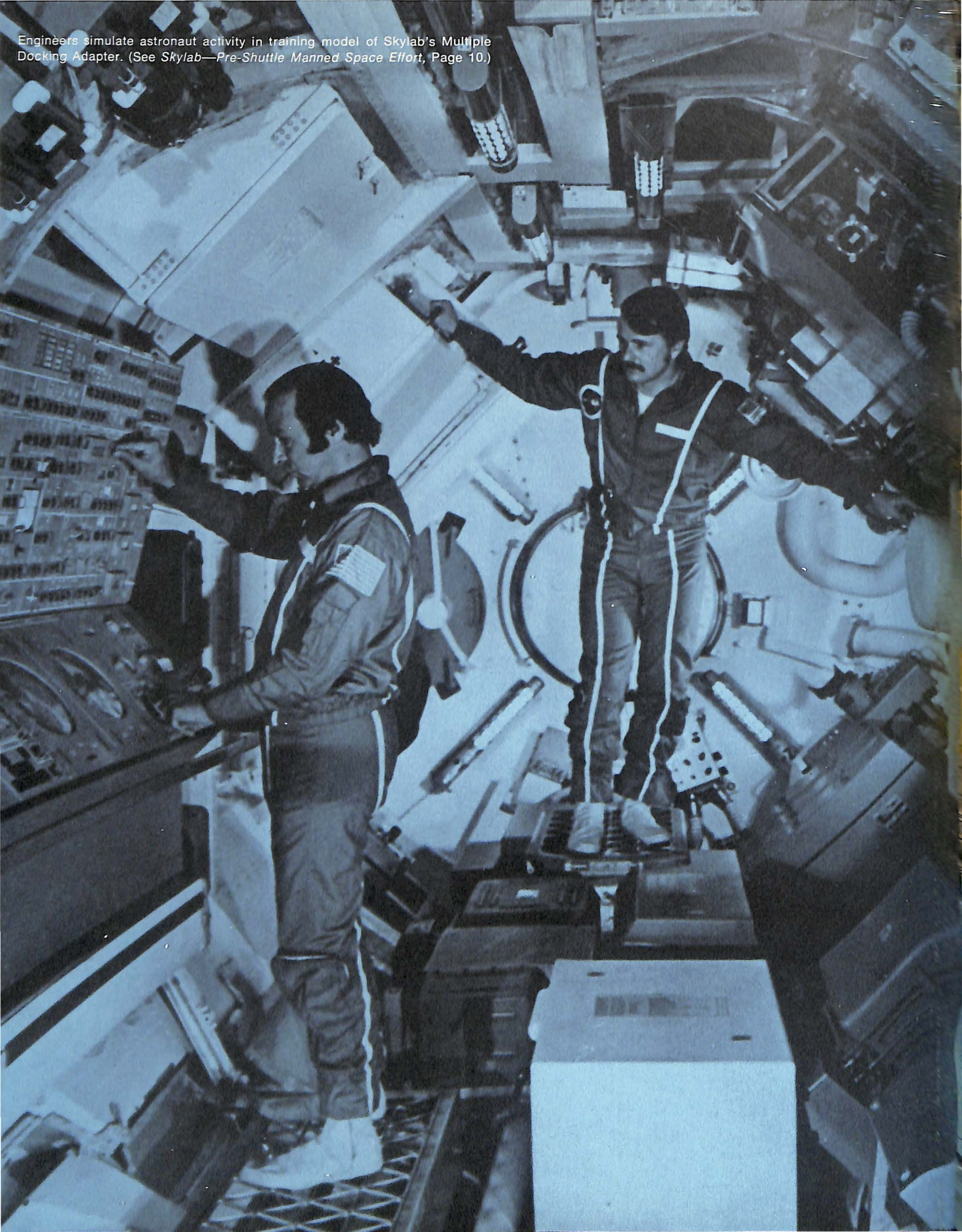
Tool Research and Engineering Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory



Engineers simulate astronaut activity in training model of Skylab's Multiple Docking Adapter. (See *Skylab—Pre-Shuttle Manned Space Effort*, Page 10.)

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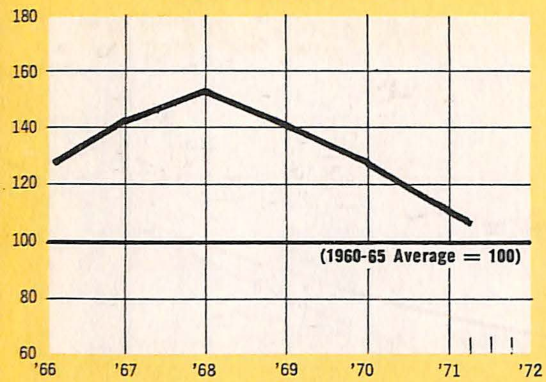
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • JULY 1972

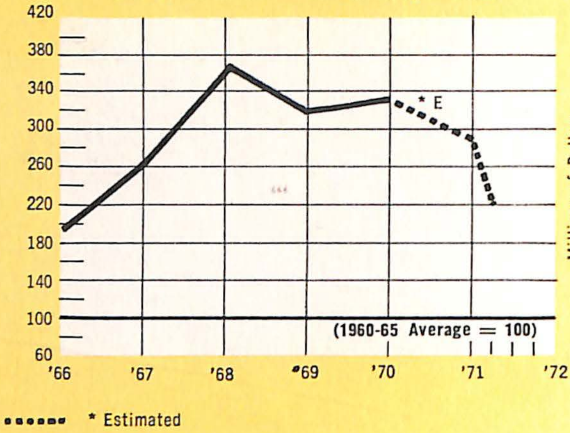
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

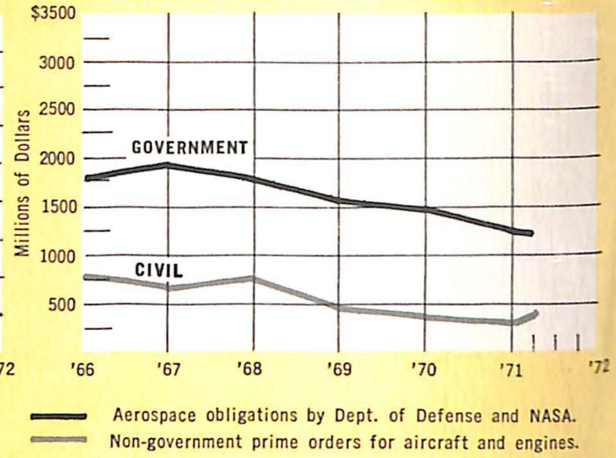


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1960-1965 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $ Billion $	Annual Rate Quarterly	19.4 4.8	1st Quarter 1972	24.4 5.4	21.6 5.2	21.0 4.8
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	Dec. 1971	1,570	938	1,565
Aircraft	Million $	Monthly	601	Dec. 1971	729	541	900
Missiles & Space	Million $	Monthly	550	Dec. 1971	841	397	665
Aerospace outlays: Total	Million $	Monthly	1,067	Dec. 1971	1,345	1,034	1,120
Aircraft	Million $	Monthly	561	Dec. 1971	856	619	681
Missiles & Space	Million $	Monthly	506	Dec. 1971	489	415	439
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	920✠	Feb. 1972	551	993	879
Aircraft	Million $	Monthly	447	Feb. 1972	328	634	469
Missiles & Space	Million $	Monthly	473	Feb. 1972	223	359	410
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Apr. 1972	291	287	233
Expenditures	Million $	Monthly	130	Apr. 1972	242	315	242
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3#	1st Quarter 1972	24,489	23,935	23,952
U.S. Government	Billion $	Quarterly	11.6		12,972	13,347	13,661
Nongovernment	Billion $	Quarterly	3.7		11,517	10,588	10,291
EXPORTS							
Total (Including military)	Million $	Monthly	110	Mar. 1972	509	285	493
New Commercial Transports	Million $	Monthly	24	Mar. 1972	282	120	252
PROFITS (After Taxes)				1st Quarter 1972			
Aerospace — Based on Sales	Percent	Quarterly	2.3		1.7	1.4	2.1
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		3.9	4.1	4.0
EMPLOYMENT: Total	Thousands	Monthly	1,132	Feb. 1972	1,054	921	927
Aircraft	Thousands	Monthly	469	Feb. 1972	602	505	511
Missiles & Space	Thousands	Monthly	496	Feb. 1972	94	89	89
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Feb. 1972	4.29	4.42	4.51

R Revised
E Estimate
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
# Averages for 1961-65.
✠ Averages for fiscal years 1960-1965.

Source: Aerospace Industries Association

TECHNOLOGY FOR THE FUTURE OF ALL MANKIND

BY KARL G. HARR, JR.
President,
Aerospace Industries Association

With the distribution of the prior issue of this magazine we conducted a readership survey.

We were gratified not only by the high percentage of readers who took the time and effort to return the postcard, but also by the tenor of the great majority of comments. All comments, and particularly those offering substantive recommendations, are being studied in an effort to improve this association publication.

The principal lesson learned from the hundreds of comments is that the magazine plays a welcome role in providing useful information and educational material to educators and students particularly in the range from upper grade school through college.

We thank those who have helped us with their comments.

During recent months this Association and leaders throughout industry and the Government have been documenting the importance to the nation's well-being of high-technology endeavor.

This issue of *Aerospace* continues such discussion.

One article covers TRANSPO '72, the world's first international transportation exposition, held at Dulles International Airport during late May and early June. It reports briefly upon the variety of high-technology efforts that U.S. aerospace and other industries are making to develop a total, integrated system of transportation, from urban area people-movers to intercontinental air transports.

A second article explores the role that quality assurance plays in the high-technology aerospace industry — an effort essential to great safety, comfort, productivity (capacity plus speed) and stability in the per-mile cost of air transportation.

The other major article looks at the problem of aircraft noise. It reviews the considerable strides that have been made in reducing noise, thus making better neighbors of the airborne vehicles of our essential air transportation system.

Each report in this issue contributes to a simple message:

There is no need to turn our backs on technology. We have the energy, the wisdom, the desire and the resources necessary to ensure the use of technology to better the future of all mankind. Seeing that it does so is up to all of us. That's what today's and tomorrow's technology is all about.

AIA

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Official Publication of the
Aerospace Industries Association of America, Inc.

