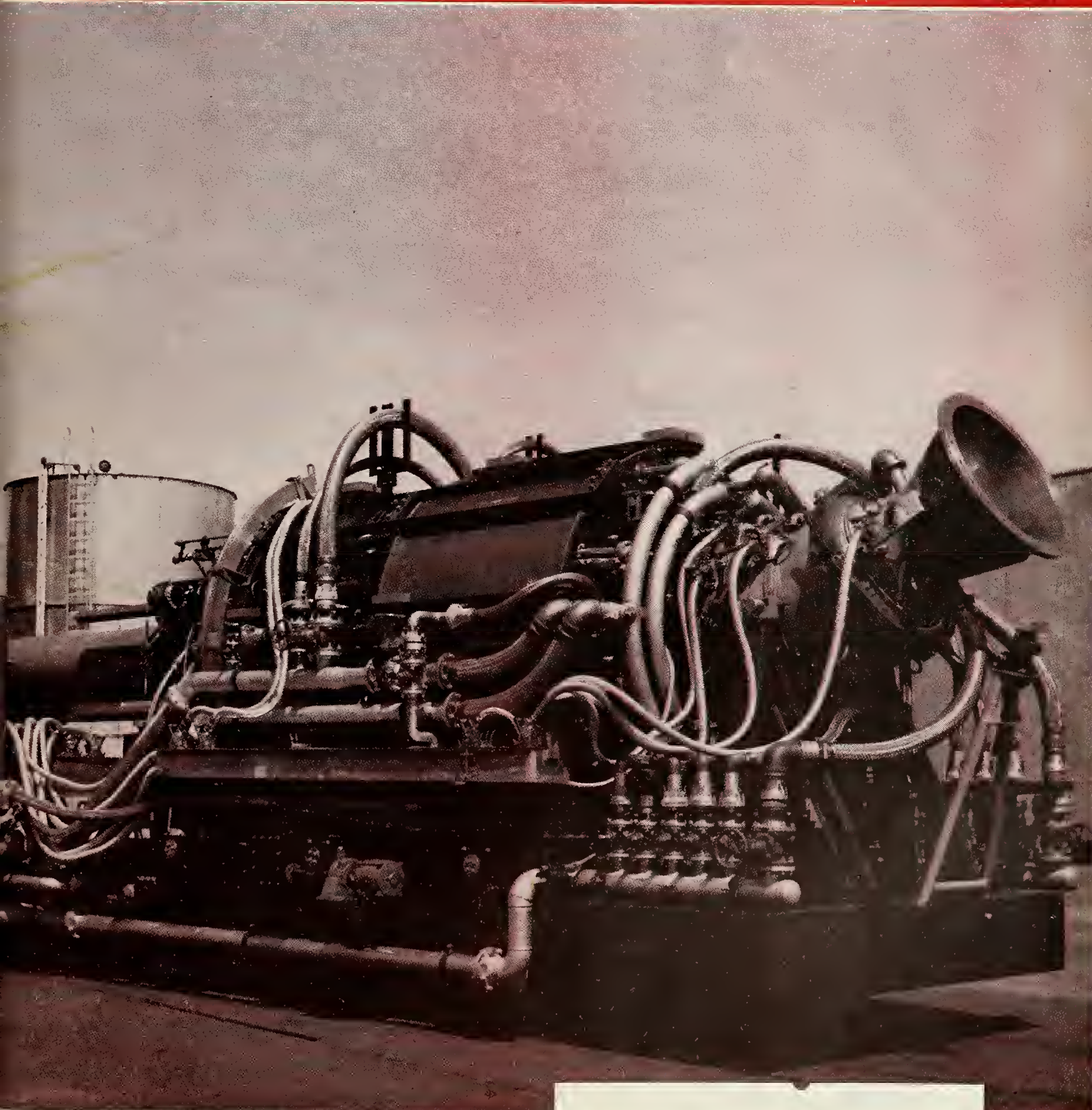
AUGUST 8, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



AEC's Tory IIA Nuclear Ramjet

Special Report

Industry Guide to NASA's Next 10 Years . . . 17

AN AMERICAN AVIATION PUBLICATION

THE MISSILE/SPACE WEEKLY

missiles and rockets

August 8, 1960 Volume 7, No. 6

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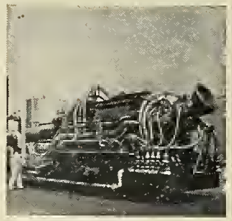
THE COVER



Tory IIA is an experimental reactor in joint AEC-AF Pluto program to demonstrate feasibility of nuclear ramjet propulsion. Static test is due this year in Nevada.

AUGUST 8 HEADLINES

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ASTRONAUTICS ENGINEERING

GROUND SUPPORT EQUIPMENT

ASW ENGINEERING

DEPARTMENTS

30,218 copies this issue

The Countdown

WASHINGTON

Campaign Surprise

Administration officials are keeping mum, but COUNTDOWN hears Nixon forces may uncork a real surprise at the height of the campaign. The word is out that the Navy could—starting today—put five *Polaris* submarines on station within three weeks. Just the George Washington is scheduled to be ready in October. But the *Polaris* program has moved fast enough so that four more subs could be loaded up with 1200-mile missiles and sent to sea anytime if a real emergency developed. This would put 80 *Polaris* missiles around Russia.

New Army-AF Battle Brewing

The Tactical Air Command is understood to be reaching for authority to deploy 1000-mile range ballistic missiles—presumably developed by the AF. This range is a gap in the U.S. missile arsenal that the Army has been flirting with for years. There could be a collision if the Army tries to fill it with a souped-up *Pershing*.

Wings Return

AF officials are saying (perhaps wistfully) that if there are any additional interceptor requirements, they will revive the cancelled F-108 fighter—rather than place further orders of the *Bomarc B* missile. Although the airframe was stopped, work has continued on some of the F-108's instrumentation.

Luck o' the GOP

A whole series of space shots are due in October—right at a critical period in the presidential campaign. Republicans will be hoping they have better luck than during the week of the GOP convention. A half-dozen shots were scheduled at the Cape that week. Some were scrubbed, a *Titan J* was destroyed and an *Atlas-Mercury* blew up.

Fix for Discoverer

The AF thinks it finally has a fix on *Discoverer*. At any rate, the next shot in the series—*Discoverer XIII*—will be carrying special equipment that is expected to send back the best data yet on precisely what happens when a *Discoverer* tries to eject a capsule back to earth from orbit. Launching of the 13th is imminent.

New Slip for Transit

Transit—the Navy-ARPA navigation satellite—is slipping again. The next R&D shot won't come off until late October. The problem is said to be booster and pad scheduling at the Cape.

State Stays SNAP-1

Fear of international repercussions reportedly has prompted the State Department to insist upon a delay in flight-testing SNAP-1, which generates 3 watts from a Polonium-210 isotope. AEC, NASA and DOD are all agreed there is no hazard—but State considers it a hot potato.

INDUSTRY

Medaris to Lionel

Former AOMC Chief John B. Medaris is the new president of Lionel Corp. The toy train maker is branching out into defense electronics.

Personnel Problem

AF's non-profit Aerospace Corp. is reported to be wrestling with a top management organizational problem. As a result, recruiting of lower echelon personnel is about a month behind time. Still undecided whether he will go with the new company is STL's director of advanced systems planning, Al Donovan.

Firefly is Bottled

NASA has decided not to fund the flashing-light geodetic satellite, sometimes called *Firefly*. A review is underway on the program with DOD sitting in. NASA may release funds in the future if the study indicates the program is still warranted.

Shelter Prototype?

A by-product of the *Titan* base-building program may be civil defense shelters. Some congressional investigators are looking into the possibility of adapting to shelter construction the methods used to build the hard underground tunnels at *Titan* sites.

Contracts

The Army has signed a $30 million contract with Martin-Orlando for continued work on the *Pershing* solid-fueled missile. . . . Atlantic Research Corp. has a $130,000 award to aluminize the *Arcon* sounding rocket so that it will boost 40 lbs to 85 miles, against present 25 lbs to 70 miles.

INTERNATIONAL

Which Red Missile

Best speculation regarding Soviet Adm. Golovko's claim that Russia has several operational missiles aboard subs and surface ships is that he was referring to the *J-3* and *M-2* missiles. The 450-600 mile range *J-3* and the *M-2* have been sighted, according to reports by the Swedish Navy, aboard seven Soviet cruisers. But, the Russians are also known to be working in the Black Sea on underwater launching of missiles. One of these may be the 600-mile solid-fueled *Komet 2*.

Matra 530 Tested

France has started test-firing the solid-fueled *Matra 530* (similar to U.S. *Falcon*) from Vautour fighters.

Scout to Italy

NASA is furnishing some *Scout* rockets to Italy for some rocket testing that is to begin in November on Sardinia.

FOR USE BY THE STRATEGIC AIR COMMAND, MSVD has developed this soon-to-be operational ablation re-entry vehicle for Atlas—the Mark 3. Currently, MSVD-developed heat-sink Mark 2 re-entry vehicles are operational with SAC.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in payload delivery for SAC

Today, as a vital part of SAC's deterrent weapon mix, Mark 2 operational re-entry vehicles developed by the General Electric Missile and Space Vehicle Department stand ready—helping to guard the peace of the Free World.

Continuing its progress under the direction of the Air Force Ballistic Missile Division, MSVD has developed an even more advanced re-entry vehicle—the Mark 3—which soon will be operational with SAC's missile squadrons. The Mark 3's payload delivery capability was dramatically demonstrated just 4 weeks ago when it successfully survived a 9,000 mile trajectory—longest re-entry vehicle flight in the world to date.

Now MSVD is designing and will build the re-entry vehicles for SAC's newest air-launched ballistic missile, the GAM-87A, SKYBOLT.

Hand-in-hand with this re-entry vehicle progress, MSVD has designed and developed items of re-entry vehicle ground support equipment for SAC. Latest of these is the air-suspension mating trailer, now being produced for SAC's use on both Titan and Atlas missiles.

Through such programs, MSVD continues to help increase the deterrent capability of SAC—strongest power for peace in the world today. Missile and Space Vehicle Department, General Electric Co., Philadelphia 1, Penna. 160-94

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD

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Big Hike in Defense Funds Unlikely

by James Baar

Demands for immediate big new defense spending appeared this week to be more oratory than planned action as Congress gathered for its pre-election "catch-up" session.

Here is the outlook:

—The Republicans indicated they might unfreeze some more of the $866 million added to the defense bill by Congress before it adjourned for the national conventions. But, at the same time, they made clear that they had no intention of requesting the multi-billion-dollar supplemental bill sought by GOP Gov. Nelson Rockefeller of New York.

—The Democrats appeared to be emphasizing domestic programs such as farm legislation and old age health insurance for enactment in the brief session. They could push through some kind of "shopping list" defense appropriation, but congressional insiders contended that the odds were against it.

• **Democrats' dilemma**—Both Democratic Presidential nominee John F. Kennedy and GOP Presidential nominee Richard M. Nixon face serious problems if they wish to rush a new big defense bill through Congress at this time.

Kennedy and his running mate, Senate Democratic Leader Lyndon B. Johnson, undoubtedly could jam a large defense money bill through the Democratic-controlled Congress.

However, to do so, they would have to talk the powerful Senate Appropriations Committee into reversing the position it took only a month ago when it rejected individual Democratic proposals to increase defense spending. This would make the committee look rather flighty at best and open it and the Democrats to a number of unpleasant charges by the Republicans.

Finally, President Eisenhower has said through Vice President Nixon that he would veto any "massive spending measures" not accompanied by new taxes.

• **Republican compromise?** — Reports emanating from the summer White House at Newport, R.I., have said this applies particularly to any big increase in defense spending which the President would regard as a repudiation of his defense program.

And here, in the attitude of the President, lies the problem for Nixon.

Any Administration request for a big defense money bill at this time would be a complete reversal of the President's repeatedly-stated position. If Nixon were to call for such a bill, he would be openly breaking with the President, a very dubious course politically.

However, Nixon and the Administration can try what the Administration has done many times before on the defense issue: Give a little, thereby taking some of the edge from a Democratic attack.

The White House already has released the $241 million voted by Congress over Administration objections for two more *Polaris*-launching submarines. That leaves $525 million in frozen funds from which the Administration can draw in part on the grounds that the international situation has grown somewhat gloomy.

This includes money for the B-70 Mach 3 bomber, *Samos* and Army modernization.

Nor is this all. The Administration, without opening itself to charges of an about face, can call on Congress to restore part of the more than $1 billion that it cut from various defense programs. The juiciest item is the $418-million across-the-board cut in procurement.

The Republicans are being forced to make some move in this direction in order to try to undercut the Democrats.

Johnson already has demanded an accounting from Defense Secretary Thomas Gates on the use of the frozen funds. In a letter July 28, Johnson noted that the extra funds had been frozen by Gates' order and called for an item-by-item report before Congress reconvenes.

He also called for a report on how Gates eliminated "wasteful contracting, supply mismanagement and other procurement deficiencies" in order to effect the $418-million procurement cut made by Congress.

Thus, the outlook is: The Republicans probably will try to undercut the defense issue with some part-way measures. The Democrats probably will shy away from anything beyond the frozen funds rather than waste precious time winning a vetoed or frozen defense bill and some painful political punches for their trouble.

Of course, none of this follows too easily from the parties' platforms or statements.

The Democratic Platform declares that U.S. military power for the last seven and a half years "has steadily declined relative to that of the Russians and the Chinese and their satellites." It promises to lead the way to recovery. Kennedy has called for a $3-billion increase.

The Republican Platform promises to "accelerate as necessary" development and production of missiles and missile bases and to keep balanced forces for dealing with "brush-fire wars."

Both parties clearly indicate that increases are on the way. But neither platform says when.

Frozen DOD FY '61 Money

Program	Amount (in millions)
B-70	$190 to $290
Samos	$83.8
Minuteman	$27
Army Modernization	$160
Air Alert	$85
Total	$625.8

(Polaris, already released, $241)

Congress-ordered Procurement Cut

	(In millions)
Army Missiles, Equipment	$46.2
Navy Aircraft, Missiles	$66.2
Navy Shipbuilding	$71.6
Other Navy Procurement	$13
Marine Corps	$2.8
AF Aircraft	$100.5
Airlift	$9
AF Missiles	$80.8
Other AF Procurement	$27.1
Total Cuts	$418.1

Mercury Capsule Apparently Survived Explosion of Atlas

A second shot may come next month, probably testing performance of capsule in sharp-angle re-entry

by Jay Holmes

The working-model *Mercury* capsule apparently survived the explosion of an *Atlas* launch vehicle on its first flight test July 29. Sections of the capsule were recovered off Cape Canaveral by Air Force salvage vessels the following day. The capsule was unmanned and contained no animal or biological specimen.

An "event of a catastrophic nature" destroyed the *Atlas* 65 seconds after it was launched in a driving rain and heavy wind at 8:13 a.m. (EST). But the telemetry from the capsule continued until 3½ minutes after launch, at which time it presumably struck the ocean surface and broke apart.

Another *Mercury-Atlas* test will be held as soon as possible, presumably next month. NASA officials said the failure would have no effect on the schedule for the *Mercury-Redstone* tests, which will precede the launching of an astronaut on a sub-orbital ballistic trajectory. The first *Mercury-Redstone*, also unmanned and without any biological specimen, has been scheduled for next month too.

However, a high NASA official conceded a day before the *Atlas* test that a manned *Mercury-Redstone* shot before the end of 1960 is becoming less likely. Dr. Homer Joe Stewart, director of NASA's Office of Program Planning and Evaluation, told the National Rocket Club in Washington that the shot is "theoretically possible" but, "the margin is obviously rather thin."

• **Degree of success**—There was one successful phase of the July 29 test. An abort-sensing-and-implementation system (ASIS) worked perfectly. ASIS is a series of electronic monitors at various points on the *Atlas*, which check performance of engines, airframe integrity, electrical circuits and the motion of the booster frame.

In future flights, if a sensor detects a significant variation in performance, the system would signal the escape system, which would immediately separate the capsule from the booster. In the test, the system operated on an open loop basis. The 16-ft. superstructure and solid-rocket escape system was omitted.

ASIS did signal something wrong a few seconds before T plus 65. Thus, scientists said, the escape system would have worked in plenty of time to get the astronaut away from the exploding rocket. Because of its success in this shot, ASIS will not need to be tested on an open loop basis again.

The parachute re-entry could not come into play because the parachute release was to have been armed by the separation of the capsule from the *Atlas*. The explosion took place while all three *Atlas* engines were still burning. The cause has not been determined.

Sections of the capsule were found five miles offshore in water 50 ft. deep. They were returned to the Cape, where a thorough engineering analysis is under way.

• **More systems later**—The capsule, designated MA-1 *(Mercury-Atlas 1)*, did not contain all the systems that will be included in later flights. Among those omitted were the environmental control system, astronaut couch and control panel and the attitude and stabilization control jets. In their place were more than 200 lbs. of sensing instruments, cameras, recorders and a telemetry system.

Telemetry transmitted continuously on 16 channels of continuous or commutated information. It was programed to transmit throughout the flight except for a minute or two during re-entry. The planned trajectory called for the capsule to reach an altitude of 110 statute miles, a speed of about 13,000 mph and landing 1500 miles downrange 20 minutes after launch.

The flight was designed to test capsule structure and afterbody heating on a mission abort. The capsule afterbody was to sustain extremely high temperatures and high air-load conditions resulting from re-entry at a sharp angle, four to five times the normal orbital return angle of about 2°.

• **Sharp-angle procedure**—Presumably, the sharp-angle re-entry will be tested on the next *Mercury-Atlas* flight. Here is how it will work:

The *Atlas* will power four minutes of flight—a full two minutes on the booster engines and a premature shutoff of the sustainer engine—bringing the vehicle to about 100 miles above

MERCURY-ATLAS gets off pad in July 29 launch. Vehicle exploded moments later.

the earth. A few seconds later, the capsule will be freed by the firing of explosive bolts on a locking clamp ring. Then small packages of rockets attached to the blunt end of the capsule will fire, pushing it away from the booster.

When the capsule hits the atmosphere, thickening atmosphere will slow it to 700 mph. At about 42,000 ft., an altitude-sensitive switch called a barostat will release a drogue parachute, which will slow the capsule to about 200 mph.

At 10,000 ft., another barostat opens the main 63-ft. chute, which slows the capsule to 20 mph as it hits the ocean. The impact releases radio rescue beacons, turns on a flashing recovery light and releases aluminum strips to aid radar location. Sea marking materials will be loosed and two SOFAR bombs will be exploded for sonar location.

The main chute will be disconnected and all capsule electric power—except that required to operate radio aids—will be cut off.

The Missile/Space Week

New Polaris Subs to be Largest Underseas Craft

Four *Polaris* submarines recently ordered by the Navy will be the largest undersea craft ever built. Designated the Lafayette class, the subs will weigh 7000 tons, and measure 425 ft. long, 45 ft. longer than the George Washington class.

