NEEDED: 50,000 FIRMS TO BUILD AIRCRAFT

Computer ‘Flies’ Jet Engines

U. S. aircraft industry ingenuity has now come up with a new cost saving, time-savings device—a giant computing machine that can save up to two years and several million dollars in the development of advanced-design jet engines.

One of the largest ever built, this unique analog computer will enable engineers to "fly" jet engines before they are built and to forecast performance characteristics of control systems for jet engines that are still on the drawing boards.

The computer will become the "brain" for a jet engine simulator that will reduce costly wind-tunnel testing and cut down the time and cost of flight-testing.

"Flying" the computer, an engineer can become a "test pilot" and in a matter of a few hours can see how his blueprint engine reacts to such conditions as giving it the throttle at 20,000 feet altitude, 40 degrees below zero air temperature and at a speed of 1,250 miles an hour.

Previously it was not possible to check out a pre-production engine control system on a sufficiently large number of engines of one type. In many instances, the engine is either not available and its expected performance data is lacking, or, if an experimental prototype of the engine is available, engineers have been unwilling to risk the expensive prototype in grueling tests.

Checking out an experimental engine control system normally takes up to six months and costs several million dollars. It is a job time that is in a wind-tunnel and flight test phases.

The machine works this way:

Engineers study the specific problem at hand and reduce it to mathematical form. Then they convert it into equations. The computer works out these equations electrically and electronically. With the answer in the equations, the machine can take an air molecule to pass through an actual engine.

The computer, which took six years to build and 35 by 100 feet, covers 12,635 feet high. It covers a floor area of 2,635 square feet. The machine has 40 tons of air conditioning, equivalent to air conditioning 15 average-sized homes.

Industry Sets Up Aid Program

By George Hannum

Director of Industry Planning Service
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This is the age of specialization in the world of industrial organization just as it is in the fields of science and medicine. The ever-increasing productivity of American industry is due in large part to the system of supply which utilizes the specialized skills and facilities of the entire industrial community. It is the nerve system that permits industry to fully use all of America's muscles of production.

This same law of efficient quantity production also governs the production of aircraft, guided missiles and their thousands of complex components. The aircraft industry uses the manufacturing skills of more than 50,000 subcontractors and suppliers. In size these suppliers range from a small shop with two or three employees to the largest automobile manufacturing concerns. More than 90 per cent of these outside suppliers are classified as small business, since they employ less than 500 people. Furthermore, most of these small, medium and large subcontractors and suppliers must call upon other members of the industrial community to help them perform their portion of the job.

Thus, a prime contract for the production of aircraft and aeronautical equipment is cut up into perhaps more than 100,000 separate pieces and scattered throughout the entire industrial structure of this country. This chain reaction effect from the prime contractor down through the many tiers of subcontractors and suppliers divides the jobs to be done among those companies which have proven ability to meet both quality and cost yardsticks.

Revolutionary Chemical Etching Process ‘Mills’ Intricate Steel, Titanium Aircraft Parts

A revolutionary process of precision milling of steel and titanium by chemical etching has been developed by the aircraft industry in its constant efforts to cut costs and improve production methods.

The process removes unwanted metal from complex, fragile formed parts or simple parts without warpage or rejection that might result from machining. Aluminum alloy parts have been subjected to the chemical etching process in the past. However, the need for higher strength, more heat resistant materials in modern aircraft and missiles accelerated the development of a process to etch steel and titanium, and a pilot plant is now in operation.

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Aircraft engines are no longer limited in their design ideas to what is possible through conventional machining. There is considerable time saved in the process since many parts can be etched simultaneously. The only limiting factor is the size of the tanks containing the chemicals. The cost of removing the aluminum alloy by this process is only one-quarter that of a comparable machine tool operation.

The process essentially consists of etching the area of a part to be "milled" bare and covering the remaining area with a protective coating. The part is then placed into a caustic bath so that the unnecessary metal can be etched away. It permits making broad or narrow cuts with sharp corners and close tolerance tapering.

The pilot plant now being used for steel and titanium parts proves that the chemical facility occupies less space than those used by the equivalent in machine tools.
The Limitless Vista

Graduates of our universities and colleges who this month received their degrees in engineering or science have before them the limitless vista of man's progress through technological gains. It is an inspiring scene. Recent breakthroughs in scientific knowledge have brought us to the brink of an understanding of the very laws of nature — the composition of matter — so the scientists say.

This new crop of young scientists and engineers, spurred by the progress already made, are ready to assume key roles in a future that will pale even the imaginary world of science fiction.

There is only one barrier to the discoveries that will make a fuller life for all the world's people: lack of numbers in trained manpower. That alone will be the stumbling block to the problems that limit us.