PRESIDENT • Karl G. Harr, Jr.
VICE PRESIDENT FOR PUBLIC AFFAIRS • Carlyle H. Jones
PUBLISHER • Rodger R. Bankson

VOL. 10, NO. 3 *JULY 1972*

EDITOR • Gerald J. McAllister
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ASSOCIATE EDITOR • Jean Ross Howard
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

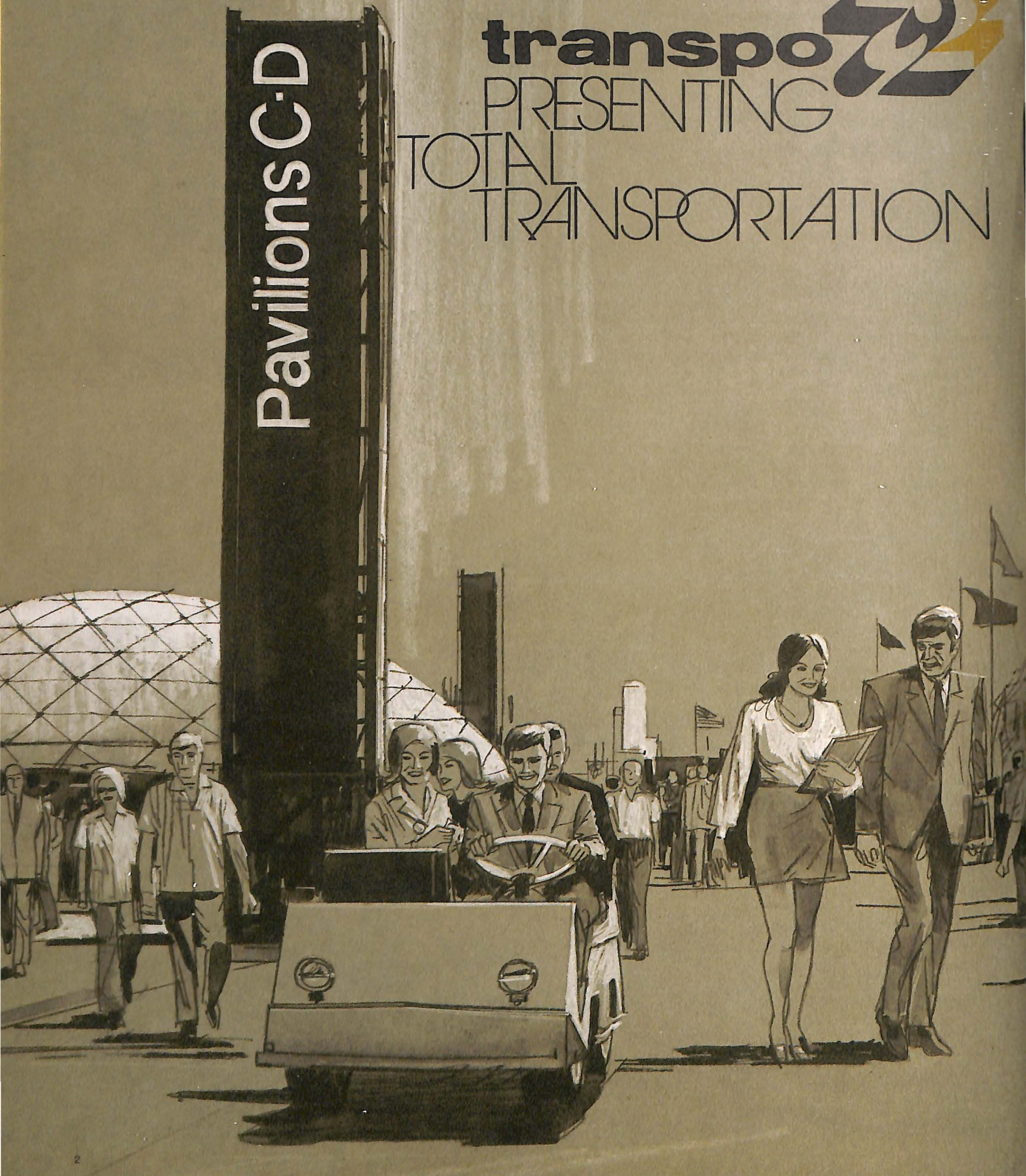
Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

Publication Office: 1725 De Sales Street, N.W., Washington, D. C. 20036

transpo72
PRESENTING TOTAL TRANSPORTATION



TRANSPO 72 abounded in superlatives.

For example:

- The largest *total* transportation—land, sea, air, even space—international exposition ever held.
- An estimated 1.5 million people visited the huge 9-day show.
- There were 450 exhibitors with 666 exhibits occupying 1.3 million square feet of space at Dulles International Airport in Virginia.

But to the one and a half million visitors, including an estimated 50,000 from foreign countries, the most important statistic was a non-superlative:

- Not one *major* traffic jam.

The exposition had three major goals:

- To show the public and the world that the United States has not abandoned its role as a technological leader.
- To demonstrate to people of all nations the whole spectrum of the transportation systems.
- To increase the sales of U. S. products here and abroad.

The first two objectives were solidly met, and the future looks good for meeting the third goal.

The aerospace industry, with a broad background of technological creativity and innovation in aircraft and space vehicles, was strongly represented in the field of surface transportation, where new concepts are required to meet the demands of mass transportation on the ground. In the U. S. alone, planning experts estimate that about 45 urban transit systems costing about $11 billion should be built in the next decade.

Among the new ground systems shown were mock-ups of tracked air cushion vehicles (TACV) designed by LTV Aerospace Corp. and Grumman Aerospace Corp.

TAVC are aerodynamically styled, high-speed vehicles capable of being propelled over a thin cushion of air in a U-shaped guideway.

They were developed for the Urban Mass Transportation Administration of the U. S. Department of Transportation.

The TACV designed by LTV accommodates 60 passengers in modern surroundings, seated four abreast in 15 rows of large seats equivalent to first-class seating on commercial airlines.

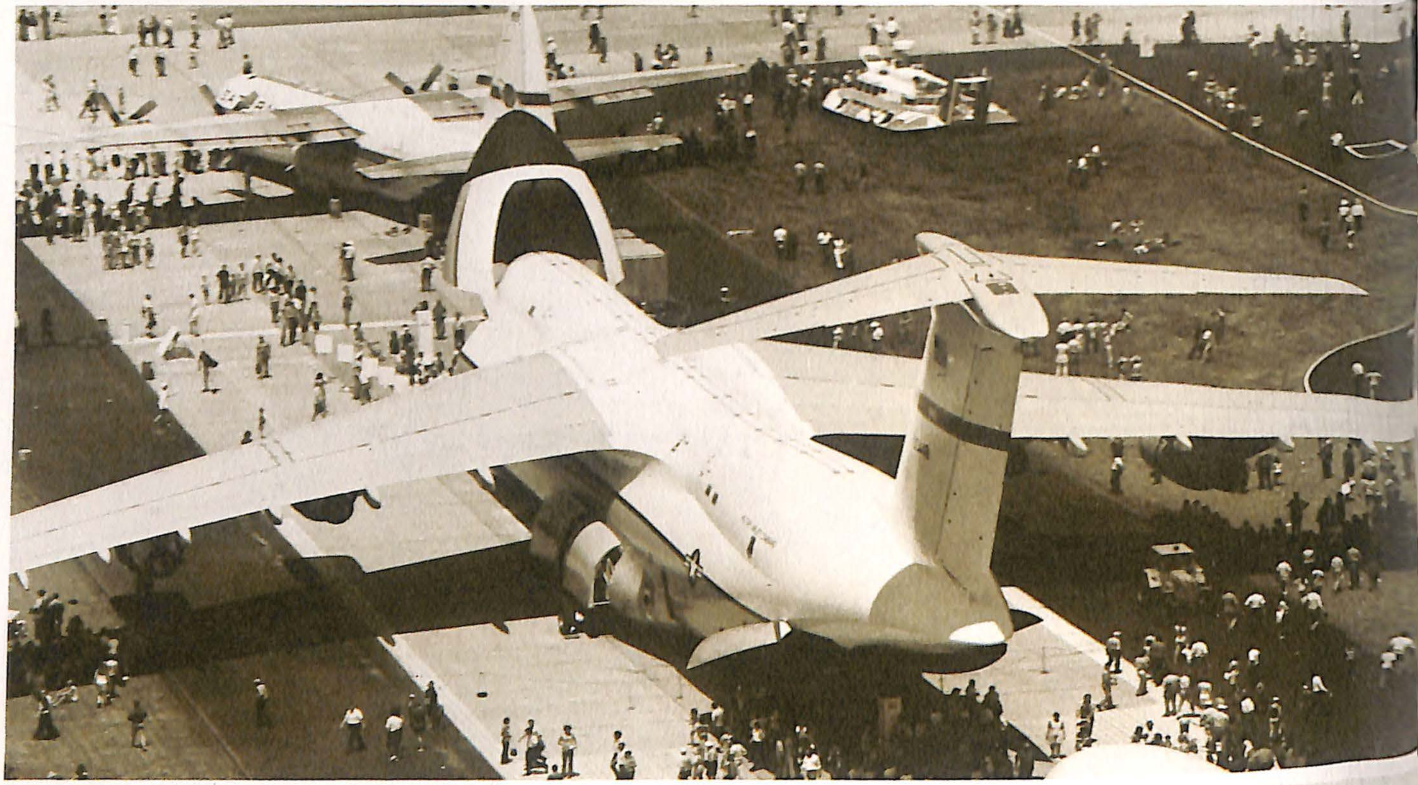
The exterior of the aluminum vehicle resembles a wingless, tailless airplane, and it does, in fact, "fly" about one-tenth inch off its flat concrete guideway.

The TACV has four braking devices, including power reversal of the linear induction motor, two independent sets of wheel brakes and skids. The devices are used in multiple combination to insure highly reliable braking.

The lower one-fourth of the TACV houses the air cushion and propulsion systems, with that portion of the exterior being shielded from the bystander's view by the guideway system.

The air cushions guide the vehicle along the track as well as supporting its weight. A thin film of air between the bottom of the cushion and the guideway

transpo 72



Boeing's first aircraft, the BW-1 nestles up against the Dash-80, the first four-engine jet commercial transport prototype. It was presented to the Smithsonian in ceremonies at TRANSPO 72 (above) The Lockheed C-5A (right) drew its share of visitors to the first total transportation show ever held. Two of the huge exhibition halls are shown at the bottom.

prevents contact even in the most extreme conditions. The air bag between the body and the cushion pads serves as the suspension system for the vehicle.