Polaris Blown Up in Fourth Underwater Test

After three successful 1100-mile trips, the fourth *Polaris* missile to be fired from a submerged submarine veered off its course 47 seconds after launch and had to be destroyed. The actual launch from the George Washington nuclear submarine and mid-air ignition of the solid rocket motors were termed successful, the malfunction occurring in flight.

US-Great Britain Hold Talks on Missile Subs

Britain disclosed last week that talks are underway between United States and Great Britain on the use of British ports by rocket-firing submarines. The Foreign Office report scotched rumors that Britain had already agreed to use of her ports for replenishment by *Polaris*-carrying submarines.

Atlas, Titan Site Activation Chiefs Chosen

Twelve senior Air Force colonels have been assigned as site activation task force commanders for *Atlas* and *Titan* ICBM bases. They will be responsible for construction, installation, checkout and turnover of the sites in operational condition to SAC in accordance with an official program schedule.

Sites and their commanders are: *Atlas*—Fairchild AFB, Col. Thomas S. Jeffrey Jr.; Walker AFB, Col. Robert I. Barrowclough; Forbes AFB, Col. William E. Ruark; Schilling AFB, Col. Arthur W. Cruickshank; Altus AFB, Col Ernest L. Ramme; Dyess AFB, Col. Hugh H. Manson; Plattsburgh AFB, Col. Calvin W. Fite. *Titan*—Larson AFB, Col. Edwards J. York; Beale AFB, Col. William E. Sault; Ellsworth AFB, Col. Kenneth W. Norhamer; Mountain Home AFB, Col. Harmon E. Burns; Lowry AFB, Col. James H. Thompson.

Labor unions and management alike were charged to do their part in seeing that the missile bases are completed on schedule. Army Corps of Engineers labor relations officer E. Irving Manger recently warned that work stoppage at missile bases because of strikes could seriously endanger the nation.

Thiokol Says Year Won't Match 1959

Thiokol Chemical Corp.'s second quarter income topped the same period in 1959 by 12%, but the company forecasts that it won't equal last year's total profits. Six months earnings were $1.7 million, against $2.9 million for the first half of 1959, although sales were up 3% to $83 million. Chemical division sales in the first half fell 27% from the first half of 1959, attributed to a reduction in sales to the rocket division.

Goddard Estate Receives $1 Million

The government last week awarded one million dollars to the Robert H. Goddard estate in settlement of claims for rights to use over 200 patents covering basic inventions in rockets, guided missiles and space exploration.

Dr. Goddard assigned half interest in his patents to his widow and half to the Daniel and Florence Guggenheim Foundation, a nonprofit organization which sponsored almost all of his research.

Navy Will Buy 120 Douglas Missileers to Pack Eagles

by William J. Coughlin

SAN DIEGO—The Navy's new air-launched *Eagle* missile will be capable of knocking down aircraft and missiles traveling at speeds from subsonic to Mach 4 and altitudes from zero to 100,000 ft. Range of the Mach 4-5 solid-propelled missile will be 100 miles.

Douglas Aircraft will receive some $600,000 in contracts for the Missileer aircraft which will carry the *Eagle*.

These facts were disclosed by Vice Adm. R. B. Pirie, Deputy Chief of Naval Operations for Air, at the Institute of Aerospace Sciences meeting on the future of manned aircraft. Missiles, in fact, dominated the news coming out of the classified sessions.

Prime *Eagle* contractor is Bendix Corp., with Grumman Aircraft as airframe system contractor. Radar homing guidance is by Bendix, and Aerojet-General is developing the solid booster. Litton Industries won the competition on the fire control system.

The *Eagle* is one half of a new Navy defensive concept: high-performance missiles on relatively low-performance aircraft. The contract for Missileer was awarded to Douglas last month.

The Missileer will be a twin-engined carrier-based aircraft of some 50,000-lb. gross weight, powered by Pratt & Whitney TF-30 Turbofan engines. It will carry a crew of four—two pilots and two radar operators. Each plane will carry six *Eagles*, about 15 ft. long and weighing about one ton apiece.

Each aircraft will carry what is, in effect, a small combat information center (CIC). Its electronic gear will be capable of simultaneously acquiring, tracking and firing at as many as six different targets.

The Navy will commit $75 million to the Missileer program in Fiscal 1961, according to Rear Adm. Paul Stroop, Chief, Bureau of Naval Weapons. He estimated development costs of the aircraft at about $200 million.

Each plane without spares is expected to cost about $5 million; *Eagles* should cost somewhat less than $300,000 each in quantity production.

The Navy plans to replace all fighter squadrons on its attack carriers with Missileers in the next 10 years. The Marines also will be equipped with Missileers, for an ultimate total strength of 20 squadrons.

Adm. Pirie said there will probably be six planes per squadron compared to 14 now, although this may increase.

The program as planned would cost well over $1 billion. Some estimates have placed it as high as $4 billion over the 10-year period.

Nike-Zeus Seen Ahead of Schedule

SAN DIEGO—Scientific improvements in the past 12 months have put the Army's *Nike-Zeus* anti-missile weapon system well ahead of schedule from a technical standpoint.

These improvements have included:

–An increase of three to four times in range.

–Doubling of radar power.

–Increased frequency, significant in terms of increased ability to track and discriminate.

Richard S. Morse, Army Research Director, disclosed that the Thiokol solid-propellant booster of the surface-to-air anti-ICBM and anti-IRBM weapon now develops more than 500,000 lbs. thrust. This is the nation's largest solid propellant booster under development, he pointed out, and it has been successful in every firing.

The program is on schedule, in terms of both time and money, Morse said. Construction of the Kwajalein Island site from which *Nike-Zeus* will be fired at target ICBM's launched from Vandenberg Air Force Base is well along. Test firings of this type probably will get underway sometime in early 1962 and the system is expected to be initially operational about 1964.

Morse said that in addition to 18 *Atlas* missiles which the Army will buy for use as targets, it also is planned to use *Titan* and *Minuteman* ICBM's. He said the test firings probably will continue for many years.

• **Air Force launch crews**—Although the Army will buy and "control" the target ICBM's, Morse said, Air Force crews are expected to do the launching, thus providing dual training with each firing.

Prior to the start of the *Atlas* test firings, *Nike-Zeus* will be tested at the Kwajalein Site on simulated intercepts and on low-altitude shots. Morse also disclosed that a *Nike-Zeus* installation at Pt. Mugu on the Pacific Missile Range will go into operation shortly to overcome limitations placed on testing by the short White Sands Range in New Mexico.

An Ascension Island installation of *Nike-Zeus* tracking radars already is tracking ICBM's fired from Cape Canaveral the Army Research Director said. These can discriminate between the warhead and other incoming portions of the missile.

Morse also made these points in his progress report on the program:

–*Nike-Zeus* possesses an antisatellite capability which may be exploited in the second-generation weapon.

–The system is designed specifically to cope with submarine-launched missiles as well as ICBM's.

–Out-of-atmosphere control of *Nike-Zeus* is by a "wierd" type of jet control and the system continues its discrimination capability after launch.

• **"We've got the range"**—Morse admitted that the *Nike-Zeus* system would not be able to handle a saturation of, for example, 100 enemy ballistic missiles arriving on target within a period of five seconds.

"But," he added, "I think the multiple target problem has been overplayed in some circles in this country." He said that if there were six, 10 or 15 seconds between arrivals, *Zeus* would be able to cope with the bombardment because it can simultaneously track and discriminate more than one target at a time.

Range capability of the system now is over 1000 miles, the Army Research Director said. "We've got the range we need to do the job," he commented.

He gave this sequence of events as an example of the system's operation: a Soviet ICBM aimed at Washington, D.C., would be acquired well north of Boston. By the time the incoming weapon was over New Jersey, the radars would have discriminated between the active warhead and any dummies. *Nike-Zeus* would be launched while the Soviet ICBM was somewhere between Wilmington and Baltimore on its downward trajectory. Intercept would occur about 80 miles from Washington at an altitude of 100,000 to 200,000 ft.

The nuclear warhead of the *Zeus* would destroy but not detonate the warhead of the incoming ICBM, Morse said. He declined to elaborate further on this. Any fallout would come only from the relatively clean and small nuclear warhead of the *Zeus*, it was indicated.

The Army scientist said that while the current ban on nuclear tests means that nuclear warheads will not be used in the Pacific *Nike-Zeus* test program, this is not expected to handicap the program.

He said the Army is not pushing the *Nike-Zeus* as an antisatellite weapon, but pointed out that it is the only ground-based weapon currently under development which possesses this capability.

Lt. Gen. A. G. Trudeau, Chief of Army Research and Development, told the meeting that U.S. Defense chiefs are seriously concerned with the possibility of Soviet deployment of mobile tactical missiles in Cuba (M/R, July 18, p. 51). He also suggested that instances in which sandwiches and wrenches have been found in critical portions of the *Atlas* weapon system may have been caused by sabotage.

Nuclear Flight Studies Set

The National Aeronautics and Space Administration last week chose Lockheed Aircraft Corp. and The Martin Co. to make six-month parallel paper studies of requirements for a nuclear rocket flight test program.

The studies, costing $100,000 each, will cover the scope of system preliminary design, development programming, planning of test and tracking facilities, schedules and safety factors. NASA chose two contractors to obtain differing points of view on a question that has caused a dispute between officials of NASA and the Atomic Energy Commission.

Harold B. Finger, NASA nuclear propulsion chief, and a number of NASA officials believe the first flight test should be from orbit. Col. Jack Armstrong and other AEC officials concerned with nuclear propulsion believe the first test should be a launch from the ground. A third possibility is testing the nuclear rocket as a second stage atop a chemically fueled booster over a short ballistic trajectory. The study is not limited, however, to these three alternatives.

The prime requirement of the system, called the Reactor In-flight Test System, will be that the program supply technical data applicable to a useful nuclear rocket stage. However, NASA said, the system need not be capable of performing useful space missions.

NASA has set 1965 as the target for the flight test. It is expected that *Saturn* launch vehicles will be available at that time for obital start or second-stage test.

Though tariffs are tricky . . .

U.S. Firms Find Bonanza in Europe

Liberalization of regulations in the Common Market has attracted American defense companies; there are pitfalls

by Bernard Poirier

In the Paris suburb of Montrouge this week a new company opened up for business in what is fast becoming a familiar pattern.

The maufacturing plant is a subsidiary of Polarad Electronics Corp. of Long Island City, N.Y.

Mission: production of an industrial line of microwave instrumentation for sale in the European Common Market.

Polarad, which already has a subsidiary in Amsterdam, is one of scores of American defense companies which have succumbed to the lure of doing business abroad.

Last month, the Rocketdyne division of North American Aviation and Thiokol Chemical concluded deals with France's SEPR (Societe d'Étude de la Propulsion Par Réaction)—largest rocket manufacturer on the continent. Bendix Corp. and Telefunken have just embarked on a joint venture—Teldix—in West Germany.

U.S. defense interests abroad, a risky adventure only a few years ago, today are swelling in volume as Europe grows more economically stable and as individual countries in the NATO alliance contribute more and more to their common defense.

West Europeans have a combined $12-billion defense budget which is expected to increase substantially. Foreign plans for rocket development and for supporting equipment are impressive even from the U.S. point of view and are commercially lucrative.

An American defense firm is in a particularly good bargaining position because of the intense desire of Europeans to save their own capital by learning the latest American know-how.

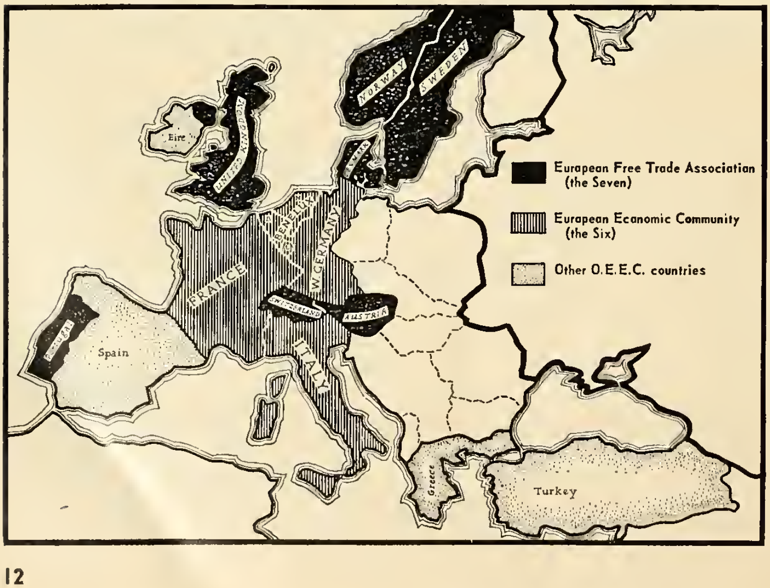
This gives the U.S. firm the chance to choose between establishing a manufacturing subsidiary and entering into a participation agreement which involves the exchange of technical know-how, products, and some capital for a share in the profits made by the European company.

What is accelerating this eastward business migration?

More than anything it is a liberalization of regulations covering defense products in the Common Market.

New rules offer a considerable advantage to U.S. firms who locate within European Economic Community countries—sometimes called the "Inner Six." They are France, Germany, Italy, Belgium, Luxembourg and the Netherlands.

A recently formed competitive group known as EFTA (European Free Trade Area) is composed of Britain, Austria, Norway, Denmark, Portugal, Sweden and Switzerland. EFTA, also referred to as the "Outer Seven," does not hold the same advantages as the Common Market.



• Lower marketing costs, more sales—Where does the best potential for profits lie? The pros and cons of locating in Europe must be carefully weighed.

It is clear that in just a few years most profits in foreign trade will return to industries located within the European market. It is also becoming apparent that export trade originating outside the European markets will find it increasingly difficult and in some cases impossible to compete.

Non-member export traders face excessive end-costs to member customers. The common external tariffs will provide member suppliers with a big edge in lower end-costs to member customers.

A fundamental concept of the Common Market is to wipe out import duties between member countries and to establish a common wall against outside competition through a uniform external tariff.

• To abolish 4 Customs Unions—The four Customs Unions within the Common Market are still effective, and will continue to be for several years until all internal tariffs are completely erased from the books. Making up these Customs Unions are the Benelux-Netherlands combination, France, Germany, and Italy. The ad valorem Tar-

FOUR LIQUID-FUEL rocket engines being tested at S.E.P.R. facility near Paris. Firm has made big deals with U.S. firms.

iff rates they had on Jan. 1, 1957, are what we will call *basic* rates.

The simple arithmetical average of each basic rate on a product serves as an interim goal for internal tariffs during the transition period at the end of which all internal tariffs will be abolished. To complete the transition cycle a common external tariff will be initiated next year against non-member countries.

Some of the new external tariffs on defense products are:

Rocket motors, jet engines ....Tariff 12% a.v.
Rocket motor components ....Tariff 12% a.v.
Helicopters, empty wt. 4400 lbs. or less ....Tariff 15% a.v.
Helicopters, empty wt. Over 4400 lbs. ....Tariff 12% a.v.

(Empty weight excludes the weight of fuel, personnel, and optional equipment.)

Another recent amendment to the EEC Treaty contains a special feature suspending all external rates until Dec. 31, 1963, for helicopters with empty weight exceeding 4400 lbs. Community members get additional benefits as can be expected. France, for instance, has suspended all internal tariffs on rocket motors and certain jet engines.

In other cases even the external tariff is suspended if the motors or engines are destined to be mounted on vehicles qualifying as being of Community origin. One overall restriction which remains is contained in Treaty Article 223; it gives each member nation the right to establish special regulations for trade involving certain defense-type products.

• **Bring a slide rule**—Once the method of calculating internal and external tariffs is understood, it becomes easier to appreciate the foreign experiences of U.S. firms. The simplest way to figure tariffs might be by remembering a short hypothetical case involving an Italian customer who informs a French firm and a U.S. firm that he wants to purchase a product which each manufactures.

Italy's basic tariff on this product had been 10% a.v., but the tariff later was established at 15% a.v., which we will call the current tariff. Common Market authorities established a uniform 20% a.v. on this product. Italy's basic tariff was obviously well below the arithmetic average used by the Common Market authorities. Therefore, when two 10% reductions on internal rates was effected, Italy had to raise the tariff on this product making it conform to the uniform trend. The present Italian internal tariff is 12%.

Now the real mental gymnastics start. The Common Market tariff by the new regulations is reduced by 20%, making it 16%. The Italian basic rate (10%) is subtracted from the 16%, leaving 6%. This is multiplied by a common factor—0.30—whose product, 1.8, represents the first increment. Since the current Italian national rate is lower than the interim Common Market tariff, the new increment must be added to the current rate as the first step in aproaching a uniform goal. Thus the Italian external tariff at this moment is 16.8% a.v.

Both the French product and the U.S. product have a F.O.B. (mfg. site) price of $44,000; the overland freight charge from the French firm is $300, while the export c.i.f. (costs, insurance and freight) from the U.S.A. is $1000.

The Italian's end cost for the French product becomes $49,616; for the U.S. product, $52,560. The Italian will save $2944 by purchasing the product manufactured in France—whether by a French firm or by an American subsidiary.

• **U.S. firms reveal problems**—Several pitfalls can be avoided by companies contemplating moves abroad if they look at the experiences of U.S. firms now in the European markets and analyze the moves made by foreign competitors in their own market. Republic Aviation has a wholly-owned subsidiary in Switzerland; but recently Republic acquired a portion of Fokker Aircraft of Amsterdam in a participation deal. When both the subsidiary and Fokker offer the same product, it is evident that Community customers will do business with Fokker to save money.

Republic said, "It is reasonable to assume that Fokker will be favored with some of the subsidiary's business" and that the U.S. firm's "close cooperation with Fokker" will more than offset any profit loss on the part of the subsidiary.

A Republic spokesman boiled the situation down to: "a company within this complex (Common Market) would be more desirable than one outside."

The economic comparison of the "Six" and "Seven" is contained in data listed in Table. When conducting a marketing study on the European markets a few observations on current

EEC and EFTA Statistics of Trade
(1957) In Billions of Dollars

Trade Category	Dollars
Total Intra-EFTA Trade	$ 6.9
Total trade between U.K. and others in EFTA	2.6
Total trade between U.K. and EEC members	2.5
Total Intra-EEC Trade	13.7
Total trade between the EFTA and the EEC	8.5
Total EFTA Foreign Trade	34.8
Total EEC Foreign Trade	46.7

Note: The EEC is the World's largest importer with almost $23 billion in 1958.

politics is essential.

• **British dilemma**—The EFTA is not an institution such as the Common Market. EFTA was conceived as a negotiation lever with the "Six" and has gone through competitive motions in an on-again-off-again manner greatly influenced by Britain's "damned if she will and damned if she won't" reply to the Common Market's invitation to join.

Her decision to join may come too late. There is the possibility that the "Six" may close the door to any new memberships.

Many defense firms entered the Common Market soon after its inception. Others already there expanded foreign facilities. United Aircraft Export Corporation has been very active in expanding its influence in the Common Market. United made early deals with FIAT of Italy and with Ratier-Figeac S.A. of France. Their Hamilton Standard division has acquired 50% interest in Microtecnica S.p.A. and 10.9% in SNECMA.