There is strong evidence that the American public is becoming more and more aware of the need for engineers and scientists to unlock new doors of knowledge. A recent public opinion survey conducted by the Aircraft Industries Association reported this consciousness of the necessity of urging our youth to take up these exciting careers. The public was asked: "In view of the shortages of engineers and scientists, should algebra and geometry (the doorways to higher mathematics) be required high school subjects for all boys?" The replies: 77 per cent said "yes," only 12 per cent said "no," and the balance had no opinion.

This attitude is encouraging, particularly in view of the fact that as recently as 1949, the Department of Labor, in its Employment Outlook for Engineers, made this doleful prediction: "In the next few years, the number of graduates will greatly exceed the demand for graduate engineers. . . . Schools could admit even fewer students and still provide an adequate supply of engineering personnel.

It would be impossible to assess the harm caused by the statement, which spread through the nation's schools and colleges. The prediction could not have been more inaccurate. Last year, there were 70,000 job opportunities for the 22,000 engineering graduates. And there is no indication that the demand has reached a stable plateau.

The initial responsibility for encouraging youth to take up engineering and science careers is as intimate and close as the family itself. Parents who would have their children a good start, today's society makes an increasing contribution to the problems that limit us.

The aircraft industry offers one of the most challenging futures, with its ever-widening fields of engineering and science. The challenge of developing the aircraft and missiles of the future embraces nearly every form of science and engineering. The aircraft industry represents a marriage of the highest skills and talents in these fields.

The engineer in the aircraft industry has come of age. He is no longer bound by the old and disproven idea that an engineer can only be an engineer. In today's involved technology, it takes a background of engineering and science to make the managerial decisions in a company. More and more persons with engineering backgrounds are becoming key figures in the administration teams that are the backbone of our aircraft companies.

In aviation there are no horizons. The long-feared sonic barrier has been left far behind. Mach 2 (twice the speed of sound) has been passed, and new multiples are being set up for future travel. Atomic power, which will allow aircraft to circle the globe without landing, is in early prospect. In the ultimate future, man may make his first venture into outer space with an earth satellite. The intercontinental ballistic missile soon will appear. Researches into the thermal barrier (the terrific heats created by multiples of the speed of sound) are in immediate prospect. There is even a serious project to explore anti-gravitation — a plan to use the power of the pull of gravity. All of these are definite aircraft industry targets.

The drama and adventure in these scientific developments provide a solid basis for your job. General Thomas S. Power, Commander of the Air Research and Development Command, recently stated the case with wisdom and wit: "Like the Soviets, we must stimulate the desire for scientific careers in our youth, and we must erase from their minds the pathetic picture of the important dreamer whose only rewards for accomplishment are the plaudits of other dreamers. Instead, we must create the picture of the so-called 'Davy Crockett' of science, the modern pioneer fighting on the frontier of human knowledge." Tomorrow belongs to these frontiersmen.
Subcontracting Gives Mobilization Base Depth for Emergencies

(Continued from page 1)

industry, unlike those engaged in production for the commercial market, supply standard off-the-shelf items. Many of these complex components and parts have been specially designed by either the prime contractor or the subcontractor. Units are designed for functional output and limited installation space which further complicates the design of the equipment. In this area the same time as the airframe, and like the airframe it has a “bug,” which must be found and corrected before the whole article can be delivered in acceptable form.

Often, for mobilization purposes, the extent of subcontracting in the aircraft industry goes beyond the point where it would normally be considered economically feasible. It must be remembered that with highly technical advances, such as we are now making, some complexities both in management and product design which make it more and more difficult to achieve, in the case of a national emergency, from the production of automobiles to airplanes; TV sets to bombsights; or typewriters to fire control mechanisms. It can be done, but not overnight. It is this system of outside suppliers, with its roots going deep into the industrial structure of the nation, that gives the mobilization base its production strength. A government mobilization base scatters the target for enemy bombers, but a mobilization base in depth provides the ability to accelerate production rapidly in an emergency.

These circumstances require not only more careful consideration in the selection of a subcontractor and supplier, but a much closer liaison between the prime contractor and the subcontractor during performance.

The overriding factor in the selection of a subcontractor or supplier is the maintenance of high standards of quality, on-time delivery, and economy. To insure that these requirements are met, subcontractors and suppliers are carefully screened on these major factors:

1. Stability of manpower and level of technical know-how available.
2. Availability of suitable facilities and manufacturing space.
3. Ability to meet specifications and quality requirements.
4. Past performance, including economy of operation and reliability.
5. Financial responsibility and business reputation.

Once a contractor has signed a subcontract agreement, the prime contractor’s responsibilities have only begun. The prime contractor, or higher tier subcontractor, is responsible for the performance and workmanship of the complete aircraft or missile, regardless of who manufactures the components. In the case of a single source supply of a particular component, the entire success of a prime contract rests squarely on the subcontractor’s performance.