The levitating power for the air cushion comes from two motors that drive two 40-inch-diameter, axial flow, single stage fans.

The air cushion is slightly over one-tenth inch thick and is created by .7 pounds-per-square-inch of pressure, compared with the 28 psi required to inflate the average automobile tire.

Nonetheless, 75,000 cubic feet of air per minute is required to operate the air pads and distribute the pressure equally over the bottom and sides of the air cushion system.

A 12,000-pound-thrust linear induction motor (LIM) powers the TACV at a cruising speed of 150 miles an hour. Speeds can be increased to 300 and 400 mph with expanded power systems.

The control system automatically starts, accelerates, and slows the vehicle as necessary for the best ride quality. It also stops the vehicle, opens and closes the doors.

A manual override permits the operation of the vehicle in reverse at speeds up to 30 miles per hour. The electrically powered vehicle is exhaust-free.

The TACV utilizes much standard off-the-shelf hardware that has been proved reliable through many years of railroad and other applications.

Rohr Industries exhibited four advanced systems, each designed to serve a different segment of a balanced transportation network. There were vehicles with steel wheels, rubber wheels and no wheels, one that floats on air and another that hangs in the air.

Rohr had an operating "people mover" called Monocab, a rail transit car built for San Francisco's new BART (Bay Area Rapid Transit) system, the latest city buses, and a full-scale engineering mockup of Aerotrain, and a tracked air cushion vehicle.

In addition, there was a demonstration of a research vehicle called ROMAG that uses electromagnetic forces to support itself a fraction of an inch above a set of guide rails as well as guide and propel itself.

A company official explained how a suburban family might use a balanced transportation network: "Mr. Jones would catch a bus a block from home and ride it to a nearby transit station where a train would take him downtown in half an hour or less. At the downtown terminal, a Monocab would be waiting to take him directly to his office," he said.

"I want to stress that these vehicles will be different than any in service today. We are designing buses that have more in common with luxury automobiles than with the buses being used today," he stated. "And the transit vehicles we build, such as those for BART, are more like jet airliners than rail cars."

"When Mrs. Jones goes shopping, a bus would take her directly to a nearby center where a people mover like Monocab would carry her right to her favorite stores," he continued.

"Via bus and train, their son Jim reaches his college campus in little more than 20 minutes, where a people mover carries him to his first class," he said. "No more will he have an excuse for being late because he couldn't find parking space for his car," he added.

A "people mover" system in which a computer decides the fastest, safest route to stations along the line was demonstrated by the Bendix Corporation at Transpo 72.

The demonstration system featured two air-condi-

Early designs of U.S. aircraft competed for attention with the latest models from all over the world. This aircraft joined World War I aircraft in the display area.

tioned, electrically-powered vehicles which carried 31 passengers at speeds up to 20 miles per hour along a 1,200-foot guideway.

The demand-responsive feature of the Bendix system permits a passenger to summon the vehicle by pressing a button at the station, then direct the vehicle to his destination by pressing a select button on board.

The computer which controls the system then decides the quickest, safest route and switches the vehicle through the appropriate guideways.

In addition to operating at the demand of passengers, the automatic vehicles can be programmed by the computer at the master control center to operate on regular schedules.

The Bendix Personal Rapid Transit (PRT) system will remain at Dulles for approximately six months to one year for study and evaluation for use at urban sites.

Stars of the show, of course, were the wide-body jets—the Boeing 747, the Lockheed L-1011 and the McDonnell Douglas DC-10. All three aircraft are now in airline service. The Lockheed C-5A, world's largest aircraft, was there and made a series of low-level flights around Dulles.

Also exhibited was a complete line of light aircraft, ranging from beautifully equipped executive transports, STOL aircraft and helicopters to an inflatable plane that can be carried in the trunk of an automobile. Inflated, the one- or two-seat aircraft, built by Goodyear Aerospace Corp., can fly at a speed of 70 mph.

Perhaps the most interesting overall aspect of TRANSPO 72 was the tremendous variety of transportranspo 72

tation products and systems exhibited. They covered such aspects as safety autos, vertical parking systems, anti-hijacking weapon detection systems, marine and air collision avoidance systems, ground traffic control systems and airline reservation systems.

Here is an example of the exhibitions shown by one participant, The Garrett Corp. The exhibit presented the high technology of the aerospace industry, and its ability to utilize this technology in nonaerospace fields. The exhibits covered ground transportation, airline transportation, general aviation and engine components.

The ground transportation exhibit included an operating model of a rail car being built for the Long Island Railroad. The car has the capability to run on third-rail electric power or to generate its own electrical power when operating beyond the third-rail limits. There was also a braking system for high-speed trains and Brayton-cycle engine designs for buses.

In the airline transportation section, Garrett displayed a refrigeration package for the McDonnell Douglas DC-10, the A300B airbus and several auxiliary power units for aircraft ranging from short-haul models to the Boeing 747, flap actuators, ground start carts and thrust reversing systems.

The general aviation display exhibited several engines, including a 3,500-lb. turbofan, a turboprop engine and a turboshaft engine for helicopters. There was also an airconditioning unit for the Bell Huey Cobra and a lightweight emergency locator transmitter.

The engine components section covered an advanced auto engine design developed as an outgrowth of work done for the Environmental Protection Agency, and numerous components for future powerplants which will keep air pollution to a minimum.

Finally, as Secretary of Transportation Volpe points out in a question-and-answer feature accompanying this article, the patriotism of the exhibitors in most cases "seems to have been generously rewarded by improved marketing outlooks." For example, the recreational vehicle exhibits were very popular. One such exhibitor, almost as an afterthought, brought along a few order blanks. After the second day he faced what is at once a salesman's delight and dilemma: He ran out of order blanks.

Following are responses by Secretary of Transportation John A. Volpe to questions posed after the close of TRANSPO 72:

Question: *What do you see now as the significance of TRANSPO 72?*
Sec. Volpe: I find it significant that so many people came to what was essentially a trade show. Most were very favorably impressed by the vast array of technological progress on display. TRANSPO gave the casual viewer new faith in America's leadership in the transportation field. It gave planners new insight into what's available now and what's coming up in transportation hardware and software. And it gave exhibitors sales and leads in new markets, both domestic and foreign.

Question: *How did our foreign visitors respond?*
Sec. Volpe: That was a side benefit of great potential significance, I feel—the tremendous amount of international good will generated during conferences and the visits with delegations from 56 nations from around the world.

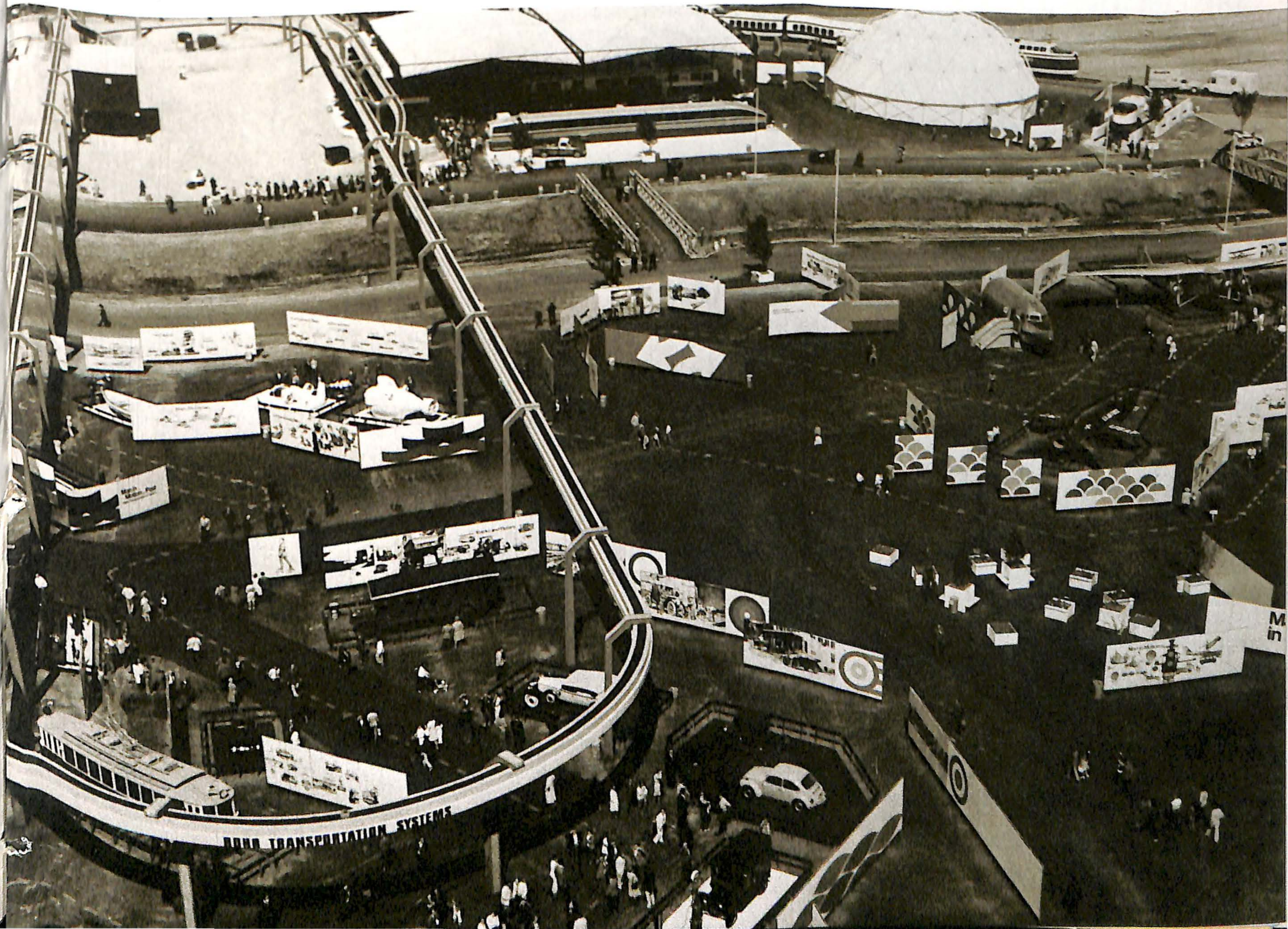
Question: *What was the exhibitor reaction?*
Sec. Volpe: You're asking me some of these questions about a month too soon. We have a firm making opinion polls of exhibitors. It questioned them on-site during the exposition and now it's checking with them again after they've been back home and had a chance to balance their costs and receipts. The report is due later this summer.