United also reported at this writing that Hamilton is negotiating with two other top firms, San Giorgio S.p.A. and Perilec S.A., "to obtain further coverage in the Common Market." Several of these European firms are important missile system contractors.

James R. Patterson, assistant to United is export president, made it clear that the expectation of profit was strong but would not elaborate for obvious "competitive reasons."

American Cyanamid, du Pont, Tracerlab, Metals and Controls, Worthington, Titanium Metals, Daystrom, Perkin-Elmer and others are among those to be found with new or additional facilities since the "Six" was formed.

• **Operation boot straps**—Community firms were the first to recognize the advantages of their own institution. Some formed subsidiaries under joint ownership, others consolidated branches which formerly were scattered over frontiers even when not demanded as much by product distribution as by former national restrictions that existed.

Matériel Schneider Westinghouse, Nobel-Bozel, SIMCA, and Ducellier are among those who consolidated. Internal deals were consummated by Merckle K.G. and Giovanni Augusta; Messerschmidt and S.F. Fouga. Following suit were Breguet, Dormier, SNECMA, Bayerische Motorenwerke and many others.

Bodenseewerk which is NATO prime for the *Sidewinder* missile is controlled by the U.S. firm Perkin-Elmer. The U.S. firm has already introduced missile support equipment manufactured by its young German affiliate during the last few months.

Passive Systems Praised at Symposium on Communications

Passive communication satellites have at least one big advantage over the active repeater types: they're within the present state of the art and offer our first hope of practical systems.

Passive systems can be put in the air within the next few years; active systems won't be operable until the 1965-70 period. In addition, the passive reflectors offer more flexibility, greater reliability, and are less vulnerable to jamming and interference.

This comparison between the two systems was offered by Donald T. Worthington of the AF Rome Air Development Center.

Speaking at last week's National Symposium on Global Communications in Washington, he said the efficiency of the passive systems could be upgraded by continued research and development to make them even more comparable to active communications satellites. He cited three areas of possible improvement: antenna gain, reflection characteristics, and information capability.

Communications satellites and associated areas received a thorough review during the GlobeCom Symposium. Two sessions were devoted to the subject—one chaired by Dr. Hans Ziegler, chief scientist of the Signal Corps R&D Laboratory, and the other by Esterly C. Page, president of Page Communications. Costs, timetables, and problems of operating military and commercial satellites were all discussed.

• **Years away**—Dr. Ruben F. Mettler, executive v-p of STL, confirmed other opinions that practical systems are some years off. He said that "we will probably fall short of what is now predicted for accomplishment during the next three years, but will probably do more during the next 25 years than is generally accepted today."

He predicted that a large and expanding communication satellite system development is warranted on the basis that it will contribute sufficiently to our communication needs and objectives.

• **Profit promised**—The practicality of commercial systems was demonstrated by L. Pollack of ITT. He said that such a system would operate at a profit.

He estimated overall costs of a typical global satellite network to be in the neighborhood of $18 million per year over a ten-year period. Gross annual revenue would amount to about $80 million. In addition, Pollack pointed out that satellites would provide communications for many small countries now virtually isolated.

In line with previous statements that passive reflectors need considerable refinement, Maurice G. Chatelain reported on Ryan Electronics' work on anisotropic reflectors. Pointing out that the simple isotropic reflector—such as NASA's 100-foot metallized Echo sphere—leaves much to be desired in efficiency, he discussed ways of making the inflatable reflectors more efficient. He cited several examples of configurations that offered promise—some spherical and others of polyhedral construction.

The spherical models described included several interesting modifications to the *Echo*-type balloon. Generally, these involved partial metallizing of the sphere's surface. One method proposed was a metallized checkerboard pattern which reportedly reflects and back-scatters a larger proportion of incident energy than a 100% reflecting surface and reduces weight of the sphere.

Two different polyhedral satellite configurations were described by Chatelain. These involved 12-face dodecahedron and 20-face icosahedron shapes moulded into the satellite's surface. Each face can be surrounded by 135-degree oblique walls to provide high incident-energy reflection. According to Chatelain, this type shows the most promise of those investigated at Ryan.

For active satellites, best directive antennas seem to be those built on a sphere, inflated in space, and containing spherical arrays of conical helixes or spiral beam antennas. The spherical spiral antenna developed for *Transit* was mentioned as a candidate for active communication satellites.

Interference big problem in communications—Attention given to interference and spectral problems at GlobeCom was inversely proportional to its importance, according to some observers. One session was devoted to this subject.

One speaker—Bernard H. Baldridge of GE's Light Military Electronics Department—deplored inadequate system planning that has permitted evolution and system mix of megawatt and microwatt power-level equipment "with little concern for overall system degradations resulting from subsystem interactions." According to Baldridge, "we don't build a system by marrying together sets of sets; we just let them live together in sin."

Autolite, Hiller May Merge

Electric Autolite Co. may move further into the defense business field with a merger with Hiller Aircraft Co. Hiller makes light helicopters and is prominent in Vertical Take-Off and Landing (VTOL) aircraft development and other military research projects.

Stanley Hiller, Jr. president of Hiller Aircraft Corp. and R. H. Davies, Autolite president jointly disclosed that negotiations are underway for the merger. Autolite would acquire Hiller on the basis of one Autolite share for each four and one-quarter shares of Hiller.

Although Hiller would operate as a separate unit, the newly-formed Autolite Aero/Space Division and Special Product and Research Division (SPARD) would cooperate in research and development activities. Ceramics, electro-hydraulics, electronics have been mentioned among areas of cooperation.

mergers and expansions

CONVAIR ASTRONAUTICS, General Dynamics Corp. will complete a million-dollar electronics manufacturing facility at Kearny Mesa, Calif. by September. The 68,400 sq. ft. structure will house areas for constructing prototypes of electronics products for advanced missile and space studies, components for Azusa tracking system, and a modern calibration laboratory.

The plant will feature a "dust control" station through which all materials will pass for cleaning prior to distribution. Working environment will be controlled to temperatures between 73° and 83°.

BOWMAR INSTRUMENT CORP. has doubled its manufacturing capacity with a 23,000 sq. ft. plant at Fort Wayne, Ind. The facility features a newly-equipped laboratory and special enclosed sections for ultra-precision machining, heat treating and painting of tiny precision components.

ELECTRO-MECHANICAL RESEARCH has formed a Systems Division to assume advance planning, engineering, development, production and quality control services. Initial efforts will be directed to airborne and ground telemetry systems, data processing and reduction systems, satellite systems, ground support equipment, automatic checkout equipment and others.

HYDROMATICS, INC. of Livingston, N.J. has bought a complex of buildings totaling 80,000 sq. ft. from General Electric in Bloomfield. Move will be made Sept. 1.

LABORATORY FOR ELECTRONICS, INC. has leased a 100,000 sq. ft. plant and office facility adjacent to its present headquarters in Boston. LFE departments and divisions in other sections of Boston will be relocated there by December.

NORTHERN RESEARCH & ENGINEERING CORP. has opened research and development offices in London, England. The firm conducts R&D and industrial consultations on heat transfer, thermodynamics fluid mechanics and related technical marketing.

financial

Thompson Ramo Wooldridge—reports increased sales and earnings for the first half of 1960 compared to the same period a year ago. Sales of $219.1 million represent a gain of $19.6 million, or about 10% over sales for the like period of 1959. Gain was attributed to a 35% increase in electronics, missiles and space business, compensating for a slight decline of military requirements for manned jet aircraft components.

Net income totaled $5 million for six months, compared with $4.9 million for the first period last year.

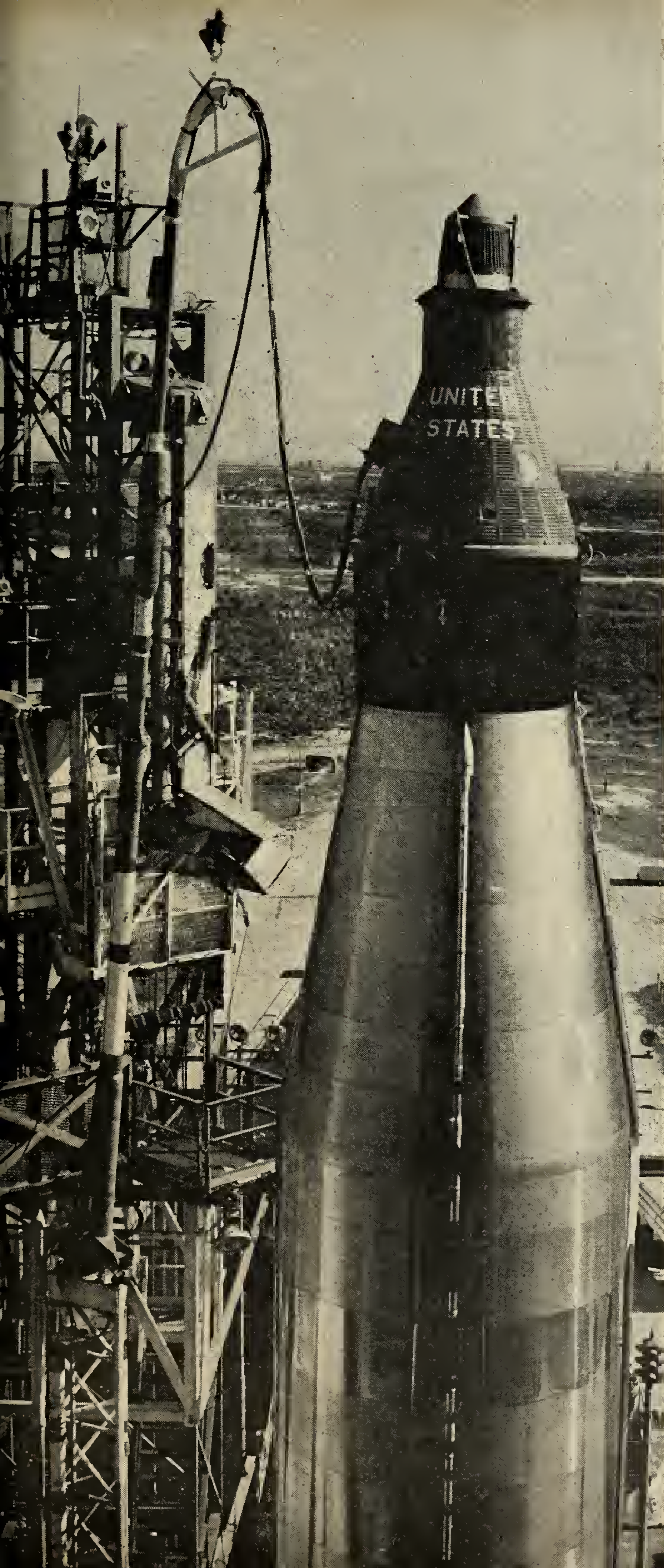
Chance-Vought Aircraft—Sales and incomes for six months ended June 30 this year total $113.6 million, compared to last year's $132.5 million. Net income dropped to $1.5 million from $3 million.

Minnesota Mining & Manufacturing—3-M reports second quarter sales of $134.3 million and earnings of $16.1 million. In the same 1959 period, sales were $122.2 million with earnings of $15.6 million.

Bell & Howell—Highest second quarter and six months sales and earnings in the history of Bell & Howell, (including Consolidated Electrodynamics Corp.) were reported. Second quarter earnings were $2.4 million compared with $1.8 million for the same 1959 period. Sales were up from $23.1 million to $30.1 million for the second quarter.

Reflectors for Space Generator

HUNDREDS OF THESE 4-inch solar reflectors will be built by Hamilton Standard Div., United Aircraft Corp., to develop a workable 100-watt prototype space generator for the Air Force. Ultimate goal is a 1500-watt system using 7000 reflectors over 700 sq. ft. Conversion mechanism is a thermocouple employing a temperature differential of as high as 600°.



NASA

SPECIAL REPORT

Industry May Get $12 Billion

NASA's 10 Year Plan: more contracts with private companies—including Saturn booster, Apollo spacecraft and new satellite projects

Industry and other contractors will share in the National Aeronautics and Space Administration plans in the amount of $9 to $12 billion—and possibly more—in the next decade.

This prospect is held out by Administrator T. Keith Glennan. Of a budget for the decade totaling $12 to $15 billion, he says, at least 75% will be spent with contractors. If the total for the decade is to reach this figure, Glennan says, annual spending must rise from the current level of $915 million to more than $1½ billion.

These other key points emerged from a July 28-29 NASA-industry conference:

–Production of the *Saturn* booster may be shifted to industry after the first 10 boosters are produced at Huntsville, Ala.

–The NASA payroll will rise from its current level of just under 17,000 and stabilize at about 19,000.

–A prime systems contract for Project *Apollo,* America's first civilian space ship, may be awarded in FY 1962.

Names and details of a series of advanced space projects were disclosed. They include:

• **Project Prospector,** an unmanned spacecraft boosted by the *Saturn* launch vehicle, capable of making a soft landing on the moon and remote-controlled exploration of an area within 50 miles of the landing point. Under study by the Jet Propulsion Laboratory and the Marshall Space Flight Center at Huntsville, Ala.

• **Project Voyager,** an unmanned spacecraft boosted by *Saturn* and able to fly to Mars or Venus, orbit the planet and eject an instrumented capsule for atmospheric entry and perhaps landing. Under study at JPL.

• **Project Aeros,** a 24-hour weather satellite program not yet approved but under study. If approved, the project could begin in 1962 and launchings might begin in 1964.

• **Project Mariner,** a series of early interplanetary probes that will mark the first U.S. missions to Venus and Mars.

• **Project Surveyor,** a name just assigned to the spacecraft boosted by *Centaur* that will make the first soft landing on the moon and conduct a variety of observations from a stationary position. Space Technology Laboratories, McDonnell Aircraft, North American Aviation and Hughes Aircraft were chosen last month to make competitive five-month studies. The contract, to be awarded early next year, could mean business totaling $50- to $100-million for the winner.

The only important growth in the NASA payroll is planned at the Marshall Center in Huntsville and the Goddard Space Flight Center in Beltsville, Md., Glennan said. The overall NASA total July 1 was 16,840. This included 4524 at Marshall and 1265 at Goddard. By next year, Marshall will grow to 5500 and Goddard will reach 2400.

No major new government installations are planned and no major increases in existing installations are expected after Marshall and Goddard reach authorized strength, Glennan said.

"With the exception of the Marshall Space Flight Center, NASA possesses no significant capacity to design, develop and manufacture launch vehicle systems," the administrator said. "Only a very limited capacity to undertake the design and prototype production of spacecraft and instrumentation to be carried in those spacecraft is available in NASA centers."

Maj. Gen. Don R. Ostrander, director of launch vehicle programs, told the conferees that NASA will be depending on industry more and more in the development of launch vehicles. Although the first stage of the big *Saturn* booster was engineered at the Marshall Center, he said all of its upper stages will be designed and built by industry.

PROJECT PROSPECTOR unmanned spacecraft will be boosted by the Saturn vehicle to a soft landing on the moon, where it will explore by remote control.

"In fact," Ostrander continued, "it may prove desirable at some point in the future to have the first stage built by industry. The increased workload at Marshall, because of the responsibility for many more development tasks under NASA, is going to result as time goes on in greater and greater reliance on industry."

A spokesman said the space agency held the conference, its first such meeting, because officials felt there was a need to give industry a comprehensive account of the program, which has been laid out in detail before Congress. It had been given to industry only in bits and pieces previously.

The spokesman said the conference had no political implication. However, it was obvious NASA was at least indirectly soliciting support for its plans for bigger budgets in the years to come.

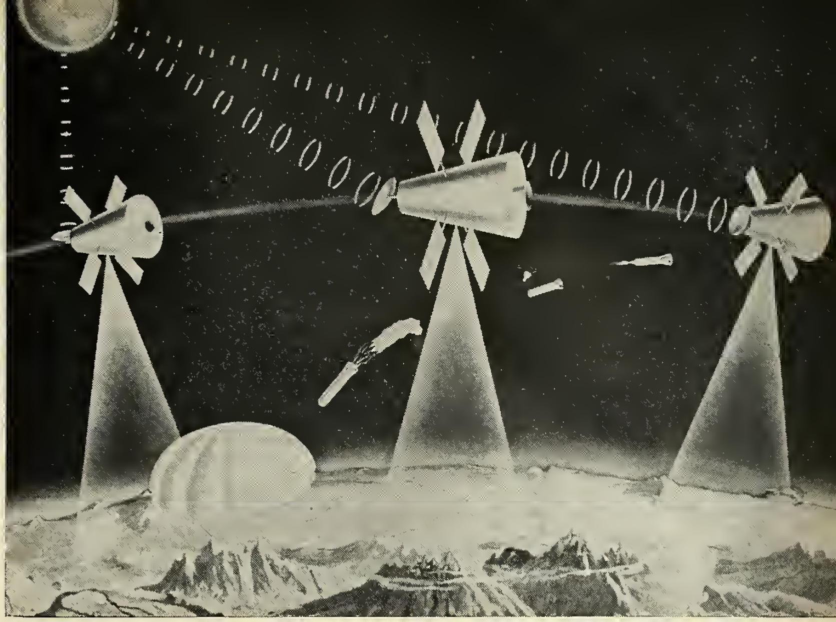
Deputy Administrator Hugh L. Dryden said NASA plans 260 launchings during the decade. Of these, 41 will be missions relating to manned space flight, 96 will be scientific satellites, 33 will be lunar and planetary scientific missions and 28 will be satellite applications.

Dryden gave this timetable of major launchings:

- **1960**—First launchings of *Tiros* meteorological satellite (already accomplished); *Echo* passive reflector satellite; *Scout, Delta* and *Atlas-Able* vehicles; suborbital flight of an astronaut.
- **1961**—First orbital flight of an astronaut; first launchings of *Centaur* vehicle and lunar impact vehicle.
- **1962**—First instrumented probe to the vicinity of Venus and/or Mars; first launching of a two-stage *Saturn* vehicle.
- **1963 or 1964**—First launchings of unmanned vehicle for controlled landing on the moon and orbiting astronomical observatory.
- **1964**—First unmanned vehicle intended to circumnavigate the moon and return to earth; first reconnaissance of Mars and/or Venus by an unmanned vehicle.
- **1965**—First flight test of a nuclear second stage "if unexpected problems are not encountered."
- **1965-67**—First launching in a program leading to manned flight around the moon and to a near-earth space station.
- **Beyond 1970**—Manned flight to a moon landing and return to earth.

A continuing shift in the NASA program from aeronautical to space research was reported by Ira H. Abbott, director of advanced research programs. About 26% of the in-house effort is primarily aeronautical and about 65% is primarily space-oriented, Abbott said.

Abbott gave this outline of the missions, staff and capital invested at the research centers:



PROJECT VOYAGER unmanned craft, also boosted by Saturn, will be able to fly to Mars or Venus, orbit either planet and eject an instrumented capsule.