Prime contractors and many of the larger subcontractors, therefore, have established an extensive program to assist the subcontractor and improve proper performance of the contract. The program includes these features:

1. Field teams provide constant liaison with suppliers on problems concerning performance, drawings, quality control, blueprints, interpretation, materials handling, coordinating essential materials, coordinating engineering changes and inspection.
2. The contractor’s management organization is made available to assist the subcontractor. Key people visit the subcontractor’s plant, and in some cases, representatives are assigned on a semi-permanent basis to work with the subcontractor.
3. Varied techniques are used to bring subcontractors and suppliers into the prime contractor’s family. Subcontractor representatives are invited to attend symposia organized by the prime on tooling, quality control, material conservation, manufacturing, and similar matters. Specialists in each field provide them with the latest information to help solve their problems. These meetings are a two-way street; the prime is also able to learn from the subcontractor.
4. The prime contractor also periodically reviews the subcontractor’s performance and progress. Analysis of supplier production control data provides warning of slowdowns in deliveries. When this occurs, task forces are assigned to assist in finding solutions before the time delay becomes critical enough to delay production.

Despite the necessity for subcontracting for economic reasons, as well as for mobilization purposes, the Air Force recently spent considerable sums by Congress to expand subcontracting and outside purchases, particularly among small businesses. The prime contractor is often penalized financially for expanding subcontracting activities. The rate of earnings that he is permitted to retain by the Air Force Board on this portion of his total sales volume is considerably lower than the profits he may retain on the manufacturing development portion of an operation. Generally, the same will hold true with the military insofar as the negotiation of profit rates is concerned.

There is no question that subcontracting must continue at a high rate. But the incentive to do subcontracting should be built in, the penalty removed to give the aircraft industry the fullest possible freedom in furthering the program.

Aircraft engines must be able to operate in all kinds of weather. And the aircraft industry has devised some amazing tests to prove their ruggedness and reliability.

For example, a turboprop engine was recently put through a series of tests that demonstrated its ability to operate in ice and hail. The engine was set up on a rigid test stand and operated at 13,838 revolutions per minute without its propeller. Spheres of ice ranging in size from a half inch to three inches in diameter were prepared, weighing nearly a half pound each at the maximum. The spheres were stored at zero temperature until shortly before use and then were warmed slowly to 25 to 30 degrees for maximum toughness.

A special gun was devised which fired them into the compressor inlet at speeds up to 425 miles per hour. The rig was tested with a two-inch rubber ball which penetrated a sheet of plywood, three-quarters of an inch thick.

The tests started by firing small ice pellets at 200 miles per hour and worked up to firing one-and-a-half-inch ice balls directly into the air inlet at 425 miles per hour. Sals of four one-inch balls peppered the inlet guide vanes.

High speed movies at 6,000 frames per second showed the ice balls striking the inlet guide vanes and the fragments passing into the compressor. The vanes oscillated as much as a quarter of an inch for a fraction of a second under the impact. The only discernible damage was a dent in the leading edge of one vane and two other vanes were slightly bowed.

In another test, an air inlet duct from a military turboprop aircraft was installed on the engine, and ice balls up to three inches in diameter were fired into the duct while the engine spun at 13,838 revolutions per minute. Multiple salvos of 30 ice balls of various sizes totalling two pounds per minute were fired.

The tests clearly proved that even under these simulated hail conditions, which exceeded those encountered in actual flight, the engines would continue to operate.

As an additional backstop, modern turboprop aircraft will use storm detecting radar which will keep the aircraft clear of such areas in the first place.

Radioactive Material Aids Safety Drive

A radioactive material has been turned into a safety agent by the aircraft industry.

One knotty problem in aircraft production is insuring the removal of rivet bucking bars and other small tools from the aircraft and component sub-assemblies prior to flight.

The aircraft industry, after lengthy study and testing, developed a method of imbedding a small amount of radioactive material—Cesium 137—in the body of each tool. The tool is absolutely safe to handle, but gives off sufficient radiation that can be detected by scintillation counters.

Many methods of tool recovery were tested before this system was adopted. The gamma rays given off by Cesium 137 are energetic enough so that minor obstructions between the source and the detector do not seriously limit detectability. No adverse change in radiation output occurs during the average life of the tool.
Water Triggers Life Jacket

A new life saving device that automatically inflates a pilot's "Mae West" life jacket upon contact with water has been perfected by one of the nation's large aircraft companies. The automatic life jacket inflator compares in importance with such standard safety features as the automatic lap belt and automatic parachute release.

The entire automatic inflator assembly weighs five ounces, and will inflate a life jacket within 15 seconds after immersion in water. Formerly, pilots falling unconscious into the water usually drowned because the inflator was not automatic.