Question: *Do you have an interim opinion?*
Sec. Volpe: Yes, based on my own experiences out at Dulles. Exhibitors in all fields of transport told me that shoppers were buying and expressing an interest in their products that far exceeded their fondest expectations. I can tell you now that some manufacturers exhibited more as a patriotic gesture than with any hope of commercial reward. I'm happy to say their patriotism in most cases seems to have been generously rewarded by improved marketing outlooks. My correspondence since TRANSPO bears this out.

Question: *What did you learn in staging this first international transportation exposition?*
Sec. Volpe: Plenty. As you know, we were pioneering in a really uncharted wilderness. Just a few months ago we were bravely predicting that we might have 300 exhibitors; we had 666 exhibits staged by about 450 exhibitors. The crowds were even harder to estimate. Without that almost ideal weather, attendance could have been quite another story. When TRANSPO 72 is all wrapped up, we'll know what costs are involved, what service facilities are needed for this size undertaking. Anybody planning an exposition in the future would at least have our experience base on which to build.

Question: *Mr. Secretary, was it worth all the challenges of pioneering a new exposition?*
Sec. Volpe: I'd say yes. I'm convinced this exposition was good for the United States, good for the future of transportation, and good for the people who will enjoy improved urban, intrastate, interstate, and international travel because those responsible for transport facilities and services found better ideas at TRANSPO.

The gantry-like apparatus (above) was one of the biggest sellers at TRANSPO 72. Capable of storing 22 autos in the ground space of two standard cars, the Park Mobile towers were a huge success with civic and other officials. On the upper right is one of the many Hertz girls providing Otis-golf-cart transportation. The aerial view of the public entrance area (below) shows part of the "Man In Motion" thematic displays, the Rohr Monocab People Mover system and the Department of Transportation display sections, including the United Aircraft Turbo Train.




AEROSPACE
QUALITY ASSURANCE

"Exfoliation-Corrosion Acceptance Standards for -T76 Temper Series of Aluminum Alloys 7075 and 7178"

"FAA-USAF-NASA Runway Research Program — DC-9 Flight Test Schedule"

"Proposed Flight Special Conditions for Aerospatiale, France, and British Aircraft Corporation, England, for the Concorde Airplane"

"MSC Program Plan for Evaluation of Improved Aircraft Cabin Materials"

"MSC Project 341-4, MIL-M — 3171 Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion"

"Fuel Systems Fire Safety"

The above are six of the hundreds of technological programs under way in the high-technology industries of the United States, particularly in the aerospace industry.

What do they mean to Americans, and to other people all around the world?

They mean that in 1971, when 53,644 people were killed on U.S. highways, and when an estimated 27,000 Americans were killed in home accidents, 173,667,000 people traveled more than 142 billion passenger miles on U.S. scheduled airlines with only 174 fatalities. This was a safety rate of 99.99989%, or about one fatality for each 8 hundred million passenger miles. (In the previous calendar year, 1970, two persons were killed in U.S. scheduled airline flights — a safety rate of 99.999999%.)

They mean that in 1971 six U.S. astronauts traveled a combined total of close to three million miles to the Moon and back in safety. This does not include many thousands of additional miles travelled in lunar orbit.

A modern jet airliner such as the Boeing 747, the McDonnell Douglas DC-10, or the Lockheed L-1011, is created by putting together many thousands of parts. Failure of any one of many of these could result in a tragic disaster. An airliner with 200 or 300 people aboard can't park by the side of the road, raise its hood and wait for a tow truck. It must take off on time, fly a predescribed route and land on time without undue incidents.

Nowhere is the quality and reliability of component parts more vital, of course, than in space flight. An assembled Saturn V-Apollo booster/spacecraft contains a total of more than five million parts. On one of the earlier Apollo flights, there were five part failures; all had "redundant," or back-up units, and none of the failures interfered with the mission. Thus, the parts reliability percentage was 99.99% plus.

QUALITY ASSURANCE

This continuing success story in space and aviation safety obviously did not "just happen." It is the result of tremendous — but largely unheralded — efforts behind the scene by industry experts in the quality assurance area, which involves everything from the number of threads on a screw to the composition and thickness of the metal skin for a wing.

The magnitude of the quality assurance effort becomes apparent when we realize that literally thousands of subcontractors and sub-subcontractors work in dedicated support of the major airframe and engine manufacturers whose names are associated with the final product.

There is virtually no planning, engineering, production or maintenance function in the aerospace industry that doesn't depend to a significant degree on quality assurance. And the more sophisticated and complex the product, the more effort must be expended to ensure its reliability and level of performance.

Detailed quality assurance work starts at the time plans are drawn and materials are ordered, then continues throughout the life of the product, whether it is carrying 300 people from New York to San Francisco or three astronauts to the Moon and back.

This assurance is no less necessary in the case of automated machines, from missiles to satellites, not under the direct controlling hand of a human being.

A great many of the accomplishments in safety have derived from work done by industry, and within Government laboratories and test centers, to improve the reliability of military aircraft, missiles and other systems. Products delivered to the military must meet a myriad of standards and specifications which constantly grow more stringent. Thus, the defense programs help to push advanced technology ever forward, to the benefit of all concerned.

For the manufacturer, there are three major elements to be considered before the product even gets to the customer:

- Definition of end use: This description (specification) must completely describe the performance expected of the end product under all conditions of use and environments under which it must operate. Included must be expected life, maintenance cycles, etc.
- Definition of end product — This must be a complete, detailed description of the end product and include detailed drawings, specifications, tools, loft data, etc. (engineering).
- Manufacturing and inspection of the end product — In most cases, the manufacturing inspection plan involves extensive planning by the manufacturing engineer on the production of the detailed parts, inherent capability of each machine and process, manpower skills requirements vs. what is available, and tools required in fabrication and assembly.

During this same planning period, the quality engineer and inspection planner are working with manufacturing to evaluate which characteristics are controlled by the process, machine, or the tool — and which others must be tested — measurements and operational tests, for example.

Finally, there is the detailed inspection of each part, assembly, and then the final product by the floor inspector. Prior to delivery, there is the actual operational test to verify the conformance of the end product to the original specification.

The manufacturing plan includes "make-or-buy" decisions, which determine whether parts, assemblies, and special facilities shall be produced in-plant or procured elsewhere. In the latter case, inspection planning and testing must still be carried out prior to actual hardware production, just as it is in-plant.

A major key to the unprecedented accomplishments in aerospace safety is the comparatively new technology of nondestructive inspection — testing materials, structures and finished parts to determine whether they are without flaws and otherwise meet specifications through use of methods that do not result in destruction of the usually expensive test items. There are three general methods:

- *Visual,* using either the "calibrated" (in the sense of an individual aware of what needs to be looked for) human eye to check on "condition," or the naked eye supplemented with micrometers, scales, transits or other devices.
- *Nondestructive testing methods* primarily to establish "Go-No-Go" acceptance through the acceptance of standards. Typical methods include X-ray, magnetic particle inspection, penetrants, eddy current and ultrasonics.
- *Operational testing* with supplemental instrumentation, usually within and/or used with the functional test equipment to determine performance to engineering-specified performance criteria. This starts with functional components and continues through the assembly process to include the total end item.

GROWING PARTNERSHIP

Beyond the manufacture of an aircraft, and its acceptance by the airline which buys it, is the vital matter of its reliability and maintainability once it enters service. In recent years increasing recognition has been given to the fact that reliability and maintainability (R&M) — with all of its obvious importance to both safety and satisfactory operating costs — must be a joint responsibility of both the aircraft designer and his customer, the airline operator.

Now this partnership is growing, as witnessed by the excellent progress in development of the new wide-body airliners — the Boeing 747, the McDonnell Douglas DC-10 and the Lockheed L-1011, all of which have now been certificated. Reliability and maintainability promise to be greatly enhanced by bringing the manufacturers' designers into full collaboration with the airlines from the outset of a program — a full partner not only in design of the aircraft, but in planning the maintenance.

The approach to R&M in the DC-10 and L-1011 programs owes much of its sophistication to work done earlier on the maintenance program for the now well-proved Boeing 747 four-engine wide-body transport, which has been in commercial service for more than two years.

As with the later tri-jet programs, the effort in connection with the Boeing 747 was long and arduous, and involved three distinct elements: the manufacturers of airframe and engine, their airline customers, and the members of the Federal Aviation Administration's Maintenance Review Board (MRB).

Essentially, the process for originating a maintenance

program is the same for any new-model aircraft: Work is jointly begun by the airlines and the manufacturers at least one and one-half years before the airplane is scheduled to be certificated for service, following which (after lengthy review) the FAA passes judgment on each individual airline program. However, new features were added in the cases of the new wide-body ships.

QUALITY WAYS AND MEANS

To meet the severe demands of quality assurance on aircraft and spacecraft, manufacturing companies have developed a host of new techniques and processes. The following is a representative sampling.

The Space Division of North American Rockwell has established a Quality Motivation Program which makes individual employees fully aware of the critical importance of error-free performance, identifies specific goals, and recognizes superior work with awards. A number of innovations have resulted from the program. Among them:

- A new X-ray inspection technique to cut the cost and operating time in radiographic inspection of the welding in the S-II stage of the Saturn V launch vehicle. The first oxygen-compatible fluorescent penetrant was developed by NR's Los Angeles Division for interior inspection of oxygen tankage and is now available for commercial use.

Convair Areospace Division (Fort Worth) of General Dynamics has developed a number of systems and techniques to improve aircraft reliability and save time in manufacturing. Examples include:

- Delta ultrasonic inspection, first used in large-scale production on the F-111 program. This technique was named for the triangular position of the transducers used in the test. If a defect exists in the material being tested, it is located through a flow of sound energy, the information is displayed on a cathode ray tube and an alarm is set off.
- A system to ultarsonically test for hardness. This development arose from a need to determine the hardness of three surfaces on a highly stressed part without making indentations.

McDonnell Douglas activity in the hardware area has included:

- A specification developed by the McDonnell Douglas Astronautics Company (Huntington Beach, Calif.) on criteria for quality control of increasingly microminiaturized monolithic circuits (or integrated circuits — IC's). Using as an acceptance tool its Scanning Electron Microscope (SEM), the company has markedly increased the reliability of IC's it uses in aerospace equipment.
- A contribution to future lower-cost and more densely packaged electronics through establishing necessary

quality control standards to produce the first 4" by 6", 5-layer ceramic multilayer board.