- **Langley Research Center, Langley, Va.**—Structures and material applications, aerodynamics of re-entry vehicles, aircraft aerodynamics and structures, and fundamental plasma physics; staff 3220; investment $154 million.
- **Lewis Research Center, Cleveland, Ohio**—Propulsion and power generation for space vehicles; staff 2736; investment $148 million.
- **Ames Research Center, Moffett NAS, San Francisco, Calif.**—Aerodynamics, gas dynamics at extreme speeds, automatic stabilization, guidance and control of space and re-entry vehicles, space environmental physics; staff 1440; investment $107 million.
- **Flight Research Center, Edwards AFB., Calif.**—*X-15* flights, *Dyna-Soar* studies; staff 116.

Abbott said the four centers will cost $100 million to operate this year. New facilities will cost $22 million.

Ostrander defended NASA's policy of having fewer backup vehicles available than does the military program. "In our civilian space exploration program," he said, "although failure in any particular program or specific launch is certainly undesirable, it is not catastrophic to the extent that our security may be in jeopardy or that the remaining space program will grind to a halt until we obtain success." He added:

"In a civilian program, it is usually more prudent to back a broader program to gain additional knowledge than to provide dual capability to assure performance of a single task."

The percentage of industry participation is greater in the spacecraft programs than in the NASA program as a whole. Dr. Abe Silverstein, director of space flight programs, estimated that 75% of the space flight program budget goes to industry contractors, 5% to universities and non-profit organizations, and 20% is spent in-house. The current space flight total is $312 million.

In all space-flight missions, Silverstein said, there is need for tracking equipment capable of determining orbital data or position time histories, and for command signals, telemetry receivers, data acquisition and computing equipment.

Industry Guide . . . NASA's Next 10 Years

The comprehensive report of NASA's plans for the next decade starting on these pages fills a special section extending through page 33.

Missiles & Rockets editors compiled the report from censored copies of a 100,000-word classified document presented to 1300 representatives of industry, universities and other government agencies by NASA officials on July 28-29.

The document comprising 22 papers actually contained only three short sentences which were classified. But, because these three sentences were read at the briefings, the press was barred from the proceedings.

Apollo 3-Man Craft to Follow Mercury

Tests flights could start by '62—if program gets funds; Saturn to be used as booster for earth-orbital missions in '66

Provided they get the money, NASA space specialists hope to begin test flights of a three-man spacecraft successor to *Mercury* by 1962.

As described by George M. Low, Chief of NASA's Manned Space Flight Program, to industry representatives, *Apollo* will be a three-man modular spacecraft that can perform as an earth-orbiting space station or circle man around the moon and bring him back.

Pointing out that *Apollo* "has no official standing as yet," Low optimistically predicts that Congress will give NASA money during FY '62 to turn the proposal into development hardware. He says a prime contract will be let during that fiscal year for design studies, engineering and fabrication.

Low believes that development of *Apollo* will be rapid enough to test early configurations on top of *Atlas-Agena-B's* in 1962. These tests will continue until *Saturn* is available.

"Earth-orbital missions, using the final spacecraft, could conceivably begin in 1966," Low predicts, "with circumlunar missions following as soon as the state of both technical and aeromedical knowledge permits such flights."

Nothing Low said revised the earlier NASA estimate that the U.S. space program would not put a man on the moon before 1970.

The post-*Mercury* program had $2 million alloted to it in FY '60, but this was handed over to *Mercury* when that program's costs began to run well ahead of estimates and when Congress refused to give NASA requested *Mercury* funds. (See M/R, Jan. 11, 1960.)

• **Module concept**—What is now called *Apollo* actually received only $100,000 during FY '60 and $1 million during the present fiscal year.

In order to allow *Apollo* to perform multiple missions, NASA has employed the "building block" concept for this three man spacecraft's theoretical design.

Industry would be called upon to produce a spacecraft consisting of three modules: A command center module, a propulsion module, and a mission module.

As described by Low, the command center module "would house the crew during launch and re-entry phases of flight; it would also serve as the flight control center for the remainder of the mission. We anticipate that this module would be identical for both the circumlunar and earth-orbital missions."

The propulsion module, according to Low, "would serve the primary function of providing safe return to earth in case of an aborted mission. In this sense, it might be compared with the escape tower and retrorockets of the *Mercury* capsule.

"In addition, for circumlunar flight, this component should have the capability of making midcourse corrections; it might also be used to place the spacecraft into an orbit around the moon and eject it from orbit."

In an earth-orbital mission, the propulsion module must, Low stipulated, "permit a degree of maneuverability in orbit or rendezvous with other vehicles."

The mission module, which might not be needed for lesser missions, would vary with the object of the mission.

• **Severe re-entry problem**—For circumlunar flight, Low believes, "it would be used to provide better living quarters than the command center can afford and some equipment for scientific observations."

During earth-orbital missions, the mission module can be considerably larger, taking up poundage used for propellant on longer missions. "This module can usefully serve as an earth-orbiting laboratory, with adequate capacity for scientific instrumentation and reasonable long lifetimes in orbit."

The more important of the three modules, from a design standpoint, is the command module, which must serve its crew during launch and re-entry. This requires an ability to "re-enter the earth's atmosphere at essentially parabolic velocity, or about 36,000 feet. It will have to withstand the severe heating encountered at these velocities, and must be statically stable over the entire speed range from 36,000 feet per second to the landing speed."

It was disclosed at NASA's 1959 Inspection (See M/R, Oct. 19, 1959, p. 11) that the Langley Research Center is already doing extensive research on two new types of heat shields that could give *Apollo* this capability.

One of the two types under study which could withstand greater heat and allow the capsule to have a greater angle of re-entry uses an insulating material which is held in place on the load-carrying structure by a thin metallic outer skin. The outer skin is corrugated to provide a means for absorbing thermal expansion and to provide sufficient stiffness to prevent flutter. This design will be fabricated from a refractory metal such as molybdenum, niobium, or tungsten, and will reduce the temperature of the load carrying structure to 1200° F when the heat shield surface temperatures are 2500° F.

The other type of heat shield under investigation has an added heat-absorbing capacity in the form of water which is stored in a light absorbent material in channels formed by the stiffeners on the structure. This type of shield provides protection to the entire capsule or module structure and can hold the structure's temperature to that of boiling water. A more complicated structure design will be needed because of the difference in temperature between the shield and the structure.

• **Midcourse power**—In order to allow the command module to stay within the rather narrow flight corridor during the period of re-entry, a degree of maneuverability will be required. This can be provided, according to Low, by a midcourse propulsion system.

How much of a role will the three pilots play in maneuvering *Apollo?* Low believes that if Project *Mercury* demonstrates that man can, indeed, perform useful functions in space, "we believe that in all future missions the primary control should be onboard."

Function of the propulsion module will, according to Low, greatly depend on the mission. One duty it must always perform is abort of the manned payload in case of a "catastrophic failure of any of the *Saturn* stages . . ."

Other primary duties of the propulsion module, Low states, will be the ability to correct *Apollo's* course, and to return it from orbit. The propulsion module during more advanced missions must also allow *Apollo* to affect a lunar orbit and to maneuver within its earth orbits.

Once *Apollo* is outside the earth's atmosphere and free of the radiation belts, its three-man crew, according to present planning, can take off their pressure suits, and conduct "shirtsleeve" operations in the mission module.

This comfort will especially be needed, according to Low, during *Apollo's* missions as an earth-orbiting laboratory or during circumlunar orbits. "where it may be desirable to keep" . . . the craft in space . . . "for periods ranging from two weeks to two months."

One important challenge that industry must fulfill before *Apollo* becomes a reality is the development of a 3-man environmental system, that will provide, during certain periods of the flight, the "shirtsleeve" environment.

"These systems," according to Low, "will be incorporated into the command center, the orbiting laboratory, and the circumlunar module. Gaseous-, liquid-, and chemical-oxygen systems all deserve consideration for these applications."

And two other problems calling for solution are the need for a system sensing and controlling the craft's attitude, and power supplies that can provide something like 400 kilowatt hours, with a peak load of roughly four kilowatts.

• **Shielding impractical**—A major problem which must be solved before man goes very far into space for any length of time is radiation.

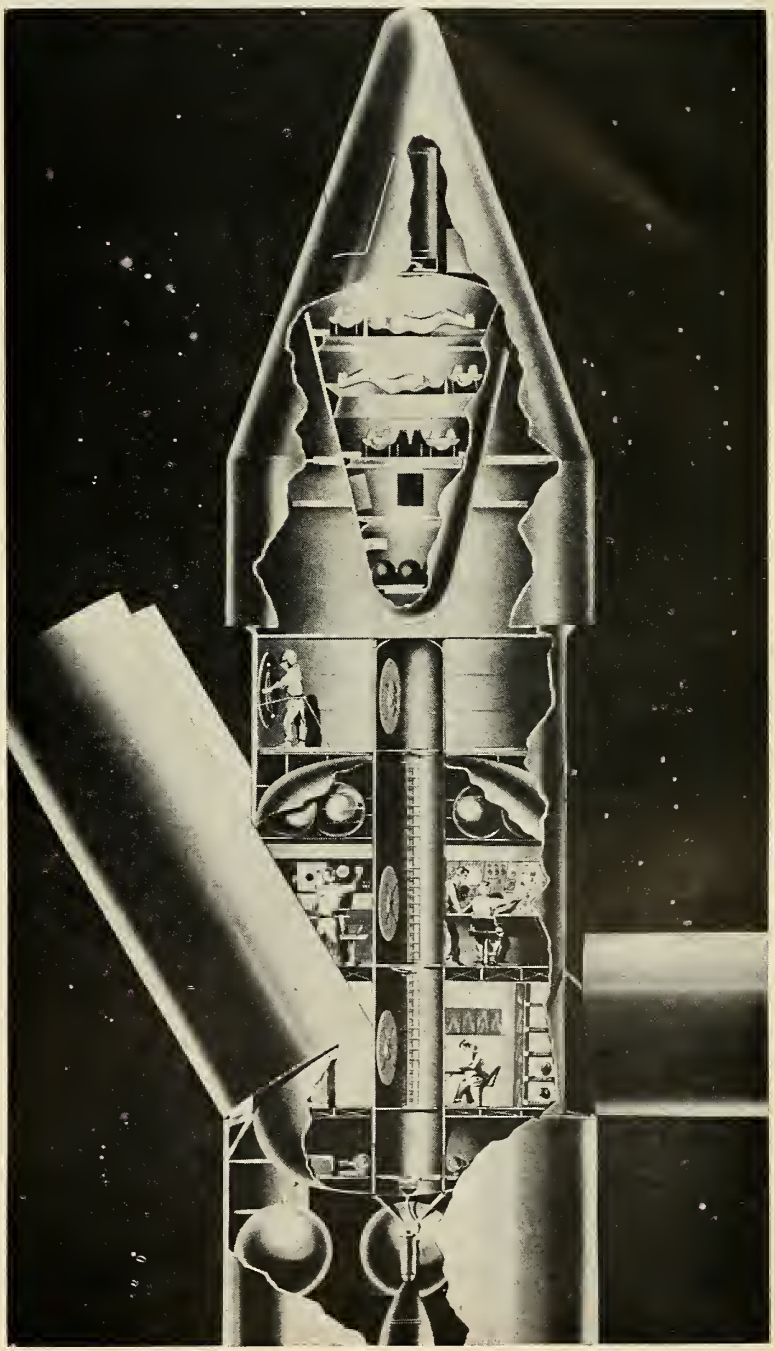
The trapped radiation in the Van Allen belts, which is of rather high intensity but of low energy, can be overcome with only a small amount of shielding.

"The energies of cosmic radiation," according to Low, "are so high that shielding becomes impractical. However, the peak intensity is sufficiently low that no danger is expected in a five-day mission."

The real danger is from solar flares where the energy is "of a magnitude that may require more shielding than is practical from the standpoint of weight."

The only present solution, according to Low, is that "it should be possible to predict these flares," circumventing their danger by "avoiding flights during a time of anticipated major flare activity."

Though NASA does extensive research on *Apollo's* problems in its laboratories, Low believes that the space agency must rely on industry for many of their solutions. He believes that *Apollo* may give the missile and space industry one of their greatest challenges of the space era.



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STEP BEYOND APOLLO could be this space laboratory capable of sustaining a crew of six or more.

Huge Fleet of Unmanned Ships Needed

Funding of spacecraft and payload development—$35 million this fiscal year—expected to swell; rugged instruments are demanded

A total of $35 million will be spent in industry this fiscal year for developing unmanned spacecraft and their payloads for the National Aeronautics and Space Administration. This money is expected to go up with time.

Total NASA money programed this year for unmanned lunar and planetary exploration is $75 million. Of this amount, $20 million is being spent on launch vehicles. The remaining $20 million is being used for NASA in-house work connected with the program.

For its unmanned lunar work during the 60's, NASA will be developing and buying fly-bys, rough orbiters, impactors, stationary soft landers, soft landers with mobile payloads, advanced orbiters, and craft for remote return of surface samples.

NASA is calling for similar but more advanced craft for its unmanned planetary and interplanetary explorations. Thus this program involves deep-space probes, fly-bys of near planets, planet orbiters, planet landers, and higher energy missions such as those out of the plane of the ecliptic or to distant planets.

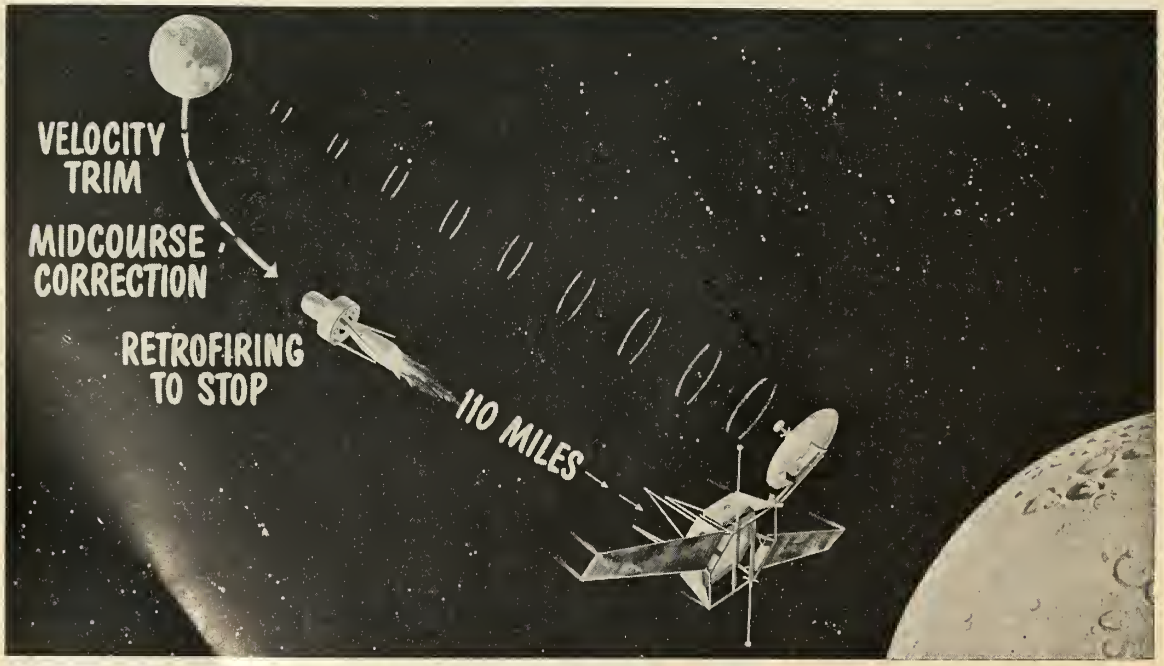
The Jet Propulsion Laboratory under direction of NASA headquarters will be executing the agency's lunar, planetary and interplanetary unmanned program. "JPL will rely heavily on contracting to industry not only for complete spacecraft but also for systems, subsystems, components and parts," says Edgar M. Cortright, Assistant Director for Lunar and Planetary Programs.

He added that universities and non-profit organizations will be playing a major role in developing the scientific experiments.

• **Advanced instruments needed**—One point was understood. "NASA would welcome additional initiative on the part of instrument companies" in devising effective and rugged devices for making environmental and observational measurements.

In his list of needed instruments, Cortright stated that NASA could use the following ones, which fall in the somewhat arbitrary environmental category:

–Radiation detectors of all types



PRELIMINARY CONCEPT of a late phase of Project Ranger. On nearing the moon, the spacecraft's instruments begin taking TV pictures and gamma-ray spectography. The ship then rough-lands, depositing a seismometer on the lunar surface.

covering all ranges of the energy spectrum and hopefully discriminating between particle types and electro-magnetic radiation.

–Micrometeroid detectors.

–Pressure, temperature, and ionization gages.

–Sound detectors and analyzers.

–Mass spectrometers.

Under the category of observational instruments, the ones needed were given as follows:

–Television, ranging all the way from microscopic examination of particles to far-scanning of the lunar terrain.

–Radar to be utilized both on the surface and in orbit to determine not only position but also contour of the land and perhaps some of the surface structure.

–Spectrometers of all types including the X-ray, fluorescent, gamma-ray, and mass varieties.

–Seismometers.

–Magnetometers.

–Penetrometers

–Chemical analyzers.

–Microbiological equipment.

–Gravimeters.

The major problem is to place the required instruments at the exploration site and then have them obtain the desired information and send it back to earth. Cortright said preliminary work on many of these instruments has already begun, and indeed first-generation ones have been flown on a number of occasions.

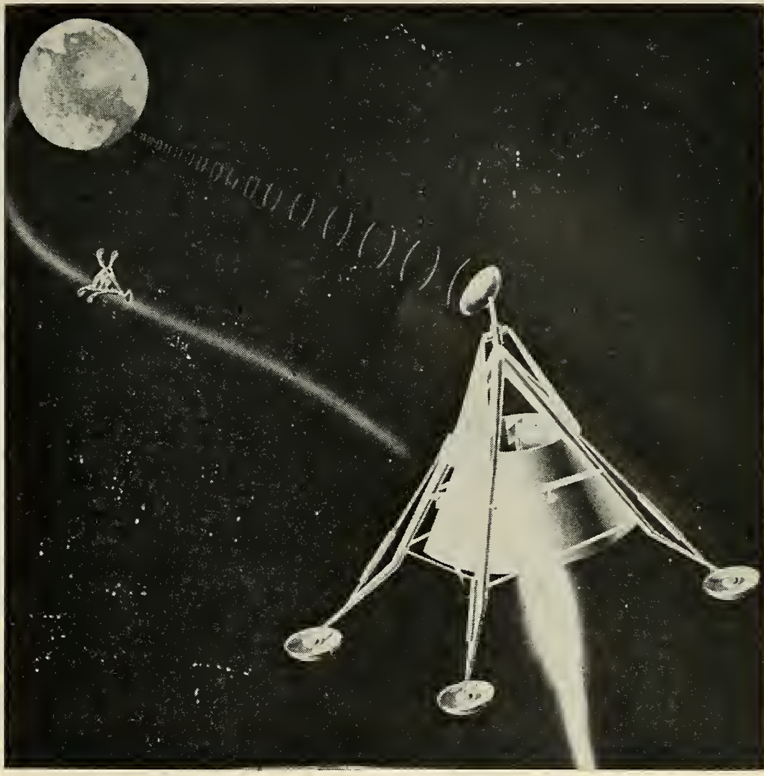
Cortright underscored the need for strong imagination and initiative to develop the advanced equipment required for interplanetary missions. These include high-power telemetry; low-noise receivers; improved power supplies of chemical, solar, and nuclear varieties; and advanced computers to be carried aboard the spacecraft.