The new device consists of a cap, a piston, a spring-loaded plunger, a soft rubber flapper valve and an effervescent pill (60 per cent tartric acid and 40 per cent sodium bicarbonate) that is about the size of an Alka Seltzer tablet.

The automatic inflator does not interfere with the normal manual operation. As the pilot drops into the ocean, water rushes through an opening in one end of the metal cap, forcing open the rubber flapper valve. The water passes through the valve and strikes the surface of the tablet causing it to dissolve and produce a cloud of gas. The gas pushes the flapper valve back into place at one end of the small chamber and forces down the piston at the other end. This in turn releases the spring-loaded plunger, which strikes the manual operating lever with the force of a hard yank by a man, fires the cartridge and thus inflates the jacket.

The device cannot be set off accidentally by rainfall, heavy dew or accumulated moisture, such as might be encountered by military pilots under field conditions, because the flapper valve holds the opening closed until it is forced open by the pressure of a body of water on the outside.

Precision Gages Set Industry Standards

Precision is the hallmark of the aircraft industry and the gage is accuracy's final authority.

One aircraft engine manufacturer uses more than 47,000 precision measuring instruments. It is unusual to find tolerances of parts, such as certain ball bearings, held to 50-millions of an inch — less than 1/4 the thickness of a human hair. One gage is capable of taking 18 different measurements at the same time.

The necessity for these critical tolerances is due to the great gains made by aircraft engine manufacturers in the horsepower-to-engine weight ratio. At the end of World War I, an aircraft engine developed one horsepower for each two-and-a-quarter pounds of weight. At the end of World War II, the weight was down to one pound per horsepower under combat conditions.

Today a modern jet engine delivers the equivalent of six horsepower for each pound of weight. Only by quality, which is based on strict precision, can this be achieved — and the gage sets the standard.

Jet Ground Noise Drastically Reduced By New Attachment

Another important advance in jet engine noise suppression has been made by the aircraft industry.

A new noise control attachment will drastically cut the jet exhaust sound, thereby permitting mechanisms to work in a more comfortable environment. By substantially reducing the noise in areas immediately behind the exhaust during ground runs, the device is a perforated sheet metal cylinder around which are wrapped three conical shrouds. It is about six feet long, two feet in diameter and weighs 150 pounds. It is equipped with a simple clamp which permits easy attachment to the engine tailpipe.

The device was dramatically demonstrated during a recent field test in the engine of a long-range jet bomber. The engine was started and, after idling it for a few minutes, its power was increased to where it would be cruising more than 10,000 pounds thrust. At this time a test was completed, one of the spectators standing about 100 feet away inquired as to when they were going to start running the engine and was told it was a noise control device not a tester in the strict sense of the word. It controls the turbulent flow so that what noise is produced is of such a high frequency it is not audible to the human ear.

The aircraft industry has developed an electronic "crew member" for jet bombers that is able to navigate the aircraft, sight the target and release a bomb or monomoteur a task too delicate and complex for humans. The bomb run of a modern jet starts 32 miles from the runway, and at 40,000 feet the bomb is released around five miles ahead of the impact point.

Altitude Simulator Hits New High

Capable of simulating altitudes which at the present time can be reached only by jet-powered aircraft, a new mammoth laboratory facility recently installed in Phoenix, Arizona, by General Electric Co. to help the U.S. aircraft industry's continual drive for better, faster, more efficiently produced aircraft.

Illustrative of the vast sums being invested by the industry in research and development projects, this privately financed $5 million production test facility makes it now possible to test, research and develop, at a record rate, hundreds of aircraft components and accessory systems. These are a major part of the vast and complex auxiliary systems required by today's and tomorrow's ultra-modern jet aircraft.

An intricate compressed air system in the test facility requires hundreds of miles of piping to channel off air at different pressures and temperatures to all parts of the test facility for mass production testing purposes. Vacuum pumps used in operating the compressor system are 4500 times more powerful than a household vacuum sweeper.

Products which can be mass production tested at the new test facility are gas turbine engines, aircraft turbines, and the new jet engines as turbine engines, air turbine starters, pneumatic controls, cabin pressure regulators, hot and cold air valves, refrigeration turbines, heat transfer equipment, as well as complete systems employing these components.

Vital pressurization and cooling equipment for ever higher flying aircraft are put to extreme testing in the new facility's giant altitude and cold chambers. Measuring 15 feet in diameter and 32 feet long, atmospheric conditions from more than 1000 feet below sea level to more than 75,000 feet above sea level may be created in the cabin atmosphere altitude chambers. Here any type of aeronautical project may be tested.

Banks of air turbines outside the chamber control its atmosphere. It can climb from sea level to 70,000 feet in one minute. Temperature ranges from -75 degrees Fahrenheit to 900 degrees Fahrenheit—and an extreme low of -125 degrees Fahrenheit can be reached.