• Both the Quality Audit and the Quality Engineering sections of Quality Assurance at McDonnell Aircraft Company (St. Louis, Mo.) teach courses in their area to people from various companies representing a wide range of industries.

AiResearch Manufacturing Company of Arizona, a division of the Garrett Corporation, has tightened its supplier rating system to ensure that corrective action is taken when parts or products are defective. Such suppliers who fail to fix the problems involved are first placed on a "warned" list, then on a "restricted list, and finally on a "disapproved" list if the problems remain uncorrected.

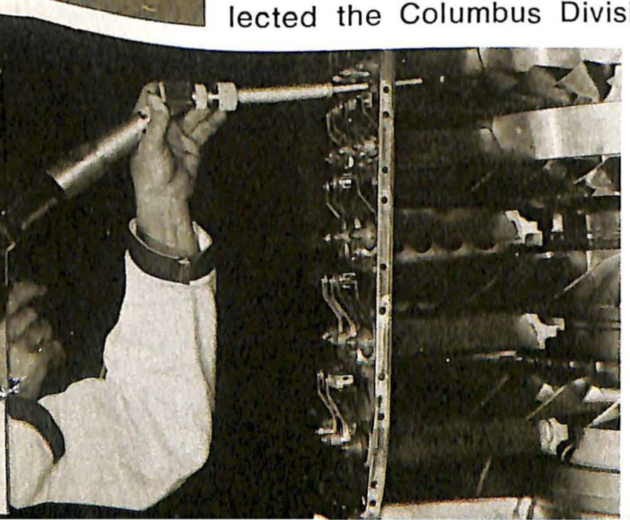
The company reports that at the end of the first year of this program, rejections by AiResearch inspectors were down 49 percent, rejections at receiving inspection were down 21 percent, and unsatisfactory supplier-produced parts discovered during assembly were down 37 percent. The result was higher-quality products and reduction in costs — the latter for the supplier as well as the buyer.

Rohr Corporation (Chula Vista, Calif.) is using holographic interferometry — a unique and versatile technique — for quality assurance. Coherent laser light is applied in recording and reconstructing three-dimensional images and interference fringe patterns. Holographic Nondestructive Testing (HNDT) can quickly, accurately, and reliably detect anomalies in aerospace-type structure. In particular, it may be utilized in the detection of internal defects in all types of high-temperature sandwich structures and adhesively bonded sandwich structures.

The Columbus Division of North American Rockwell established a Contamination Control Committee in 1958 to deal with contamination problems in aircraft hydraulic fluids and systems. Through its efforts, methods of measuring fluid contaminants and establishing contamination limits were pioneered and a program for control was initiated. During the next three years, the rejection rate of fluid samples dropped dramatically — from 39 percent to eight percent. In 1962, a brochure was published on Hydraulic Fluid Contamination. Requests for copies have been received from all parts of the United States and from Great Britain.

Because the control program was so successful on aircraft, it was expanded to include the numerically controlled milling machines in the heavy machining department. Problems with servo valve failures soon disappeared.

In April, 1970, the Naval Air Systems Command selected the Columbus Division to implement the contamination control program at the Naval Air Station at Albany, Ga. The mission was to evaluate the potential of the program for service use, and to prepare a training film. The Navy is considering expanding this industry-developed control system to other shore stations and aircraft carriers.



A unique course which applied aerospace industry training techniques in nondestructive testing was conducted by the Convair Division of General Dynamics for Pacific Gas & Electric Company.

The course was taken by supervisors, engineers and inspectors employed by PG&E in activities involving quality assurance and related quality control work during the construction of power-generation facilities including the nuclear units at Diablo Canyon Site near San Luis Obispo, Calif.

The three-week course, one of a series conducted monthly by Convair for management and engineering personnel at all decision-making levels, is broadly based upon the applications and limitations of nondestructive testing. Upon completion of the instruction, the student has fulfilled the training requirements prescribed by the American Society of Nondestructive Testing for certification.

Students have been sent to the school by other aerospace manufacturing companies, airlines, and both civilian and military Government agencies.

INVESTMENT AND PAYOFF

This is only a sampling of the efforts constantly being made in aerospace manufacturing, in cooperation with the purchasers of its products, to ensure the highest possible degree of safety and reliability.

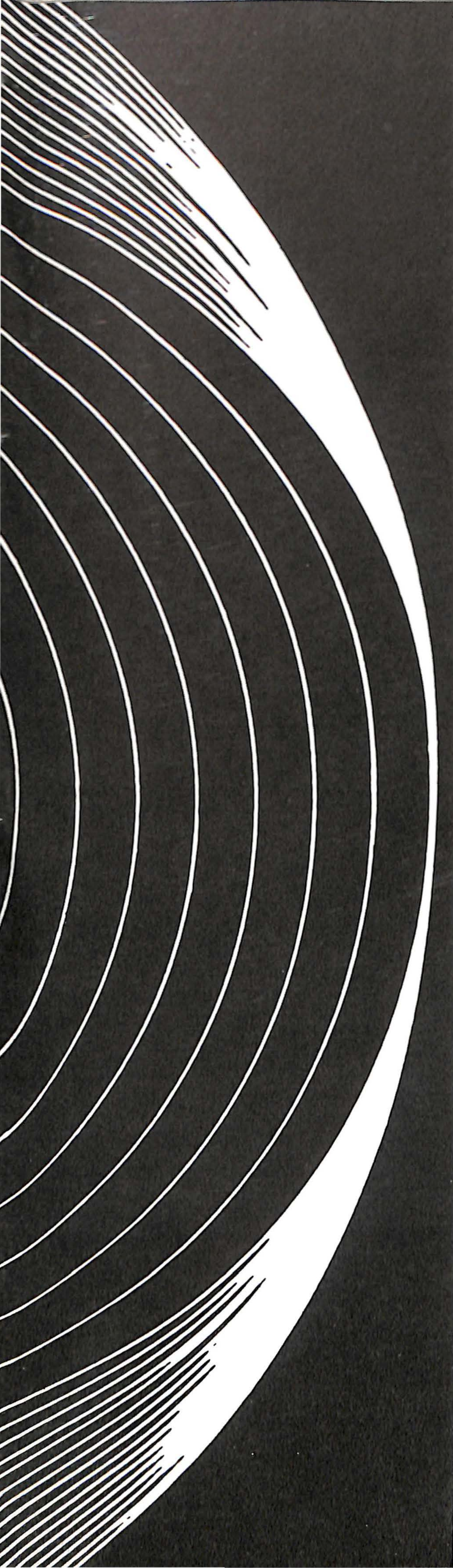
A significant statistic is that in the aerospace industry the quality effort — in manhours, as compared with the total manufacturing direct hours — is 23.5 percent — that is, virtually one employee in four is involved in maintaining and improving the quality of airframe, engines, spacecraft and other products. In the case of missiles and space, the percentage is a remarkable 45.8 percent!

Because for years the scheduled airliner has been by far the greatest mode of transportation for persons travelling more than short distances, the statistics that are of most importance have to do with the safety record of the airlines over the years.

From 1938 through 1971 — a span of 33 years — there were 201 airline accidents, resulting in a total of 4,212 fatalities. These occurred during the course of more than 1.3 trillion passenger miles traveled. In none of those 33 years was the safety factor lower than 99.99 percent (as noted earlier, in 1970 the factor was 99.999999 percent).

Thus, we enjoy an extremely high degree of safety in an airliner — thanks to the dedicated work of the many thousands of aerospace and airline employees whose careers are devoted to quality assurance.

The vast presence of this effort throughout the development and production of high-technology aerospace manufacturing is one of the less apparent reasons that aerospace products almost traditionally have carried relatively high pricetags. And the customer would have it no other way — he would not sacrifice quality assurance for cost cutting in the purchase of fighter aircraft for the armed forces, for aircraft for commercial transportation, or for satellites for high-quality, worldwide communications.



What The QUIET Is All About

In 1973 the scheduled world passenger traffic aboard commercial aircraft is expected to total nearly 400 billion (400,000,000,000) revenue passenger miles — about 'double what it was in 1968. That's 16 million trips around the earth.

By 1980 the revenue passenger miles flown in a single year are expected to double again to about 800 billion.

Unfortunately, this widespread acceptance of air transportation, together with the rapid population growth of our metropolitan areas, has combined to accent the congestion and noise associated with the movement of large numbers of people. Cities and their suburbs have expanded and airports that were in rural areas when first established inevitably have attracted communities of homes and businesses. Airports now too often are thought of as bad neighbors, and new airports, essential to our national welfare and mobility, often are opposed by local communities. Oddly enough, this opposition has developed concurrently with public recognition that the airport is a key factor in the economic viability of any progressive community.

This article looks briefly at what is being done to solve the problem of noise annoyance created by the industry that builds modern commercial aircraft, and by the industry that uses those aircraft.

HOW DID WE GET HERE?

A brief look at the history of commercial air transportation is warranted.

During World War II thousands of servicemen became acquainted with air travel, and after World War II air transportation expanded rapidly, utilizing those great piston-engine aircraft, the DC-3, DC-4, DC-6, DC-7, Boeing Stratocruiser, Lockheed Constellation and Convairliner.

Early in the 1950s, air transports had sufficient range to fly across the United States non-stop. By the mid-1950s non-stop transatlantic operation without restriction was available and more people were flying to Europe from the United States than were traveling by ship. Soon, however, technology advances were made in military gas turbine engines that caused a revolutionary change in commercial aircraft and triggered a phenomenal growth in air transportation.

The turbojet engine made significant

ncreases in speed possible by elimi-ating the speed limitation of the pro-eller and by providing larger amounts f thrust with lower engine weights han were possible with the piston ngine.

The significantly lower fuel con-umption of the J57 turbojet engine, leveloped for the B-52 bomber in the early 1950s, opened the door to jet-powered transports and the JT3C commercial engine version of this engine was qualified for commercial transport service in 1958. The era of commercial jet travel in the United States began in October 1958 when Pan American World Airways flew the Boeing 707 transport for the first time in commercial operation.

With the introduction of the turbojet powered aircraft into commercial service, the passenger capacity was more than doubled and cruise speeds were increased by approximately 200 miles per hour, cutting trip times for long distance travel in half.