• **Mobile planetary vehicles**—Other needs include advanced guidance, navigation and control equipment for both midcourse and terminal phases, and advanced spacecraft propulsion equipment of both the chemical and electrical variety.

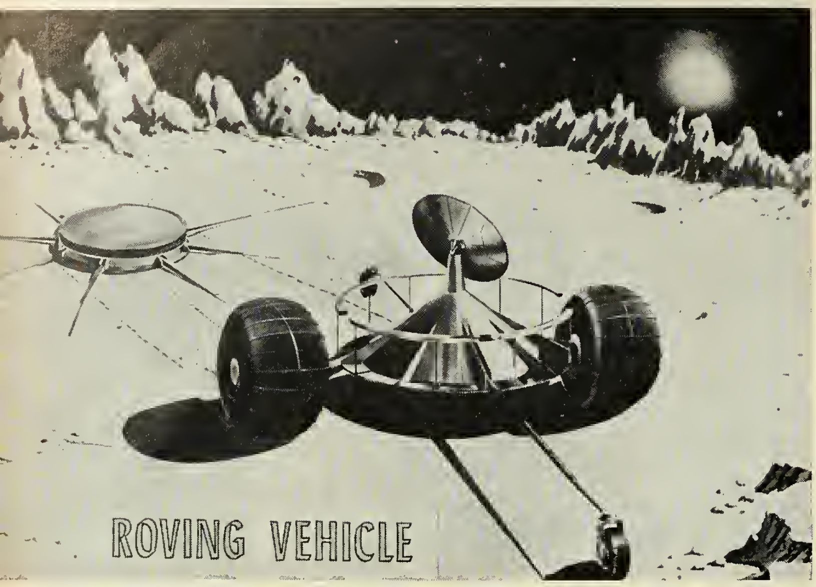
As a matter of fact, electrical propulsion shows definite promise for the more difficult exploratory missions, Cortright said.

There is a requirement for improved lightweight spacecraft structures and packaging techniques. Furthermore, methods must be developed for entry and survival in the planetary atmospheres. Equipment must be researched and developed for sample gathering and processing through the scientific instruments.

A major problem exists in developing propulsion techniques for mobile surface exploration vehicles. The ve-



PROJECT SURVEYOR spacecraft, powered by a Centaur launch vehicle, would make a soft landing on the moon carrying a payload of some 200 lbs. of instruments.



ARTIST'S CONCEPTION of Prospector spacecraft, shown in background, and roving vehicle that craft deposited on lunar surface for exploring the nearby terrain.

hicle planned for *Prospector* will be capable of exploring throughout a radius of perhaps 50 miles, terrain permitting. It would obtain orders of magnitude more data than could be obtained with a stationary spacecraft.

Cortright emphasized that "applying to all of these technological areas, and to the instruments as well, is the vital necessity for improved length of life and reliability."

The objectives in NASA's program of unmanned instrumented deep-space exploration can be roughly grouped into:

–Physics of the moon and planets.

–Solar and interplanetary physics.

–Biosciences and extraterrestrial life.

–Cosmology.

With these objectives in mind, NASA has devised its unmanned deep-space program under two governing principles: (1) Selection of a limited number of important goals on which to concentrate. (2) Establishment of an evolutionary sequence of missions where each step paves the way for the more difficult phase to follow and makes full use of increased technological capability as it becomes available.

Program for Unmanned Lunar and Interplanetary Spacecraft

Project Name	Mission	Launch Vehicle	Status	Notes
Spacecraft Under Development				
(none)	lunar orbiter	Atlas-Able	Previous flight attempt aborted 11/26/59. Next shot expected October 1960. Craft developed by Space Technology Laboratories reporting through Air Force Ballistic Missile Div. to the Goddard Space Flight Center.	Spacecraft weighs about 400 lbs., including the hydrazine monopropellant for midcourse and terminal maneuvers, is spin-stabilized, and carries eight separate experiments. Looks very much like Pioneer V.
Ranger	interplanetary flights	Atlas-Agena B	A set of seven scientific experiments have been approved for flight. First flight planned for 1961.	Spacecraft weights will vary between 600 and 1200 lbs. Flights intended primarily to test spacecraft and components development.
Mariner	flights to Mars and Venus	Atlas-Agena B	First flight planned for 1961.	Differs from Ranger primarily in instrumentation carried.
Ranger (later phase)	lunar landing, rough but safe	Atlas-Agena B	Planned for 1961-2. Spacecraft being developed by Jet Propulsion Laboratory; capsule under contract to Aeronutronics Div. of Ford Motor Co.	Spacecraft designed to carry a survivable capsule containing a seismometer as the primary experiment.
Spacecraft Being Planned				
Surveyor	lunar soft landing	Centaur	Four companies currently making spacecraft design studies which are to be completed by end of 1960. Developer of hardware to be selected early 1961. Landings planned for 1963-4.	Spacecraft for putting on moon a moderately heavy scientific payload, 100 to 300 lbs.
Prospector	lunar soft landing	Saturn	Planned for 1965. Under study by the Jet Propulsion Laboratory, and by the Marshall Space Flight Center for JPL.	First priority payload is a mobile laboratory able to explore near-terrain.
Voyager	Mars and Venus orbiter	Saturn	Planned for 1965.	Orbiter ejects instrument capsule for atmospheric entry and perhaps landing on planet. Data relayed from capsule to orbiter, and then to earth.

Agency Eyes Standardized Satellite

Multi-purpose concept would save money, add reliability; survey of satellite application plans, long-range launching program

National Aeronautics and Space Administration is thinking of developing a standardized satellite which it can use for its orbiting astronomical and geophysical observatories.

Morton J. Stoller, assistant director for the Satellite and Sounding Rocket Program, says that if the concept can be developed successfully, a number of future space experiments would be conducted with the vehicle.

The standardized units would employ the same structure, same basic power supply, attitude control, telemetry and command system. Built to carry large payloads (the orbiting astronomical laboratory will weigh 3500 lbs.), NASA would have only to take it "off-the-shelf" and put in the scientific sensors and specialized devices it wants to do a specific job. This would result not only in a savings in cost and time, but significantly increase reliability.

For FY 1961, the agency has programed $33 million for satellite scientific experiments. An additional $15 million will go to the meteorological satellite program and $5.5 million for communication satellites. Sounding rocket studies will get $5.5 million, with $2.5 million going for sounding rocket vehicle procurement.

Industry can expect to get the lion's share of this money. NASA says about 75% of the spaceflight program funds will go to private industry, 5% to university and other non-profit research organizations, and 20% to NASA installations.

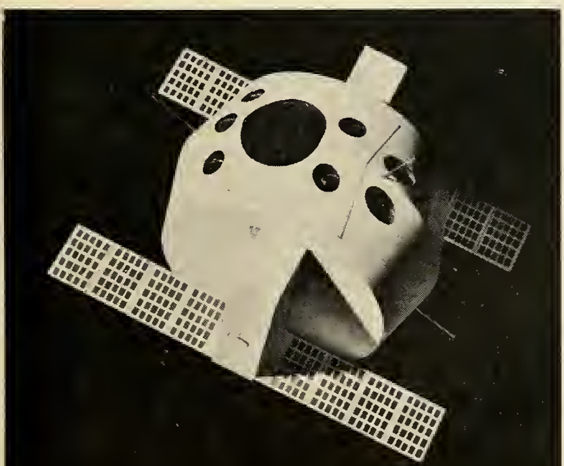
SATELLITE APPLICATION PROGRAM

There are two major fields in this program—meteorology and communication. NASA cautions that because of its experimental nature, the program is subject to change. However, Newell D. Sanders, assistant director for applications and manned flight programs, announced this schedule:

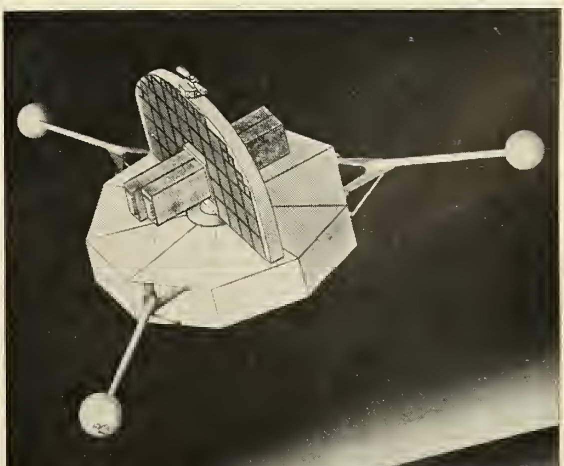
• **Meteorological:**—*Tiros*—Follow-on experiments to *Tiros I,* launched in April are scheduled during 1960 and 1961. Infrared equipment will be added for measuring the earth's heat balance and for measuring radiation in particular spectral ranges.

–*Nimbus*—Now under development, a systems integration and basic structure contract will be awarded this fall. Specifications are now being written and the invitation for proposals is imminent. Other contracts to be awarded separately are for the stabilization system, power supply, sensing equipment and special experiments to be carried aboard.

Managed by the Goddard Space Flight Center, the 600-700 lb. satellite will be launched by *Thor-Agena.* A stabilization system will keep cameras pointed earthward. Sensors will include television cameras, passive and scan-type radiation-sending equipment and



LARGEST PAYLOAD U.S. has attempted so far, 3500-lb. NASA Orbiting Astronomical Observatory will be about 10 feet in diameter.



SOLAR OBSERVATORY will weigh about 350 lbs. Large flywheel and extended arms rotate to stabilize; arm (top) holds instruments.

other experiments. Later models may include simplified radar for observing precipitation, spectrometer for temperature measurement and an image orthicon camera for observing night cloud cover.

–*Aeros*—Not yet approved, the code name *Aeros* has been selected for a proposed "24-hour satellite" which might be initiated in 1962 with possible launchings in 1964. The satellite would be launched in an equatorial orbit which would make it appear to stand stationary, since its orbital period would coincide with the earth's rotational period. Three satellites could permit continuous observation of most of the earth's surface.

NASA asks industry for ideas on feasible methods and devices for atmosphere measurement. Areas which must be measured and observed are: a) cloud cover and storm location, b) precipitation, c) temperature, d) wind direction, e) heat balance, f) water vapor and other constituents.

• **Communications**—The civilian space agency has thus far confined its research to passive satellites, while DOD has studied active satellites. Active satellites later will be evaluated by NASA. Projects forthcoming at NASA:

–*Echo*—Follow-on experiments are scheduled in 1961 and 1962 with *Thor-Delta* launch vehicles. Langley Research Center is now evaluating bids for a satellite launching in this series using a rigid, large reflecting structure. Launch will come in 1962 if this concept proves feasible.

Current *Echo* experiments have been concerned with problems of inflating and orbiting large erectable satellites. Jet Propulsion Laboratory at Goldstone, Calif. and Bell Telephone Laboratories facility at Holmdel, N.J. are planning further communications experiments, as are other independent organizations.

–*Rebound*—Experiments with multiple passive communications satellites are being considered. NASA feels that at least 12 passive communications satellites spaced around the world would provide continuous communication. However, several such satellites would have to be launched by one vehicle, possibly *Atlas-Agena B*, to make the plan economically feasible.

Early projects will attempt the packaging and erecting of reflectors upon injection into orbit. The next step will be the problem of providing period control for multiple passive satellites. If all goes well, launchings might come in 1963-65.

Research and development work also is taking place at JPL and Bell Telephone Labs on ground communications facilities required for acquiring and holding the satellite—pointing the antenna—and for establishing optimum signal-modulation requirements. Studies on reflective characteristics of non-spherical shapes also will be conducted.

SATELLITE AND SOUNDING ROCKET PROGRAM

NASA plans to launch four large satellites for scientific experiment per year by 1964. Small satellites will be launched at the rate of six to nine per year now with six per year by 1963 (generally by *Scout*). One hundred sounding rockets will be launched per year by 1962.

• **Off-the-shelf**—Components will be directly or indirectly procured from commercial sources, and the agency wants to establish stable sources of supplies. Standardization and reliability are keywords in this program.

Fields in which these satellites and rockets will be employed are: 1) geodesy and gravitation, 2) upper atmosphere, 3) ionosphere, 4) magnetic and electric fields, 5) radiation belts, 6) cosmic rays, 7) the Sun, 8) solar terrestrial relations, 9) the stars, 10) biosciences. This area of research will not concern moon, planets and interplanetary space.

• **Sounding rockets**—A limited num-

Key Areas for Industry Participation

Communications satellites:

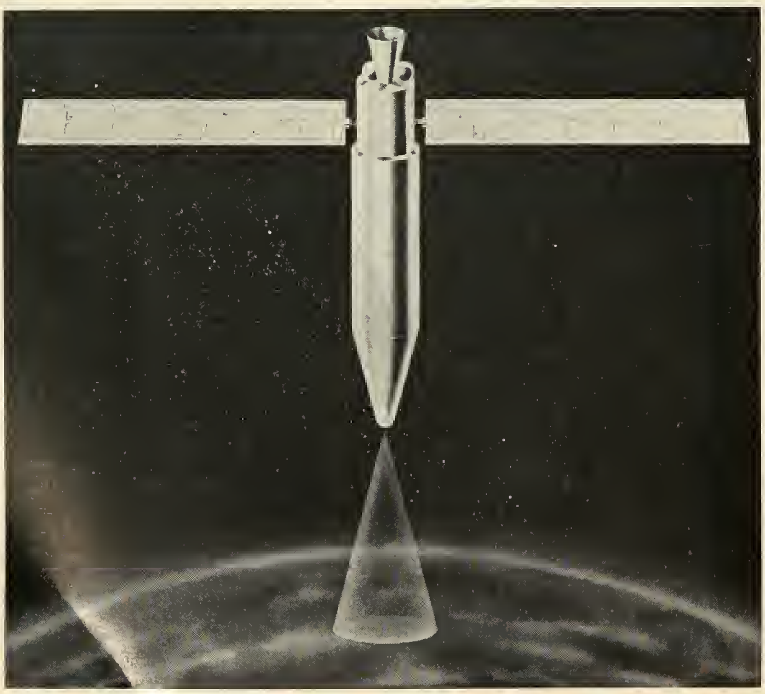
- Inflatable structures
- Plastics for space environment
- Passive stabilization
- Period control systems

Scientific studies:

- Ion mass spectrometers, vacuum gages
- Radiation detectors and analyzers
- Ultraviolet and X-Ray detectors and analyzers
- Directional magnetometers
- Plasma probes
- Telescope pointing controls

Meteorological satellites:

- Attitude sensors and stabilization systems
- High-resolution RV systems
- Data-storage systems
- Data-transmission systems
- On-board data-analysis systems
- Period control systems
- Materials for space environment
- Power supplies
- Radar



NIMBUS STABILIZATION system will keep cameras pointed earthward. Paddles carry solar cells to power subsystems. Contracts for 600-700 lb. Nimbus are due in fall.

ber of sounding rockets will be used for all research. At present, NASA has 11 types in fairly regular use, including the highly sucessful *Aerobee—Hi.* Goddard Space Flight Center will, however, ask proposals when improvements on existing models seem necessary.

Commercial electronic and mechanical systems such as telemetry, power supply units and tracking aids will be used for the sounding rocket program whenever possible. Industry and research groups are asked for work on sensors and instrumentation for the scientific investigation.

• **Earth satellites**—Two satellite systems will, in the near future, be procured from industrial sources by Goddard Space Flight Center. Spacecraft systems contractor will be selected through regular procurement procedures, with experiments handled separately.

–Orbiting Astronomical Observatory—Bids have been received and are now being considered for the largest payload attempted to date—3500 lbs. Cost of the program may mean as much as $100 million over 10 years to the winner.

In the running are: Lockheed MSD, Aeronutronics Div. of Ford Motor Co., Hughes Aircraft and General Electric MSD. Team bids are: Bendix/Republic Aviation, Systems Div., Martin Co./General Precision Instruments Inc., Westinghouse Electric/Grumman Aircraft, Aerojet-General/Motorola, McDonnell Aircraft/Philco, RCA/North American Aviation/Perkin-Elmer, and Douglas Aircraft/Itek Corp./IBM/Vidya of Massachusetts Institute of Technology.

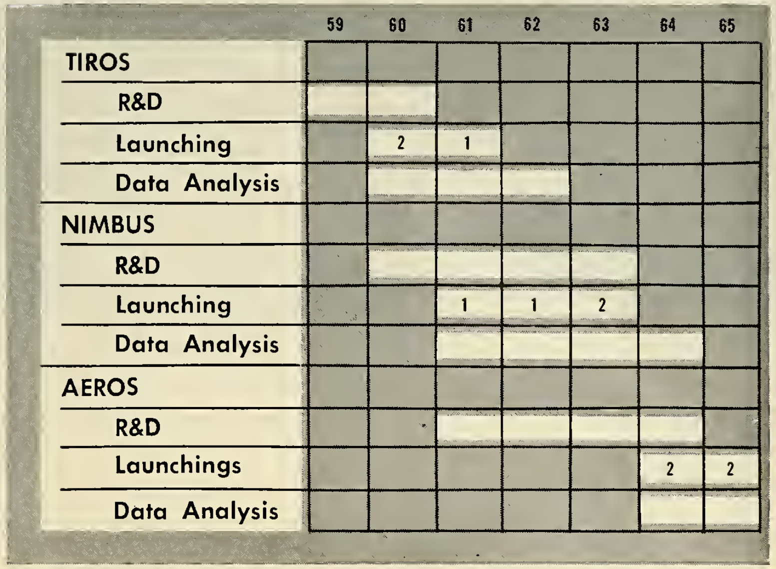
–Orbiting Geophysical Observatory—Procurement action will be initiated in four to six months, probably in the form of an inquiry as to interest in submitting a proposal. Standardization of components and systems is again expected to be emphasized.

NASA wants help on problems of efficient ways of dissipating heat released in course of operation of the international devices, since the temperature range must be restricted for stable performance. Improvement also is desired in environmental control and "desensitization" of components and subsystems.