In fact, today we can fly from the United States to Japan in the same time it took to fly across the United States in the piston-engine powered transports of the 1950s. By flying above most of the rough weather, the jet-powered transport offered a smoother, more comfortable ride than passengers had ever experienced.

The next significant advancement in engine technology was the introduction of the turbofan engine in the early 1960s. The turbofan's combination of light weight, reduced fuel consumption and increased thrust considerably reduced direct operating costs and increased the range of the jet transport to true intercontinental capability. The reduced operating costs permitted reduced fares and air travel became available to a larger segment of the population. Air transportation became the major means of long-range travel, and by 1968 more than 90% of the passenger traffic to Europe was by air.

By the mid-1960s it became obvious to the airlines that larger new equipment would be needed by the early 1970s if they were to continue to provide improved service to an increasing number of travelers. The first wide-body transport, the Boeing 747, was introduced into airline service in January 1970. It was powered by the JT9D engine, the first high bypass turbofan engine to enter commercial service. The new JT9D (Pratt & Whitney), CF6 (General Electric) and RB211 (Rolls Royce) engines provide more than twice the thrust and have approximately a 25% lower specific fuel consumption than the initial turbofan engines. The new transports that these engines power have doubled the passenger capacity of our previous transports and have provided a greater level of comfort with the introduction of the wide body, double aisle seating arrangement.

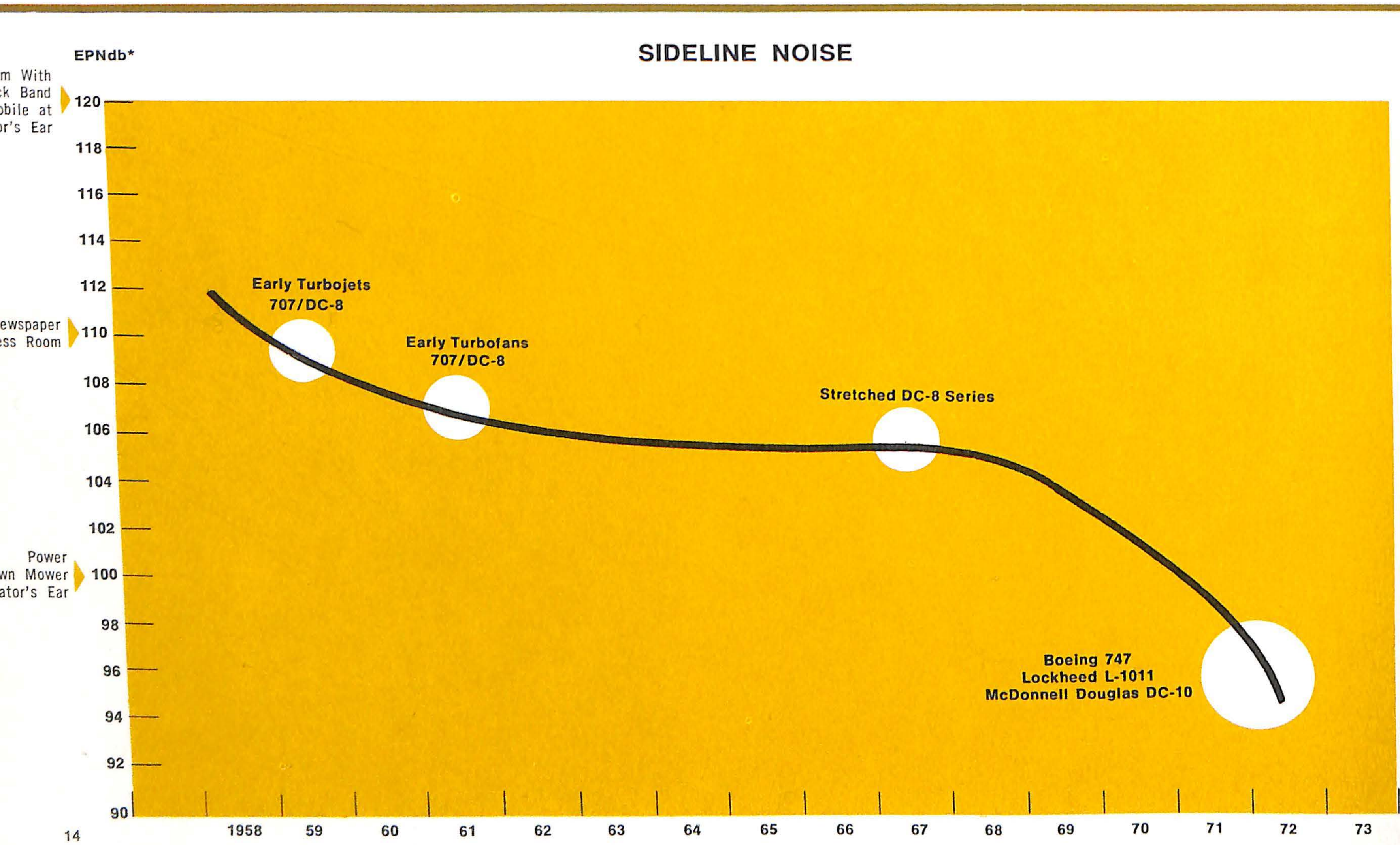
Today's passenger traffic in the United States is about 14 times greater than it was in 1950. But the fleet size has only doubled, indicating the large increase in fleet productivity that increases in speed and passenger capacity have brought about. Nevertheless, airport saturation at our major hubs of air traffic has become a serious problem and has necessitated restrictions on the number of arrivals and departures at some of the larger airports.

Our progress in mass air transportation has not been without problems other than airport congestion. Annoying noise is one of these.

NOISE IS UNWANTED SOUND

The young, freckle-faced lad who discovered what he could do to most of his first grade classmates by scraping his fingernails down the slate

LONG RANG



* Effective Perceived Noise decibels
Source: Air Transport Assn.

blackboard may have given most of us our first experience with noise pollution.

The dictionary records: *"NOISE (noiz) n. A sound of any kind, especially when loud, confused, indistinct, or disagreeable."*

In other words, sound is something we use in many ways, but when it is disagreeable it is an unwanted pollution.

The difference between acceptable and unacceptable sound varies with three characteristics: the frequency of the sound waves (pitch), the intensity (volume) and the duration.

A rooster crowing at dawn outside a bedroom window may be colorful and bearable. If he did the same thing all day long, however, he would wind up in a stew pot early during his second day. The same noise problem is inherent in the operation of motorcycles, power lawnmowers, snowmobiles, jackhammers, outboard motors and a host of other pieces of modern equipment that people apparently consider necessary or convenient.

The amazing progress that we have made in commercial air transportation has not been without some penalties. For several years there has been a growing public concern about the environment in which we live and about the impact of human beings and their activities on that environment—an environment which extends from the land and the seas to the outer edges of the life-sustaining atmosphere that surrounds this planet Earth.

This concern is good. And it is shared by the high-technology industries that must be counted on to support a constantly growing world population by using technology for the good of man, while at the same time finding the ways to eliminate adverse side effects.

WHAT IS THE PROBLEM?

It is the nature of a developing and evermore industrialized world that no matter where major airports are located they soon attract satellite communities of business firms and dwellings. Soon there are complaints about the noise generated by aircraft operations. A world accustomed to the noise of reciprocating engines in automobiles, trucks, tractors and older airplanes has not been completely willing to accept the higher and louder noise created by jet aircraft engines.

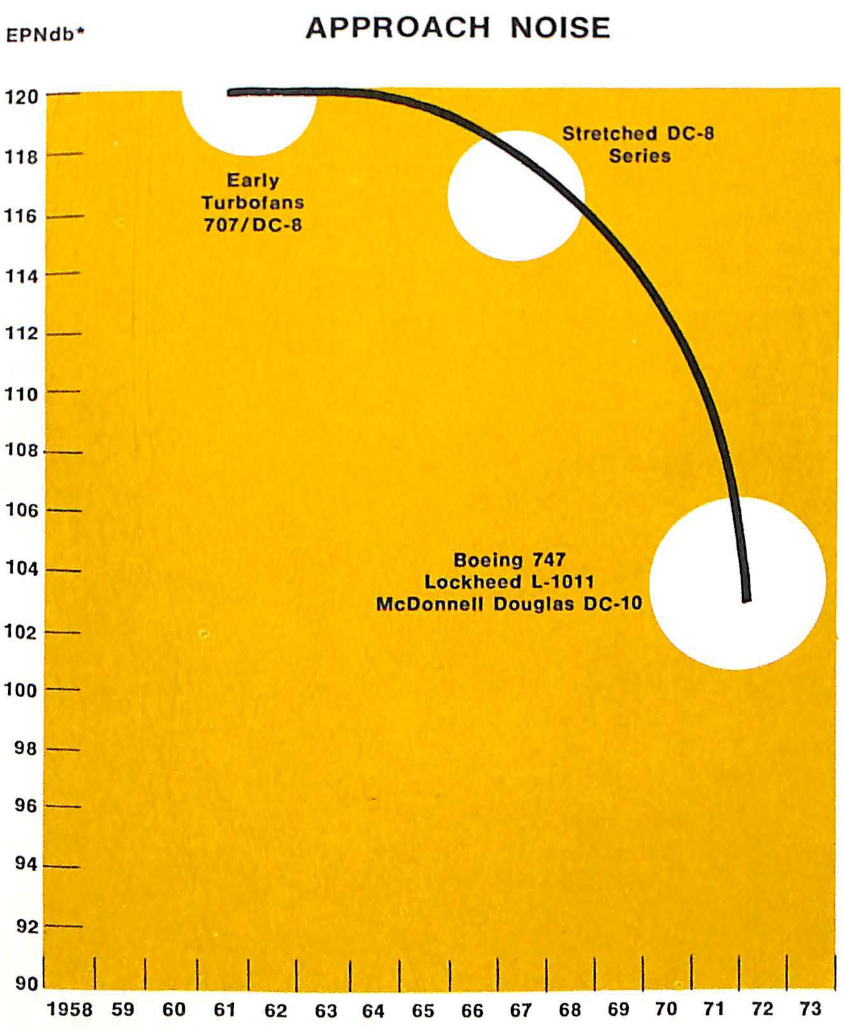
It is true that long-term exposure to high noise levels can have an adverse physiological effect on humans, to include some loss of hearing. However, the problem noise connected with aircraft operations is that of intermittent high-level turbine whine combined with deep-throated exhaust roar. Jet aircraft noise, because of the relatively short duration of each aircraft takeoff or landing operation, probably is more psychologically annoying than anything else. (People who work close to jet aircraft have sound-reducing earphones). Even so, the demand to reduce such noise must be met to the extent possible.