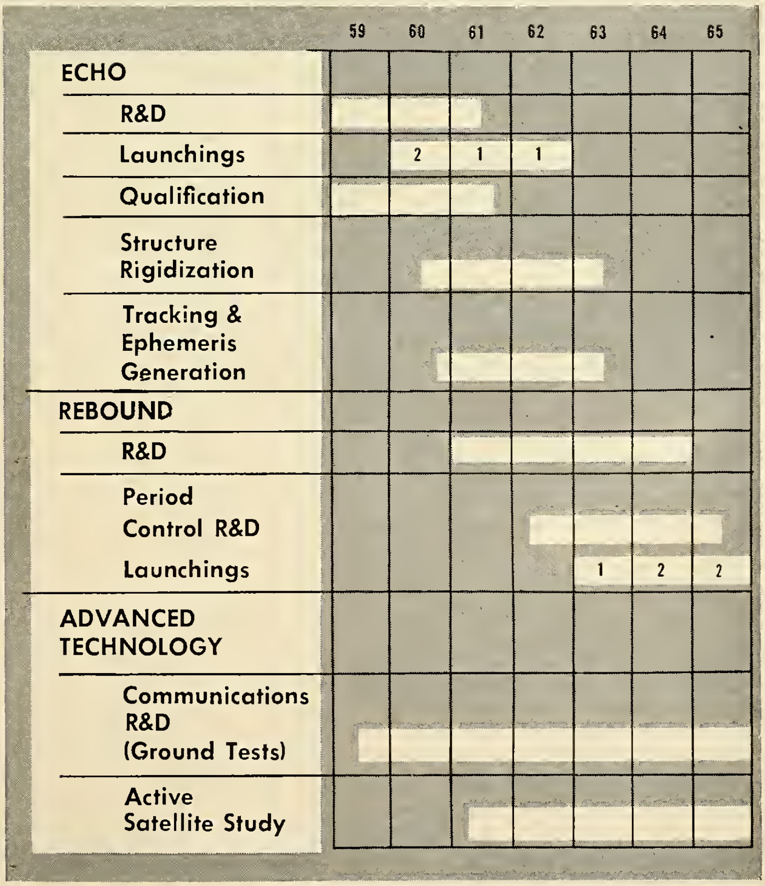
• **Data Collection and Processing**—One of the biggest problems in the satellite and sounding rockets programs will be the processing of the enormous amounts of data that can be obtained. Industry is asked for work on preprocessing and automatic processing techniques for both satellite and ground readout stations. Specialized requirements will be announced later as each program progresses.

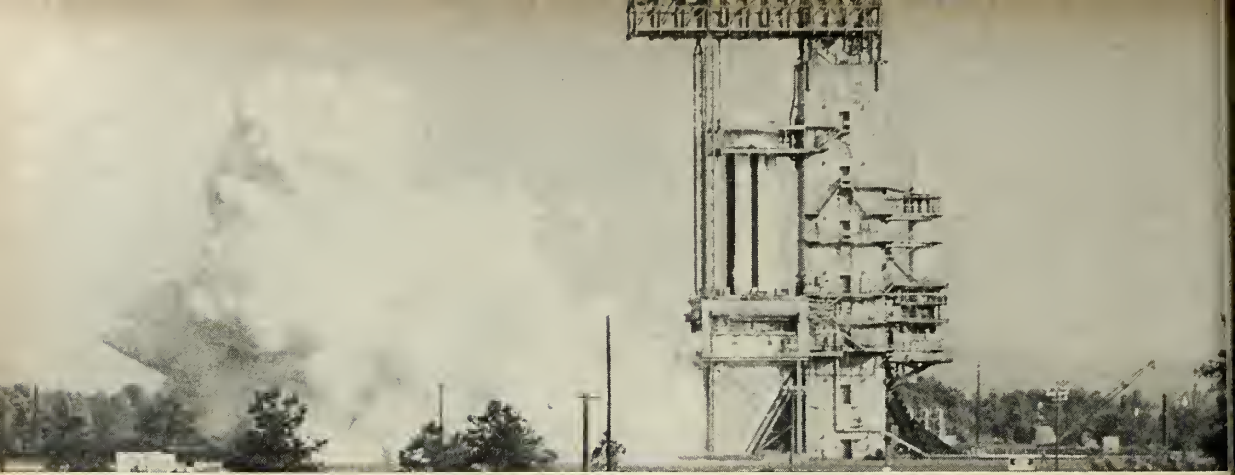
NASA Satellite Application Program

METEOROLOGICAL



COMMUNICATIONS





SATURN STATIC TEST at NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

NASA
SPECIAL REPORT

Launch Vehicle List May Drop to Four

Survey of propulsion plans includes Saturn schedule and programs for nuclear, electrical and chemical power

The National Aeronautics and Space Administration is reducing from 10 to six the number of launch vehicles it will use. The number may drop to four later.

Abraham Hayatt, deputy director of launch vehicle programs, outlined the plans at last week's conference with industry, government and university representatives.

Present vehicles in development or operation, in ascending order of payload capacity, are *Juno II, Scout, Thor-Able, Delta, Thor-Agena B, Centaur* and *Saturn. Juno II, Thor-Able, Delta* and *Atlas-Able* will be dropped from the list.

Atlas remains on the list only for its mission of orbiting *Mercury* capsules. Heavier manned vehicles will require launch equipment of *Centaur* or *Saturn* type.

"Only eight *Thor-Agena B*'s are programed for NASA missions," Hyatt said. "Therefore, it too may disappear from the picture, particularly if *Thor* production for Air Force requirements ceases."

Thus the list will reduce to four—*Scout, Atlas-Agena B, Centaur* and *Saturn*—until programs get under way later in the decade on advanced *Saturn* and *Nova* vehicles.

• **Scout**—Hyatt disclosed that the estimated cost of a production *Scout* plus the launching operation is $900,000. This is greater than the $750,000 figure given earlier this year because launch operation costs were not included. At present, *Scout* is launched by government personnel. Later, the operation is to be turned over to a contractor completely.

Despite the rising estimate, Hyatt maintained that low cost is one of *Scout's* principal merits. "In comparison," he said, "to buy and launch a *Delta* may cost as much as $3,500,000."

Scout has a capacity of putting 200 lbs. into a 300-nautical-mile orbit or lifting smaller payloads on vertical probes up to 4000 miles. It will be launched from both the Atlantic and Pacific Missile Ranges as well as from Wallops Island, Va. Development is to be complete within a year.

• **Thor-Agena B**—An advanced version of the *Thor-Agena,* which the Air Force has been using in its *Discoverer* program, *Thor-Agena B* will be used at the Pacific Missile Range for launchings into polar orbit or highly inclined earth orbits.

Hyatt said the vehicle was chosen because of the relatively high reliability *Thor-Agena* has demonstrated for putting payloads into orbit. It will be used for such missions as scientific satellites, meteorological satellites and other missions requiring medium-weight payloads. The capacity will be 1600 lbs. in a 300-nautical-mile orbit and 850 lbs. in a 1200-nautical-mile orbit. Flights will begin next year.

• **Atlas-Agena B**—The Air Force will undertake several firings of *Atlas-Agena B* before it is used for a NASA mission. Common use by NASA and the Air Force will provide a large number of launchings and thus high reliability, Hyatt said.

NASA plans to use the vehicle for early lunar exploration and scientific earth satellites.

Most NASA launchings will be from the Atlantic Missile Range. A few will be from the Pacific Missile Range. First NASA launching will be early in 1961. Its payload capacity is 5800 lbs. in a 300-nautical-mile orbit and 750 lbs. for a lunar probe.

• **Centaur**—Design of the hydrogen-oxygen *Centaur* stage, will be atop an *Atlas,* is rapidly nearing completion, Hyatt said. *Centaur,* which will be launched in mid-1961, has an inertial guidance system with many advanced features.

Centaur will be used for lunar and planetary exploration and, geophysical satellites. It will be launched down the Atlantic Missile Range. Payload capacity is 8500 lbs. in 300-nautical-mile orbit or 1450 lbs. for escape velocity.

• **Saturn**—Oswald H. Lange, *Saturn* Project director at the Marshall Space Flight Center in Huntsville, Ala., outlined the first 10 *Saturn* vehicle flights, based on the 10 boosters to be fabricated at Huntsville.

There will be three flights of the booster and dummy upper stages, one in 1961 and two in 1962. Three flights will be of booster, live second stage and dummy third stage—one in 1962 and two in 1963. Three firings of three-stage test vehicles in 1963 will precede the first flight of the operational prototype in 1964.

In the first three flights with dummy upper stages, the H-1 engines will be operated at a thrust level of 165,000 lbs., giving a total thrust of 1.3 million lbs. Subsequent vehicles will have booster thrust at 1.5 million lbs.

The first *Saturn* vehicles to fly will be the C-1 configuration—made up of the booster, the Douglas S-IV and the Convair S-V. The S-V is a modification of the *Centaur* stage. The S-IV stage is similar to *Centaur* but has four, instead of two, Pratt & Whitney LR-115 engines.

The next version of *Saturn* will be the four-stage *Saturn* C-2. The new second stage will be the S-II, a cluster of four 200,000-lb.-thrust Rocketdyne J-2 engines. Lange said specifications for the stage depend on definitive information on the engine and will be formulated near the end of this year. Selection of a contractor for S-II is tentatively scheduled for the spring of 1962.

Lange gave these net payload capabilities for the *Saturn* C-1 vehicles:

100-mile orbit	20,000 lbs.
307-mile orbit	19,000 lbs.
Escape	6000 lbs.
24-hour orbit	3400 lbs.
Lunar soft landing	1500 lbs.

• **Nuclear propulsion**—Several NASA contracts to industry will be awarded soon in support of Project *Rover,* the NASA-Atomic Energy Commission nuclear rocket. Harold B. Finger, NASA chief of nuclear propulsion, said preliminary design work on the nuclear engine is being completed so that hardware development on a flight-test engine can begin immediately after tests have been run on a reactor using liquid hydrogen as a propellant.

Finger gave no details on the liquid hydrogen reactor test. However, AEC sources have indicated that testing of the reactor, Kiwi-B, is planned for the summer of 1961.

Finger said industry would develop the hardware. Apparently, the contract is to be awarded in the fall of 1961.

To meet plans for a 1965 flight test, Finger said, it is necessary to begin work on facilities required for developing the engine and vehicle as soon as possible. The facilities work will be handled by industry.

• **Electrical propulsion**—Finger said that according to present programing, the SNAP-8 nuclear power system will be developed to give a 90-day operating life in 3½ years and a 1-year life in 5 years. SNAP-8 will provide 30 kilowatts of power for an electrical propulsion system.

Elliot Mitchell, assistant director for propulsion in the Office of Launch Vehicle Programs, said a 30-kilowatt arc jet engine and a 30-kilowatt ion engine are being developed for readiness about 1965. The program also includes feasibility studies on a magnetohydrodynamic engine.

• **Chemical rockets**—The Rocketdyne F-1 engine, rated at 1½ million lbs. thrust, has been fired several times at thrust levels in excess of 1 million lbs., Mitchell reported.

In solid rockets, NASA is devoting considerable effort to reducing rocket inert weight in upper stages. Mitchell said it should be possible to go from the present maximum mass ratio of about 90% as high as 96%.

Large solid booster design studies will be continued to determine their feasibility as first stages for future NASA vehicles, Mitchell said.

Mitchell gave this breakdown of current propulsion spending:

–Engine development (H-1, F-1, LR-115 and J-2) .....$93.5 million

–Advanced liquid technology ....$6 million

–Solid rockets ......$2.8 million

–Electrical propulsion, $3.3 million

NASA is spending $10 million in the nuclear area—$5.5 million for nuclear rockets and $4.5 million for nuclear electric generating systems. However, the matching AEC expenditures are several times those of NASA.

In the current fiscal year, on the Saturn *project alone, NASA is spending about $160 million with industry for design efforts, component development and delivery.*

Focal point for industry contact is the Saturn Systems Office at the Marshall Space Flight Center, Huntsville, Ala., headed by Oswald H. Lange. Items under development contract or required soon from industry include:

—Guidance components

—Control equipment

—Telemetry

—Range Safety

—Tracking equipment including transmitters, receivers, transponders and antennae

—Advanced pressurization schemes

—Propellant level control devices

The budget for Fiscal Year 1962 is expected to provide for a consistently large share committed to industry, Lange said.

Orbital Missions

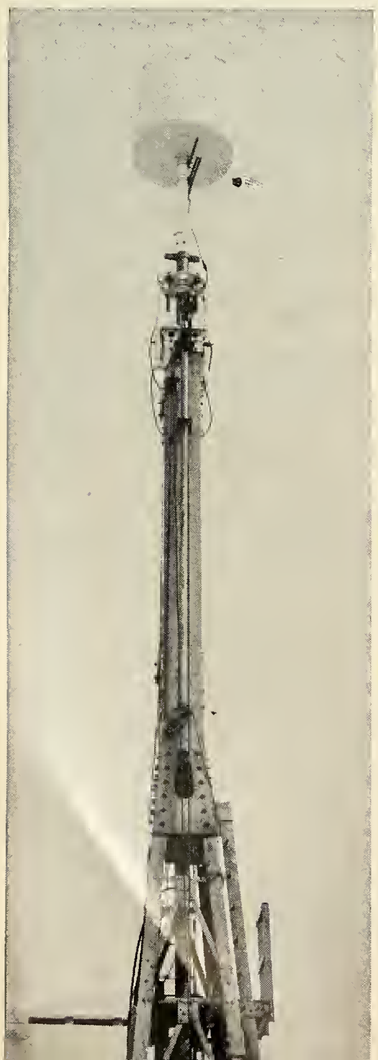
Payload Requirements		Vehicle Boost Capacities	
		Scout	200 lbs.
Geophysical, Meteorological	500-2000 lbs.	Thor-Agena B	1600 lbs.
Orbiting Astronomical Observatory	3500-6000 lbs.	Atlas-Agena B	5800 lbs.
		Centaur	8500 lbs.

Escape Missions

Payload Requirements		Vehicle Boost Capacities	
Geophysics—highly elliptical orbits, rough lunar landings	500-1500 lbs.	Atlas-Agena B	800 lbs.
		Centaur	1450 lbs.
Planet orbiters, soft lunar landings (static package)	2000-3500 lbs.	Saturn C-1	9000 lbs.
		Saturn C-2	15,000 lbs.
		Nova	120,000-200,000 lbs.
3-man circumlunar flight; moon surface exploration; planet probes	10,000-20,000 lbs.		
Manned lunar landing and return	100,000-200,000 lbs.		

Future Will See Vast Boost In Tracking

Big business of ground instrumentation will grow even bigger tomorrow



The number and capability of ground instrumentation stations must be tremendously expanded in the next ten years to meet tracking and data gathering requirements of future space satellites.

Anticipated NASA firing schedules indicate that there may be 150 to 200 artificial satellites in orbit between 1965 and 1970. Forty of these could be transmitting vehicles.

According to E. C. Buckley, assistant director for space flight operations at NASA—who outlined projected space operations in last week's industry briefings—demand on tracking and data collecting systems will be greatly increased by future requirements.

He pointed out that the primary purpose of carrying out space flight programs is to obtain information about the space environment. Therefore, the provision of adequate ground instrumentation to track the space vehicle and to acquire and record accurately the data gathered by its instruments is of paramount importance.

Buckley said that both capacity and capability must be increased: capacity of ground data collecting systems to handle higher rates of information transmitted from space vehicles to earth, and capability of ground instrumentation for operation over much longer ranges.

These increased requirements will, NASA anticipates, be met mostly by development and installation of higher capacity facilities at existing tracking sites rather than by establishment of new sites.

Buckley cited several areas where research and development are needed to provide these increased instrumentation capabilities:

–Automatic data handling
–Wideband communication links
–Satellite beacons
–Improved programing
–Low-noise amplifiers
–Improved data coding
–Increased information bandwidth
–Large ground antennas

Basic aim of deep space communications R&D is to increase both capacity and range of the space-earth data link. More efficient instrumentation, data coding, and transmission techniques were cited as possible areas of fruitful research.

Getting down to specifics, Buckley said that NASA's major R&D effort in ground instrumentation is expected to be in six areas:

–Information theory—Emphasis on improvements in communications efficiency and data-handling techniques based on application of information theory.

–Data reduction and computation—Effort in basic R&D directed toward rapid and random-access computer memories suitable to data reduction and orbit computation together with development of techniques to reduce data reduction effort.

–Low-noise multipurpose receiver components—Development of phase-stable, low-noise, parametric or maser amplifiers for ground and spaceborne applications in frequency ranges near 400, 1400, 1700, and 2300 mc.

–Data communications between sites on earth—New and improved methods of reliable data transmission to effectively make use of tracking and telemetered data.

–Large aperture antennas—Increased ranges and information collecting capabilities of space probes will require larger ground antennas with high-gain, low-noise characteristics suitable for multiple or broad frequency bands.

–Long-term reliability—Although the greatest problem is in spacecraft, reliability is also a problem in the ground complex. A critical phase of a deep-space mission may occur when only one tracking site is in view of the spacecraft, and the success of the mission would depend upon proper transmission of commands to the spacecraft.

• **Big business**—Ground instrumentation is a big business today and, based on NASA's program, will be even bigger in the future.

In fiscal year 1961, approximately $32 million is programed for the completion of our satellite tracking networks and $44.8 million for their operation. The latter figure contains $22.8 million for the *Mercury* network, including recovery costs. In addition, $10 million is programed for advanced development of ground instrumentation.

The total capital cost of Minitrack stations will be approximately $16 million. Capital costs of three large-antenna installations—Goldstone, South Africa, and Australia—will amount to about $17 million.

Total cost of the *Mercury* network now being installed will be around $53 million. Annual bill for communications tying the networks together—using a combination of commercial-leased and DOD circuits—will add up to some $8 million. Total expenditure for instrumentation and equipment at Wallops Island from 1959 through fiscal 1961 will be about $14 million.

In spelling out the future for ground instrumentation for NASA's space flight operations, Buckley pointed out that the program is "dynamic and subject to change as we progress in the field of space research."

←

'FEED' mounted on antenna tower at Jodrell Bank receives Pioneer V signals.

Stress on Fuel Cells, Solar Systems

Electrical power research aims for lighter, more reliable solar and chemical sources; nuclear systems get less attention

Key sub-system in all space vehicles is the primary electrical power systems. NASA's FY 1961 budget calls for a funding of $4.7 million in this category with a concentrated effort on fuel cells and solar energy systems.

Batteries will be improved but the trend is to replace them as soon as possible with more efficient, cheaper, lightweight systems. Current and near future use is dictated by their proven reliability.

Nuclear systems are progressing satisfactorily but the emphasis has waned.