The noise problem incident to transport aircraft operations became more severe with the introduction of jet aircraft engines which produce sound of higher pitch and volume.

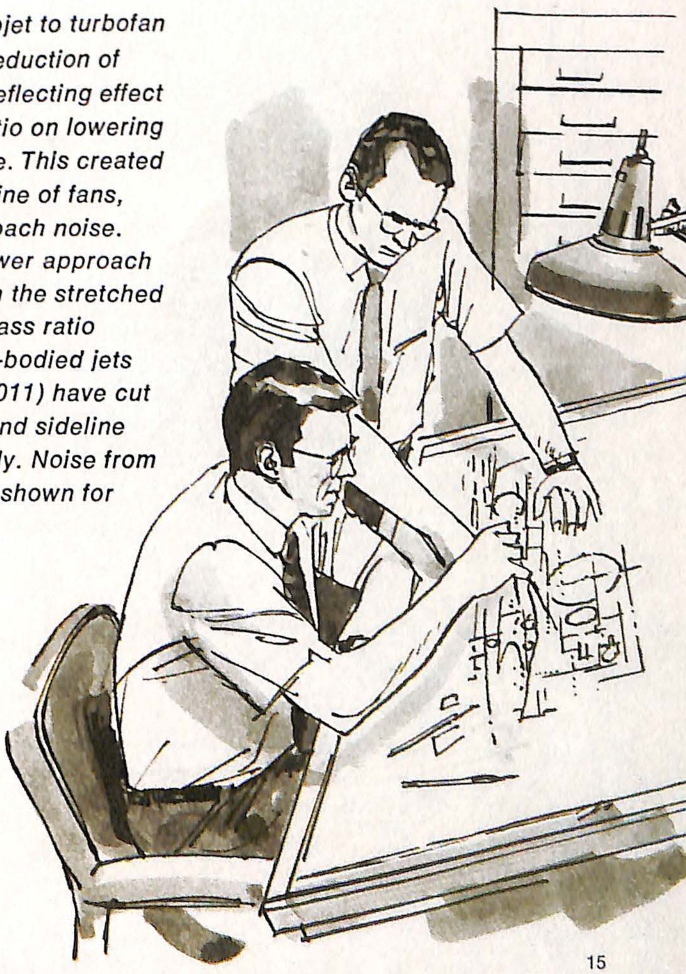
The noise of a jet engine comes largely from two sources — the jet exhaust and the interior whirling fan and turbomachinery. The jet engine exhaust creates a roar, particularly during takeoff when the high velocity exhaust mixes with surrounding undisturbed air outside and behind the engines.

The noise of the fan and the internal turbomachinery, on the other hand, is created internally and is projected for-

TRANSPORTS

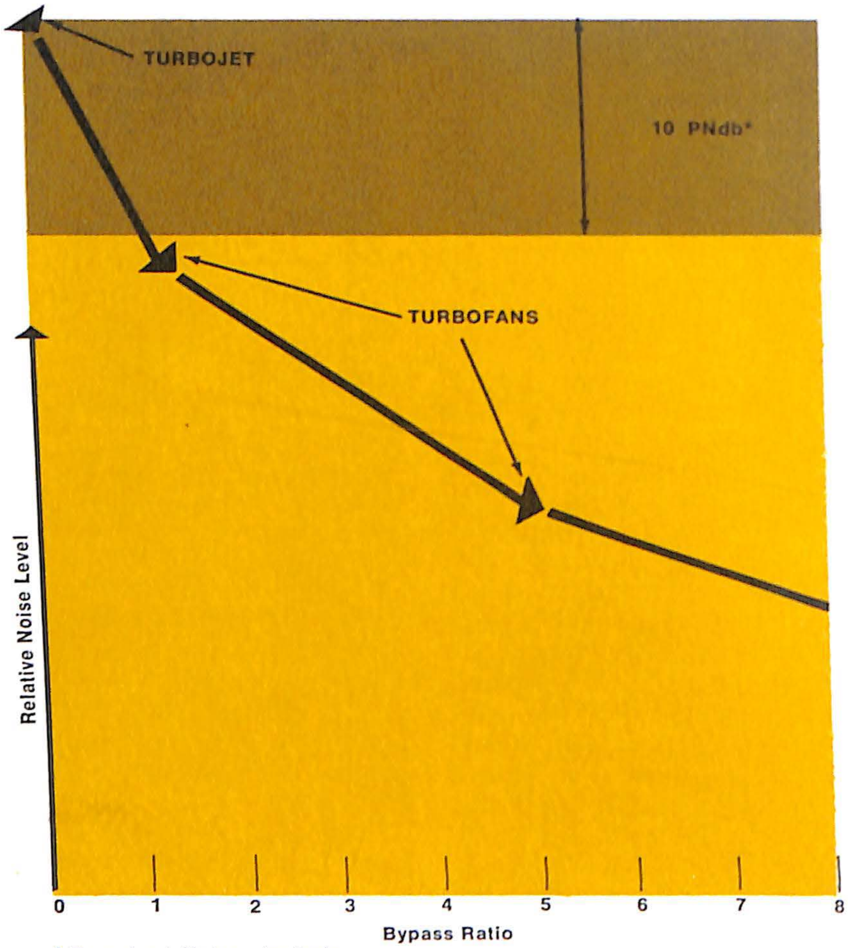


Move from turbojet to turbofan in 1961 began reduction of sideline noise, reflecting effect of 1:1 bypass ratio on lowering jet exhaust noise. This created high-pitched whine of fans, increasing approach noise. Trend toward lower approach noise began with the stretched DC-8s. High bypass ratio engines on wide-bodied jets (747, DC-10, L-1011) have cut both approach and sideline noise significantly. Noise from other sources is shown for comparison.



EFFECT OF BYPASS RATIO ON JET NOISE

Equal Take-Off Thrust



* Perceived Noise decibels
Source: Air Transport Assn.

Jet exhaust noise is reduced by using higher bypass ratio, shown here with engines of equal takeoff thrust. New wide-bodied jets carry twice as many passengers, with engines two and a half times as powerful, and bring significant reductions in noise because bypass ratio has been increased to 5:1. This compares to a ratio of 1.2:1 for the first generation of jet transports.

ward out of the air intake inlet and rearward out of the fan discharge ducts. This is the whine so characteristic of earlier model jet engines.

Approach noise reflects the predominance of noise generated in the engine and heard out in front. Sideline noise predominantly comes from the jet exhaust. Although the jet exhaust noise predominates on takeoff, it is difficult to measure because of the variability in operational procedures. Thus, sideline noise is a more accurate reflection of the trend in jet exhaust noise.

WHAT HAS BEEN DONE?

Much of the problem has been eliminated, and more is being done.

Industry, scientists and the Government needed a standard by which to measure noise, so they settled on "Effective Perceived Noise Decibels (EPNdB). (The "bel" recognizes Dr. Alexander Graham Bell.)

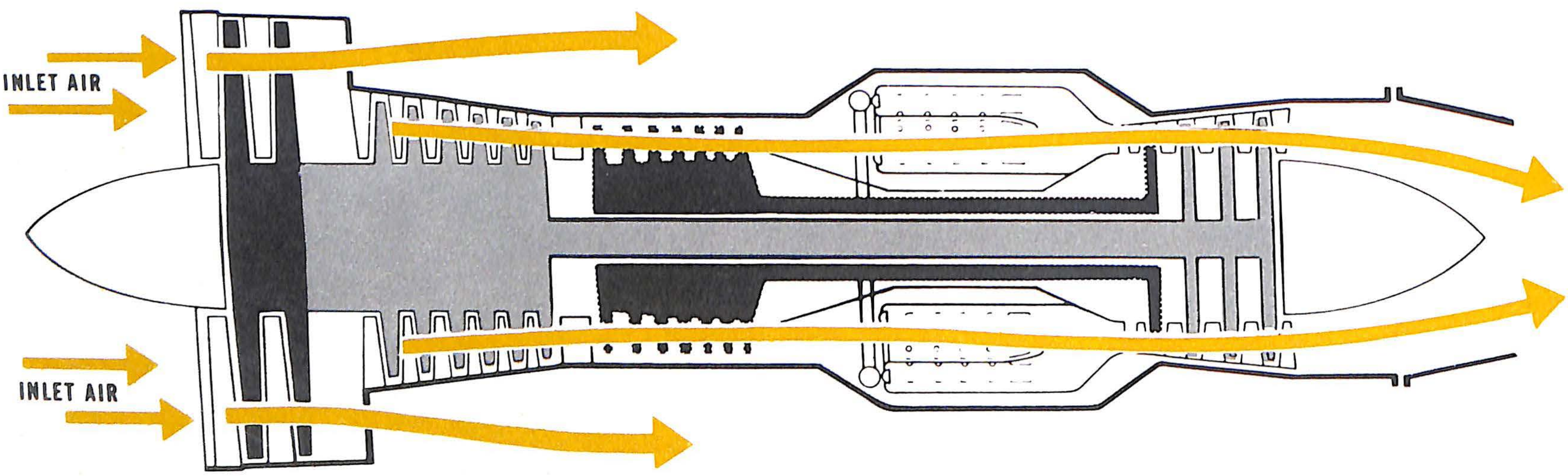
In the case of aircraft noise the Federal Aviation Administration has published Federal Aviation Regulation (FAR) Number 36, establishing certain maximum EPNdB ratings, varying with the type of aircraft being operated, measured from three different areas:

Takeoff: EPNdB measured 3.5 miles (about 21,000 feet) from the beginning of the takeoff roll.

Sideline: EPNdB measured one-quarter of a nautical mile (1,520 feet) from the side of the runway being used.

Approach: EPNdB measured one mile (about 6,000 feet) before the beginning of the runway.

Since the first turbojet engines were



A turbofan develops thrust in much the same manner as a turbojet except that a large portion of the air which is accelerated by the engine to produce thrust passes only through a "fan", attached to the forward end of the compressor. After being compressed by the fan, this air is released through the fan exit ducts, completely by-passing the burner and turbine sections, and generating propulsive thrust in the identical way that air passed through a conventional propeller does. In effect, the turbofan accelerates a relatively larger mass of air than the turbojet but to a relatively lower exit velocity. The results are improved propulsive efficiency, lower noise levels, and greater thrust for take-off and climb.

introduced, constant efforts on the part of NASA, the Department of Defense, the Federal Aviation Administration, the air transport industry and the aerospace industry have brought about major reductions in the noise created by commercial aircraft.