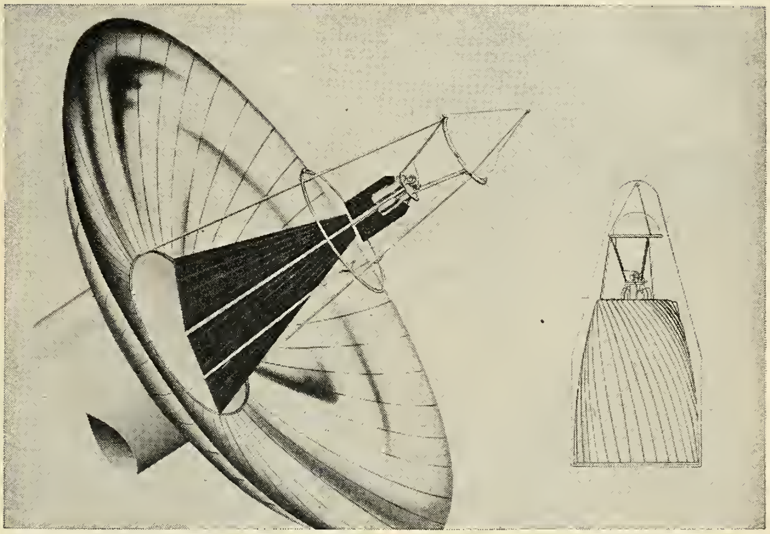
• **New payload needs**—Through 1963, average electrical power-level requirements for vehicles now scheduled is under 300 watts. NASA's William C. Cooley described what the vehicles are and what the power sources will be through the 1960's.

–Unmanned: silicon solar cells with storage batteries; *Scout* or *Delta* launched satellites—10 w; *Pioneer V* and *Tiros* type satellites—30 w; *Nimbus* (meteorological) 250 w average; *Ranger* (lunar instrument landing)—115 w, regulated, in flight and 0.2 w for 1-3 months after landing: Mars probe—over 500 w.

–Manned: *Mercury* capsule—144 lbs. silver-zinc batteries for average orbit power of 70 w, peak 1 kw; lunar circumnavigation, *Saturn* launched, 1965—1.2 kw for 14 days for 4 kw peak; orbiting laboratory, late 1960's—1 to 3 kw average with 4 to 6 kw peak.

• **Advanced power research**—Lightweight, reliable solar and chemical energy sources will receive heavy emphasis under scheduled NASA R&D. Two general programs are in effect—one for system improvement and one for new advanced systems.

–Chemical—to lift reliability of storage batteries for near-vacuum operation, Space Technology Labs. has the task of determining life capability of nickel-cadmium batteries in simulated space environments. In cooperation with DOD, more contracts will be let to improve secondary batteries.



ARTIST'S DRAWINGS show how Sunflower system will operate. At left, the collector of solar heat. At right, a detailed view of the system's turbogenerator.

Although energy-limited by chemical weight limitations in space use, chemical sources—particularly fuel cells—avoid sun-orientation problems inherent with solar power units or the hazards of nuclear systems. This is especially true for short-time manned missions up to about 2 weeks.

At least one and probably more contracts will be let to prove feasibility and develop fuel cells for space use. Biggest problem in zero-gravity state is controlling phase separation between liquid water and gaseous fuel.

–Solar—Two serious problems plague silicon solar-cell power supplies: exorbitant cost ($500,000/kilowatt) and Van Allen belt radiation degradation. The radiation damage is now being investigated for NASA by RCA.

It is hoped however that the whole problem can be bypassed with development of solar-mechanical and solar-thermionic systems. Not as sensitive, they offer the additional advantages of using thermal energy storage instead of batteries and reduced production cost per kilowatt capacity.

For *Centaur* or *Saturn* vehicles in 1964 the Sunflower program is now underway for development of a 3-kw, 1-year continuous output. Tapco Group of Thompson Ramo Wooldridge will produce the solar-turboelectric system using a mercury Rankine cycle and molten lithium hydride as the storage material.

A second system to be started this fiscal year is one using cesium vapor thermionic converters. In support of these contracts also will be studies of materials and optics for better solar collectors.

–Nuclear—The SNAP-8 30-kw system for nuclear electric power is to be designed primarily for flight testing electrical propulsion systems. SNAP-8 will use a mercury turbine in the conversion system being developed by Aerojet-General Corp.

More R&D Money for Structures, Materials

The structures and materials research budget of the National Aeronautics and Space Administration is currently hovering around $15 million—and several increases are anticipated in the next few years.

Richard V. Rhode, Assistant Director, Structures, Materials and Operating Problems, reports that this money is about evenly divided between the two fields.

In outlining the major research areas, Rhode breaks down the problems into four categories—aircraft, missiles and launch vehicles, spacecraft, and re-entry and landing vehicles.

In aircraft, the NASA expert said that aluminum alloys will not be satisfactory for speeds in excess of Mach 2. Steels and even beryllium are being investigated as structural materials. The relative merits of various structural approaches such as skin stringer and sandwich types. The latter seem to be more efficient but higher cost and fabrication difficulties will affect the degree of acceptance.

In launch vehicles, NASA expects the lengths to exceed 200 ft. and weights to be in the +1 million lb. range. Rhode points out that the importance of light structural weight leads to flimsy and flexible boosters. Thus there are problems in launch dynamics, wind shear response, flutter, noise vibration and compatibility with cryogenic environments.

Launch dynamics are complicated by the interaction of the vehicle structure, control system and the sloshing of large fluid masses.

• **Deep space vehicle**—Spacecraft design and operation include meteorite impact, long time vacuum exposure and the effects of particle radiation. This last is damaging to some types of materials but the problem is compounded by the presence of humans.

Rhode said that temperature controls and the techniques for expandable structures also require additional study.

The question of meteorite impact has led to many investigations at NASA and elsewhere. It has been established that penetration at high speeds is not nearly as deep as previously thought. This is because the projectile and the target become molten at instant of impact and the projectile disintegrates.

In re-entry vehicles, the thermal protection problems have dominated the area. A wide variety of re-entry bodies are currently being studied at NASA. These include both drag and lift configurations.

In the lift vehicles, problems of aerothermoelasticity and flutter are expected to be important. Landing impact problems, either on earth or somewhere else, are also receiving some attention.

• **Expanding boundaries**—Thermal protection systems have been explored and exploited. These include heat sink radiation and ablation approaches. NASA research will expand the boundaries of heat-protection systems to higher temperatures and longer exposure times to include lifting re-entry and re-entry from deep space.

Rhode said that combinations of ablation and radiation systems in the form of charring ablatives appear to offer "special promise" and will be ". . . exploited in our effort to extend our capability for safe re-entry."

The solid-state physics of defects was given as an example of an important basic research area at NASA. Rhode said this could be the key to understanding and controlling the strength and ductility of materials. The ultimate payoff from advancements here can be exemplified by the ultra-high strength of defect-free whiskers.

Work is continuing in the study of materials at 4200°F and higher.

SATELLITE ENVIRONMENT is closely approximated in this circular table, balanced on a metal sphere supported on a cushion of compressed air, at NASA's Ames facility.

Materials Demands

Traditional		*Additional*
Density	Directly Related to Temperature and Temperature Changes	Creep Strength
Strength		Thermal Expansion
Ductility		Thermal Conductivity
Stiffness		Specific Heat
Fatigue		Thermal Shock Resistance
		Emissivity
		Ignition Characteristics
	Directly Related to Environment of Space	Ablation Characteristics
		Radiation Shielding
		Radiation Sensitivity
		Meteorite Impact Resistance
		Vaporization

Lawyers Urge Change in Patent Law

Space agency counsel hopes Senate will okay House-passed modification, feels present policy discourages contractors

Present legislation covering NASA patents hurts the nation's space effort, and NASA lawyers hope that Congress will modify NASA patent laws during the August special session.

This was the encouraging message given by Gerald D. O'Brien, NASA's Assistant General Counsel for Patent Matters, to industry leaders.

The problem, according to O'Brien, is that "NASA contractors are largely from the same segments of American industry which contract with the Department of Defense in the aeronautical and space fields."

DOD allows industry to retain exclusive title to more proprietary items developed under government contracts than does NASA.

The resulting industry dissatisfaction, according to O'Brien, is "evidenced by some contractor opposition which hinders NASA's ability to achieve the necessary performance of its mission . . . and has caused a certain unwillingness on the part of some prospective contractors to participate in projects of importance to our national space program."

• **Senate may act**—The House has already passed a bill modifying NASA patent legislation. The bill is presently before the Senate Space Committee. O'Brien hopes that the Senate takes action during the August session.

Some opposition can be expected in the Senate because of the belief that the government must retain the rights to inventions or processes discovered in the course of a NASA contract in order to protect the national interest.

O'Brien disagrees with this view. "We are deceiving ourselves," he told his listeners, "if we assume that the government really acquires anything of value when it takes ownership to a patent in preference to a mere royalty free license."

The bill modifying NASA's patent laws, according to O'Brien, "is patterned after legislation in 1950 for the National Science Foundation."

• **Details of bill**—Generally, the bill will give NASA a non-exclusive royalty-free license to use the patentable invention and the company will retain title. But this contract is revocable and waiver of title will be affected if NASA finds the company's use of their patent is to the exclusion of the national interest.

A company retaining patent rights must also prove that it is seeking to exploit the invention within a reasonable period time. If the company fails to do so, all rights to the invention would be returned to the government.

The only two areas whereby NASA, under the modified law, may take more than a non-exclusive royalty-free license are when (1) the importance of the invention or process to the welfare of the country is such that title should be retained; or when (2) the invention or process has to do with atomic energy and AEC patent policies are involved.

Production-type Contracts May be Let in Some Programs

The National Aeronautics and Space Administration's procurement for some time to come will be research and development with no requirements for production-type contracts, according to Procurement Director Ernest W. Brackett.

Outlining NASA's procurement system before industry leaders in Washington last week, Brackett said NASA so far hasn't adopted the systems management by contractor concept, but that it may do so in an individual program where it is necessary to place full responsibility on one contractor to integrate a complete project.

He said NASA has found out that in research and development the negotiated cost-plus-fixed-fee contract is more suitable. He said the agency has made a few negotiated fixed-price contracts with a price redetermination provision but as yet has made no incentive-type contracts, either fixed-price or cost-plus-incentive-fee.

Stressing that NASA's procurement system is decentralized, he pointed out that the place to go to be considered for business is the seven NASA centers. Over 80% of the total appropriation for FY 1961, he said, is planned for contracts. Brackett said there is a big field for small business concerns in doing subcontract work, and NASA will ask larger contractors to see that small business shares.

The fixed fee, he said, is only one element of the overall cost factors. He said NASA uses a great deal of care in considering the experience, facilities, technical staff, and engineering plan as well. The major point in selection of a contractor, he said, is technical superiority. When two or more proposals are comparatively equal in technical respects, the proposal having the most reasonable cost estimate will be the one selected, he added.

Brackett said NASA is reviewing evaluation procedures in detail, including how it may debrief companies which lose competitions, in a way that will be of assistance to them in preparing later proposals.

"This missile age of ours requires vast scientific and engineering technology. MISSILES AND ROCKETS keeps us posted in this market that expands daily." D. M. Tenenbaum (left), Mgr., Test Division, Sacramento Plants.

"Technical news developments concerning the industry are a day-to-day occurrence. MISSILES AND ROCKETS keeps us right up to date." Dr. R. H. McFee (right), Dir. of Research, Aerojet-General's Avionics Division.

WHY DO SO MANY KEY PEOPLE AT AEROJET-GENERAL READ MISSILES AND ROCKETS?

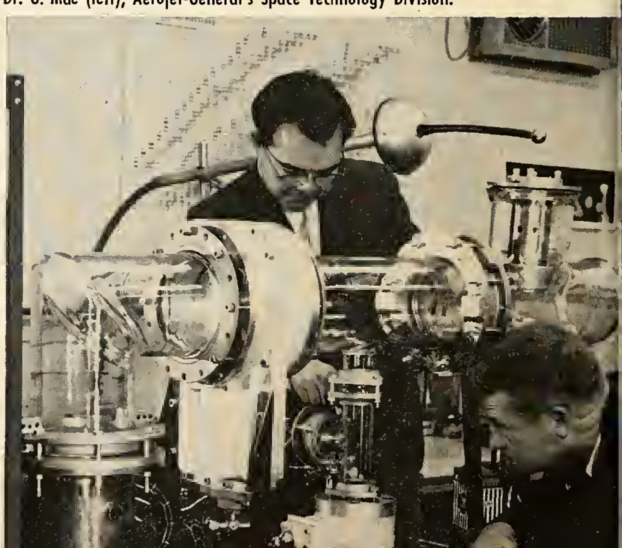
438 PAID SUBSCRIPTIONS! One of the outstanding leaders in the research, design, development, and production of both solid and liquid propellant rocket engines, Aerojet-General ranks 19th among all major defense contractors. Naturally, there are a large number of paid subscribers to MISSILES AND ROCKETS at Aerojet-General—438, to be exact. And since many of the copies have high pass-along readership, there is an even larger number of readers at Aerojet-General.

Some of the many reasons why M/R commands intense readership among key people at Aerojet-General are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Editor Richard Van Osten (insert).

These comments and those of other key readers in other missile/space companies clearly show what M/R has known all along . . . that the missile/space industry is a separate, distinct market with rapidly changing requirements that can best be met by *undiluted, weekly* technical/news coverage. It is this kind of coverage that makes M/R unique . . . explains its deep, penetrating readership and acceptance.

"Today's missile industry evolved from the old concept of the aircraft-missile business but each is now a separate and distinct industry. We read MISSILES AND ROCKETS for that very reason. It deals 100% with Astronautics." M. L. Stary, Director, Aerojet-General's Systems Division.

"In this young industry it is absolutely necessary that engineers be filled in on new data as it develops. MISSILES AND ROCKETS provides a complete, clear picture weekly of what's happening in the field of World Astronautics." Dr. G. Moe (left), Aerojet-General's Space Technology Division.



Technical Countdown

ELECTRONICS

Cosmic Radiation to be Studied

Biological effects of outer-space cosmic radiation will be studied under a new AF contract with Controls for Radiation, Inc. Representative mammalian cells will be bombarded by simulated cosmic rays generated by high-energy cyclotrons and linear accelerators to evaluate radiation effects on future space travelers.

CCTV Operates in Rocket Blast

A closed-circuit television camera developed by General Electric can be mounted within a few feet of a rocket engine to monitor firing and launching. The super-ruggedized camera has reportedly operated successfully in tests located in the maximum noise zone only eight feet from the engine.

Thermoelectric Coolers Into Production

AiResearch Division of Garrett Corp. has announced the first of a new line of thermoelectric cooling units for aircraft/missile electronic system components. The new Peltier-effect device dissipates 65.3 watts of heat to sea-level ambient air at 140°F.

GROUND SUPPORT EQUIPMENT

Saturn Recovery Delayed

A reputed $23-million transfer of funds from *Saturn* program to other NASA space projects by Director T. Keith Glennan will delay booster recovery-system development. Cook Electric still has a recovery-system R&D contract, but hardware production contract award will be delayed temporarily. Subsystem development has progressed rapidly. Cook recently tested its huge conical inflated retarder at the Tullahoma Wind Tunnel. Wearing its own nose cone (for re-entry), it withstood Mach-5 velocities successfully.

Polaris FCS Simulator Ready

First *Polaris* fire control simulator, developed by General Electric will be installed aboard the USS Theodore Roosevelt. Its 5 cabinets and master console can simulate all firing conditions. Used for training at sea, malfunctions can be programed into the system. The almost 5 x 5 ft. dimensions of the computer/console require its installation through the side of the sub's hull. In development 1 year, three prototypes have been built.

ASW ENGINEERING

Emphasis on Acoustics

One former Naval officer estimates there are more than 10,000 persons in the 26-odd Naval laboratories working on the ASW acoustics problem alone.

Packaged Liquids for Torpedoes?

Navy is not at all happy with solid propellant torpedo results. Problem basically is how to get enough solid propellant into almost standard 24-inch torpedo diameter and still meet the newer requirements of more burning time for longer range. Navy thus is taking a long hard look at encapsulated liquid fuels.

Systems Push by General Mills

Back of the recent acquisition of Magnaflux and Daven Companies by General Mills' electro-mechanical division, insiders say, will be a major push for ASW systems capability. Daven has been strong in electronic components development work while Magnaflux has experience in ultrasonics.

Second Attack Sub Commissioned

Navy's second attack-type submarine, USS Scorpion, was commissioned last week in Groton, Conn. Built by Electric Boat Div. of General Dynamics, Scorpion joins its sister ship, the Skipjack, which was first of this class of high speed, high performance nuclear boats. Both subs have nuclear-power plants of advanced design, streamlined hull forms, and single propellers.

PROPULSION

Max. Saturn Thrust by 1962

First use of 1.5-million lbs. thrust in *Saturn* booster will be in late 1962, says NASA. This will be the fourth flight test, but first to launch live second stage with dummy third. First three flights will carry dummy upper stages and use only 1.3 million lbs. thrust.

Fuel Needs Computed Electronically

Rocket-fuel performance data for use in determining missile and rocket requirements can now be produced rapidly by computers. The service, offered by IBM's Service Bureau Corp. in Los Angeles, can provide data on fuels with 20 atomic species, 250 molecular species, and 20 condensed phases.

MATERIALS

Largest Hopkins Ingots in Production

High-temperature alloy ingots, 20 in. diameter and weighing 8000 lbs., are being produced at Firth Sterling Inc. through the Hopkins process. The electrode is melted under a slag blanket, protecting the metal against the atmosphere and insuring against the addition of undesirable properties.

Minuteman Motor-Case Award

First-stage *Minuteman* motor cases will be produced by the Allison Division of General Motors. The contract was awarded by Thiokol, manufacturer of the missile's first-stage engine.

Polaris Motor Cases Deep Drawn

Second-stage *Polaris* motor cases will be turned out by Lyon Inc. through a proprietary deep drawing method. A $1.45-million contract was granted because of the firm's ability to produce the chamber and aft closure in one piece—eliminating welding and three-dimensional machining.

High Energy Formed Antennas

Explosive forming technique will be used at Ryan Aeronautical Co. to fabricate a large number of aircraft and missile radar antennas. The major order came from the Dalmo-Victor Co.

Lear Builds a Space Vehicle 'Cockpit'

by Charles D. LaFond

Grand Rapids, Mich.—A complex man-machine study to develop reliable and practical control-display panel design procedures for the Air Force has just been completed by Lear, Inc.

To demonstrate application of the rigid design methodology, Lear has built the Mark IV space vehicle crew station. Revealed to industry and the press recently, the mockup purports to be the four-man cockpit of some future generation boost-glider carrying SLBM's (space-launched ballistic missiles).

Efforts to identify the futuristic display with any scheduled follow-on to the *Dyna-Soar* boost-glide space vehicle brought forth conflicting answers. One official said further discussion was classified; another said the weapon system application was purely hypothetical.

Whether for real or just for fun, the mockup nevertheless is the culmination of 17 months effort and $400,000. And Lear had done similar studies for a year and a half prior to award of this contract. This phase of the program ends this month.

Next step in the program is to prove, disprove, or improve instruments and displays. This will involve a more detailed study of requirements for de-orbiting and re-entry with the "hypothetical" vehicle.

• **For 4-man crew**—The problem as seen by Wright Air Development Div.'s Flight Control Laboratory is the great lag between efficient cockpit design and other spacecraft technological advancements.

The goal is to develop a disciplined procedure for designing cockpits that will provide the best possible instrument configuration and selection for optimum operator efficiency. A second, but equally important aim, has been to improve flight safety by reducing the probability of pilot error. To do this, essential and interpretable data during critical periods of flight must be provided rapidly and accurately for proper pilot support.