The move from pure turbojets to early turbofans began a trend toward reduced sideline noise, but noise from the fan and compressor raised approach noise. This trend was reversed with later versions of the engine powering the stretched DC-8 series in 1967.

Today the new wide-body jets use advanced technology engines that provide much more power (therefore more carrying capacity) and create much less noise. A key factor in this ability to increase power greatly while holding down or reducing noise is a design known as the "high bypass ratio" engine.

The bypass ratio is the ratio of air that bypasses the combustion process to the air that is compressed and burned with the fuel. In the new high-technology engines the flow of bypass air is five or more times greater than the flow of air through the combustion chambers. This bypass ratio of 5-to-1 compares with a ratio of about 1.2-to-1 in the engines that powered the first generation of commercial jet transports.

The primary result of the high bypass ratio design is a reduction of jet exhaust noise. This noise is caused by the interaction between high velocity jet exhaust gasses and the air surrounding them. The high velocity is the result of air being compressed, then fed into the combustion chamber and burned, followed by a rapid expansion and exhaust at high velocities.

Increasing thrust by using a higher bypass ratio (more air around the engine than through it) avoids increasing the jet exhaust gas velocity, and the noise that it creates.

The economic advantage, of course, is that the modern jets, with their high bypass ratio engines, can carry two or three times as many passengers as the older jet aircraft. This means that the airlines can accommodate great increases in traffic without having to increase their costs of equipment and operations significantly. The Boeing 747, for example, usually is substituted for two Boeing 707 aircraft, thus eliminating one flight operation. This increase in productivity will be more important as air travel continues to grow in the future.

Another form of noise reduction that comes with the new wide-body jets — the 747, DC-10, L-1011 — is a lowering of the high-pitched whine of the fan blades and the internal turbomachinery. The new engines have virtually eliminated the highly objectionable turbine whine by design changes in the front part of the engine. Also, the amount of noise has been reduced by extensive soundproofing of both the engine and the nacelle into which it fits on the airplane.

Just how far the wide-body jets have brought noise reduction can be seen by studying the accompanying charts which show the history of noise by aircraft type. These charts show sound values as corrected for tone and duration of tone.

When the early 747s entered service they represented a significant reduction in both approach and sideline noise. Refinements developed since the design and production began were incorporated in later model 747s beginning with December 1971 deliveries. This accounted for an even greater reduction in noise.

For the three-engine wide-body jets the picture is equally impressive. The DC-10 and the L-1011 are the first aircraft designed from the beginning to meet FAR Part 36 limits which were established in November of 1969.

It appears now that the next generation of intermediate and long-range aircraft probably will be designed for high subsonic or possibly near sonic speeds, unless the supersonic Concorde and TU-144 receive wide acceptance after they enter service. The next generation of advanced technology engines already is here in the form of the JT9D, CF6 and RB211 which are in the 40,000-pound thrust class, with a growth potential to more than 50,000 pounds of thrust.

Using existing technology, the JT9D engine in the B-747, the CF6 engine in the DC-10 and the RB211 engine in the L-1011 have met the reduced noise limits established by the FAR 36 noise regulation. However, as we establish the requirements for future engines it is clear that our goal must be even more reduction in noise and engine emissions without sacrificing performance and economic characteristics.

Low noise is a dominant factor in establishing the design characteristics of all new engines, particularly for Short Takeoff and Landing (STOL) and higher-speed transports.

Noise levels can be reduced even more. The challenge to the engine designer is to provide these reductions with minimum safety, cost, performance and weight penalties.

Considering what industry has accomplished during the last 15 years in meeting the challenge to increase productivity, (capacity, safety, economy, comfort and speed), while at the same time reducing noise dramatically, there is no reason to doubt that these two trends can be continued.

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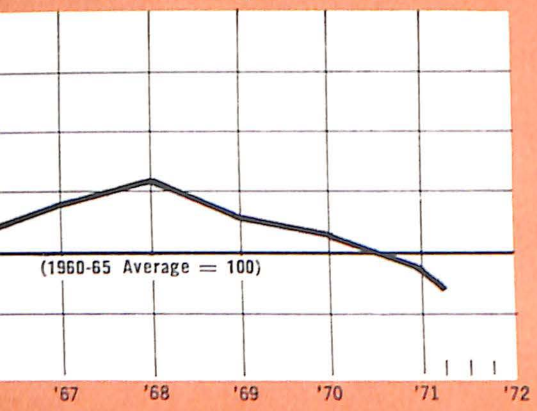
Serving Mankind —

EYES IN THE SKY

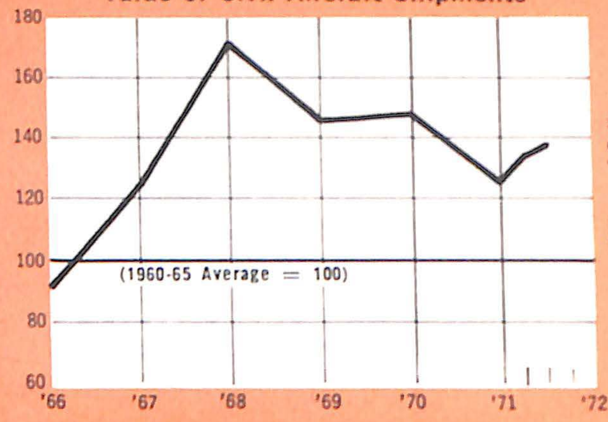
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

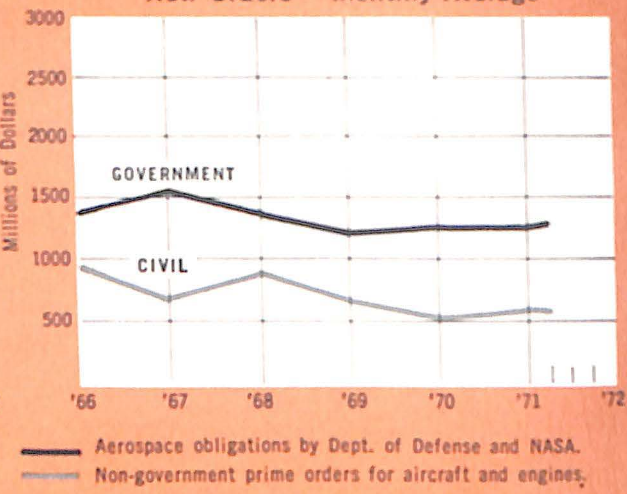


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $ Billion $	Annual Rate Quarterly	23.5 5.9	1st Quarter 1972	24.4 5.4	21.6 5.2	21.0 4.8
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	Mar. 1972	1,148	1,346	1,410
Aircraft	Million $	Monthly	733	Mar. 1972	778	836	823
Missiles & Space	Million $	Monthly	507	Mar. 1972	370	510	587
Aerospace outlays: Total	Million $	Monthly	1,147	Mar. 1972	1,104	1,156	1,299
Aircraft	Million $	Monthly	665	Mar. 1972	669	683	825
Missiles & Space	Million $	Monthly	482	Mar. 1972	435	473	474
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	July 1972	2,254	2,067	1,636
Aircraft	Million $	Monthly	631	July 1972	796	1,586	955
Missiles & Space	Million $	Monthly	426	July 1972	506	481	681
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	Aug. 1972	177	263	254
Expenditures	Million $	Monthly	277	Aug. 1972	242	221	228
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	22,719	1st Quarter 1972	24,489	23,935	23,952
U.S. Government	Billion $	Quarterly	13,588		12,972	13,347	13,661
Nongovernment	Billion $	Quarterly	9,131		11,517	10,588	10,291
EXPORTS							
Total (Including military)	Million $	Monthly	204	July 1972	249	290	301
New Commercial Transports	Million $	Monthly	59	July 1972	47	78	40
PROFITS (After Taxes)				2nd Quarter 1972			
Aerospace — Based on Sales	Percent	Quarterly	2.6		1.9	2.1	2.9
All Manufacturing — Based on Sales	Percent	Quarterly	4.9		4.5	4.0	4.5
EMPLOYMENT: Total	Thousands	Monthly	1,286	July 1972	946	924	925
Aircraft	Thousands	Monthly	699	July 1972	521	503	503
Missiles & Space	Thousands	Monthly	144	July 1972	90	92	93
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	July 1972	4.32	4.62	4.59

R Revised
* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

On a Clear Day You Can See Forever

— from a popular song

By Karl G. Harr, Jr.
President, Aerospace Industries Association

A new thing has happened. Like many truly new things, it has nearly escaped notice.

On July 23, 1972, a McDonnell Douglas Delta launch vehicle arose from Vandenberg Air Force Base, California, and took into an Earth orbit of just under 570 miles a satellite named ERTS-1 (Earth Resources Technology Satellite-1). It was built by General Electric in a variation of its highly successful Nimbus weather satellite. Aboard this spacecraft are a variety of subsystems, most prominently including cameras and other sensors developed and delivered by Hughes and RCA, with the assistance of many subcontractors and suppliers.

Just what this event means to *all* of us (emphasis added) is spelled out elsewhere in this issue of *Aerospace.*

As mentioned in the article, the British scientist Dr. Fred Hoyle believes that a major turn in human history occurred when we saw our first photographs — manned and unmanned — of Planet Earth taken from deep space.

Hoyle's notion, difficult to contradict, is that this event crystallized our awareness of our planetary fragility, the limitations of our resources and the imperative necessity of learning exactly where we stand and how we should proceed.

This we have now begun to do. We are enabled to do it because we have developed, within little more than a decade, a technology previously unimagined. We can see with precision what resources we have — what waste we have worked, and what exists that we have until now been unaware of.

ERTS-1 is to be followed next year by a second in the series. This comparatively low-cost space project — coupled with NASA programs such as Skylab and the Space Shuttle — will demonstrate that the space effort has been and continues to be one of America's best investments.

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FRONT COVER: This ERTS color composite photo, taken from an altitude of 569 miles, shows (upper right) a forest fire burning in Alaska, approximately 200 miles northwest of Fairbanks. Another fire burns in upper left. Lower part of the photo is cloud cover. Color plates courtesy of *American Forests* Magazine.

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel. and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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