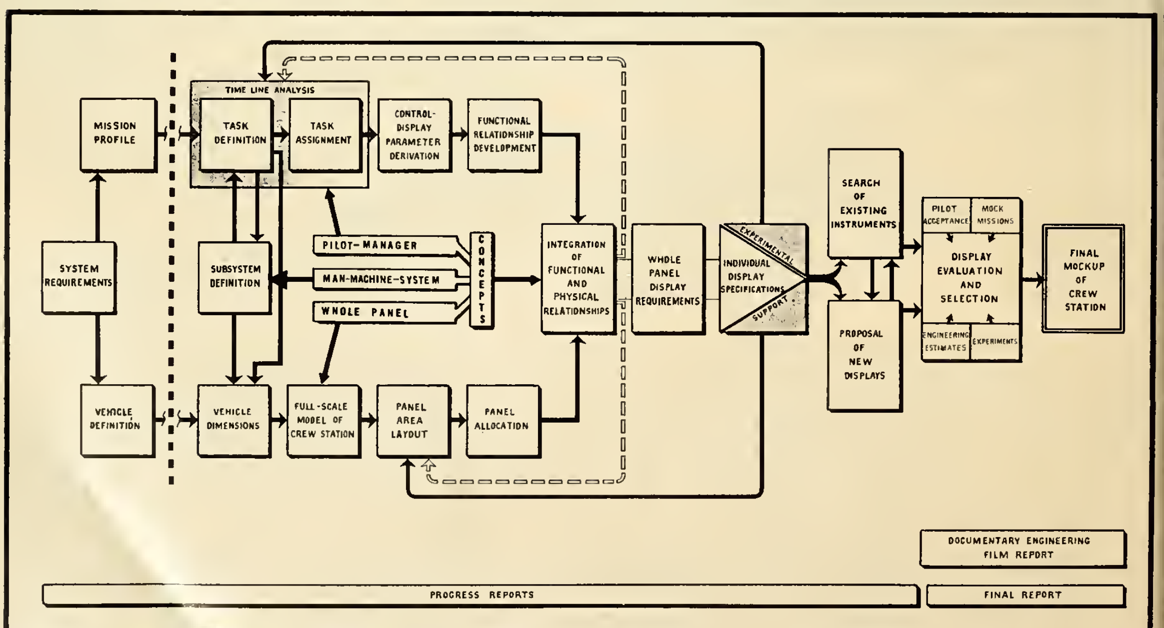
With the physical limitations imposed on the pilot during angular acceleration and re-entry, controls and readout design must correspond to operator ability to manipulate or interpret.

The hypothetical vehicle around which the study attack is centered is described by WADD as an "orbital bombardment system." Carrying a 4-man crew, the ship is designed for a 30-day mission in a roughly circular orbit, altitude 300-350 miles. The five missiles aboard would be dropped when employed and ignited after separation.

A major task in the problem is that of re-entry. Initiated by retro-rockets, the vehicle would have to be maneuvered to penetrate the Earth's atmosphere through a precisely defined, narrow corridor. Fine control must be maintained to dissipate the enormous aerodynamic heating.

Deviation from the re-entry corridor would result in either the destruction of the vehicle and crew or at the very least in missing the launching site. Following re-entry, the glide path would cover roughly one-third of the globe.

• **Singling out problems**—The WADD/Lear team is comprised of both engineers and psychologists. Together, they have studied mission requirements and human factors to develop a "time-line analysis." This is an instant-by-instant definition of tasks necessary for a successful mission.

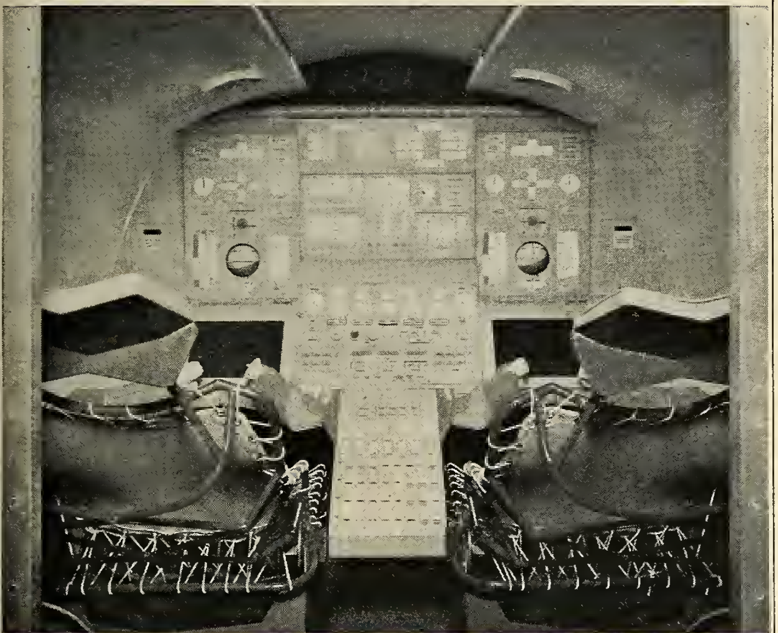


DISPLAY DEVELOPMENT Procedure Diagram is blueprint for MK-IV design method.

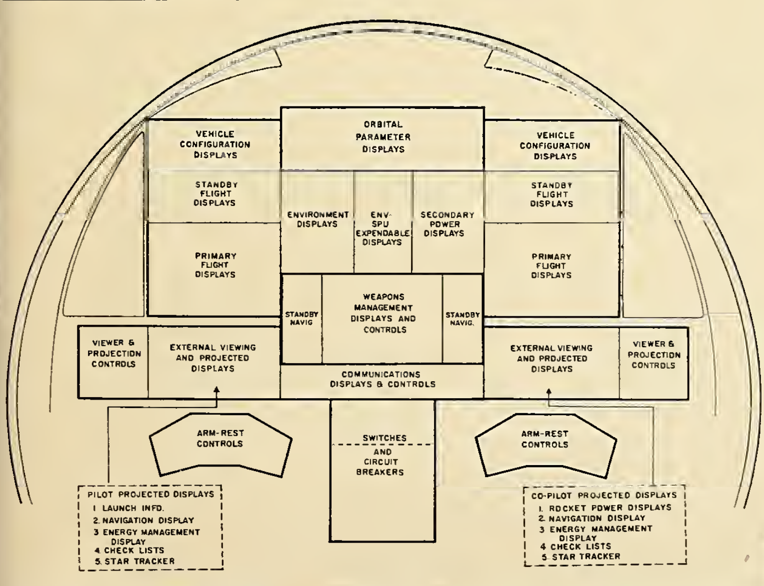
As shown in the accompanying diagram, display development requires an exhaustive and comprehensive investigation process.

The application of this design methodology points out new and often unrecognized problems long before the hardware stage is reached.

For the future, WADD intends to further refine the method of analysis of time functions. Another question to be solved is how and when should all of the various inputs be directed to the overall system designer. Further study also is required to learn what panel instrumentation is really needed by the pilot and what functions are better performed under computer control.



MARK-IV COCKPIT features instruments and screens grouped for easy readout. Soft colors used—green, yellow, blue—are non-fatiguing. Controls are operated solely by wrist and finger movements.



ALLOCATION CHART shows organization of operators' display panel.

EIA Finds Satellites Can Share Earth Frequencies

Space satellite communications systems operating on the same frequencies as point-to-point systems on earth will not interfere with each other, according to the Electronic Industries Association. This conclusion was based on an intensive study of radio frequency requirements for space communications in the bands above 890 mc.

Based on the findings, EIA has recommended that the FCC use its present frequency allocations system—which provides for channel sharing—for allocation in the above-890 mc bands.

The EIA comments were filed in the form of a statement to be included in FCC's Docket 11866. The Association's position was supported by some 28 pages of technical calculations.

The study was conducted by EIA's Microwave Section, headed by L. G. Walker, manager of communications and controls systems of Raytheon. These specific conclusions were reached:

- Satellite communications systems utilizing either the passive or active type of satellite repeater will not cause harmful interference to surface point-to-point communications systems operating on the same frequencies, providing reasonable systems engineering judgment is exercised.
- Surface point-to-point communications systems will not cause harmful interference to satellite relay systems operating on the same frequencies, again providing reasonable systems engineering judgment is exercised.
- Based on the feasibility of co-channel sharing between satellite communications and conventional point-to-point systems, it is not necessary for separate allocations to be made for this new use of the spectrum.
- Any non-government authorization for satellite communications purposes should be confined within the present allocation structures for fixed services.

Japanese May Put Rockets On Their Helicopters

Japan's Ground Self-Defense Force has begun studies on arming medium sized helicopters with radio controlled guided missiles as part of ground support operations.

The present fleet of H-13 helicopters is expected to be equipped soon with rocket guns of 2.36 in. or 3.5 in. caliber. The GSDF plans to arm the Japanese-made craft with Japanese-made air-to-surface rockets and anti-tank rockets.

Planets to be Colonized in 50 Years

Rocket authority predicts routine, scheduled space flights resulting from improved utility and vastly lowered costs

by Robert C. Truax*

Space flight is due for an explosive expansion over the next 50 years.

Within that period there will be permanent colonies on the moon, Mercury, Venus, Mars and, perhaps, on the moons of Jupiter and Saturn. Numerous manned artificial satellites or planets will have been placed in our solar system. Interplanetary space will be filled with ships making routine, scheduled trips between planets.

This increased activity will result from two main factors:

–An increase in utility which will justify a several-fold increase in financial support.

–A decrease in the cost of space operations which will permit more flights for the same number of dollars.

We all remember *Vanguard I*, when a three-pound satellite (Khrushchev's "grapefruit") had to be substituted for the original 20-pounder to save 17 pounds of weight. Seventeen pounds—out of a gross takeoff weight of some 20,000 pounds—meant the difference between success and failure. Yet now, without any obvious major advances in technique, payloads in excess of a ton can be placed on orbit.

• **Improvement on cost as well as engineering basis**—The primary reason for the improvement, and the reason which can lead one to be optimistic about the future, is that we continuously find means for improving the performance of our equipment on a *cost* basis, as well as improving it on an *engineering* basis. Over the past ten years, the improvement in items critical to the performance of a rocket, such as propellant consumption and structural weight, has not been decisive.

The principal change has been an increase in size, and a reduction in unit cost because of an expanding utility which permits one-time costs to be spread over a larger number of units. This is a self-propagating procedure which leads to explosive growth. An increase in utility spreads out the cost, which in turn opens new spheres of application, and the cycle begins anew.

• **Effects of size increase**—An increase in missile size has two important effects. The first is that the proportion of useful load which may be carried increases. This increase results from the fact that many of the items of equipment which must be carried for a vehicle to fulfill its mission are of fixed size and weight, regardless of the size vehicle to which they are attached. The guidance equipment is a notable example. In addition, there are certain practical limits to the thicknesses of the metal which may be used, imposed by limitations in fabricating techniques. As a result, large structures can generally be made somewhat more efficient than smaller ones.

• **Cost advantage**—In addition to these purely engineering advantages, there is a cost advantage as well. In general, for a given degree of complexity, it costs no more to design a large structure than it does to design a small one. Nor does it usually require a proportionate increase in the testing cost. In the manufacturing phases, the cost increase is not usually in direct proportion to the weight.

Very frequently, although larger machines must be used in the fabrication process—and a larger capital investment is necessary—the labor costs do not go up in proportion. For example, it normally requires one man to attend a lathe, whether this lathe be large or small.

Similarly, when reaching the flight testing or operational phase of a space vehicle program, there are many factors which do not vary with the size of the vehicle, or which vary in less than a direct proportion. In general, the time and manpower required to conduct pre-flight checks is a function of the complexity of the missile, rather than of its size. In erecting and servicing a vehicle, somewhat larger equipment will be required, but usually the increase in manpower will be small.

After a vehicle is launched, many of the functions still to be performed do not vary at all with size. These functions consist primarily of tracking and communications. Certainly it requires no more expensive an operation to track a large missile than it does to track a small one. In fact, cheaper and simpler equipment may sometimes be used for the larger missile.

These are all qualitative factors which tend to justify and explain the past history of increasing size for space vehicles. That history has been so short, however, that the end point cannot be readily perceived. It is interesting to note that the trend toward an increase in size of ships has continued over hundreds, even thousands, of years. The first fifty years of flight have seen a constant increase in the maximum size of aircraft.

It may be argued that the difficulty of transporting a very large space vehicle from its point of manufacture to its launch site may constitute a major deterrent to the construction and use of really large space vehicles. The current *Saturn* vehicle is already too large to be transported either by air or by land. It is perfectly possible, though, to transport the *Saturn* by barge from Huntsville, Alabama, to Cape Canaveral. Similar techniques may be applicable to boosters of vastly larger size.

These facts indicate that an increase in vehicle size may make a major contribution to reducing the cost and improving the utility of space operations. The possibility and potential in this direction should be carefully explored, from an economic as well as an engineering point of view.

• **Reusable boosters necessary**—In

**Robert C. Truax, USN (Ret.), is director of the Advanced Developments Division of Aerojet-General's Liquid Rocket Plant in Sacramento. He is a widely-known rocket authority and former national president of the American Rocket Society. He is credited with a key role in development of the Navy Polaris fleet ballistic missile, as well as other long-range missiles. He has pioneered sea-launched rocket vehicles.*

an attempt to find additional means for reducing the cost of the space program, the reuse of vehicles must be considered.

The science of space transportation is historically related to the guided missile. In such use, the vehicle is either automatically destroyed at the end of the flight, or is used under such circumstances as to make its recovery extremely difficult.

It is true that space vehicles are, in general, of relatively fragile construction and that they reach velocities and altitudes incomparably greater than those attained by any other vehicle. Nevertheless, if we examine the technical problems of providing a multiple use capability, these difficulties do not seem insurmountable. In the case of the first stage of multi-stage rockets—which, because of their size, represent a major faction of the total investment—recovery and reuse seem relatively simple.

Since the velocities acquired by succeeding stages are progressively greater, the difficulties associated with their recovery and reuse also increase. In all cases, however, the loss of payload which results from the incorporation of recovery provisions can be offset by the economic gain associated with reuse of the vehicle, provided that the reuse factor is sufficiently high.

Current indications are that the number of flights required to effect this amortization of recovery provisions is far below that associated with normal aircraft operations, for example. Since final stages frequently contain complex payload equipment, a disproportionate share of the total cost is contained in these final stages.

As an intermediate phase in the development of completely recoverable vehicles, we may find that three-stage combinations in which first and last stages are recoverable and the intermediate stage expendable, may find wide utility. In such a case, of course, the intermediate stage should be made as cheap as is consistent with reasonably good performance.

There is, throughout the industry, a gradual awakening of interest in recoverability. In most studies made to date on the economic recovery associated with the physical recovery, it appears that the missileman's point of view has dominated the thinking. In some cases it has been assumed that the missile would have to be entirely rebuilt, returned to the factory, completely disassembled, defective or damaged parts replaced, reinspected, retested, and shipped again to the launching site. The cost saving associated with such a procedure is naturally relatively small.

Whether rocket vehicles will ever attain maintenance schedules comparable on a time basis with aircraft may be open to question. There is sufficient similarity of a general nature between aircraft and rocket structures to make it unwise to disallow such a possibility, however.

A rocket vehicle designed to be reusable may differ markedly from an expendable one, or the differences may be in detail only. Depending on what manner recovery is to be effected, a booster vehicle may have wings and auxiliary air-breathing power plants, and may be very much more like an airplane than a rocket. Or it may be designed very much as it has been in the past, and equipped only with parachutes, braking rockets, or other auxiliary devices to increase the probability of successful recovery.

• **Simpler recovery methods look best**—Because of the large financial investments associated with airplane type recovery systems, it appears probable that the simpler methods of booster recovery will be investigated first. In considering the recovery of first stages by parachutes and retro-rockets, it would appear that a booster designed to be recoverable would place rather heavy emphasis on simplicity and reliability—at the expense of performance if necessary—since it appears probable that the total number of flights attainable would be a direct function of the reliability.

Even granting the development of very large recoverable vehicles, it may still be difficult to visualize space operations being routinely conducted on a large-tonnage basis. The rocket vehicle appears to be such an enormous thing for the amount of payload carried.

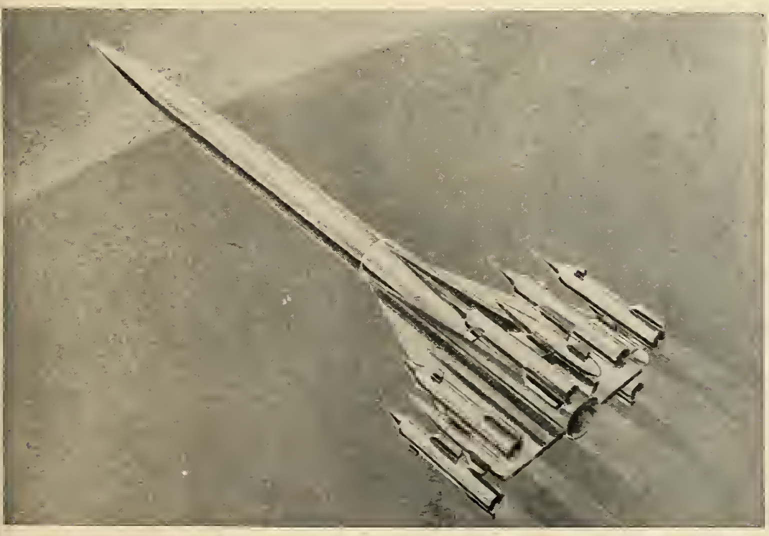
It should be noted, however, that 80 to 90% of the total mass of the rocket is propellant which, at least in the case of conventional liquid-fuel rockets, is very cheap indeed. Liquid oxygen and kerosene, such as are used in *Atlas* and *Titan* missiles, are available in unlimited supply, at a cost in the neighborhood of two cents a pound. Even with our present relatively inefficient vehicles, the propellant cost per pound of payload put into orbit, for example, is less than two dollars. Were this the only factor, beefsteak could be obtained at our satellite commissaries for less than three times the price at a terrestrial supermarket, a quite modest increase under the circumstances.

As stated earlier, the successful exploitation of space will depend on an increase in utility and a decrease in the cost of space operations.

The decrease in cost-per-ton mission will stem first from an increase in vehicle size which will give increased payload without a proportionate increase in cost.

A second major cost reducing factor will be an alteration of concept, abandoning the use of one-shot vehicles and going to those which are suitable for hundreds, or even thousands, of flights in the course of their normal lifetimes. This ascending spiral of utility and economy will make possible the support of hundreds of people at extra-terrestrial locations in the foreseeable future.

Nuclear Turbo-Ram-Rocket Concept



GE ARTIST'S CONCEPTION of a nuclear-power, turbo-ram-rocket in flight. Main nuclear powerplant is center of cluster of booster powerplant. Boosters could be dropped off at 100,000 ft.

Tiny Rocket Yields Big Charge for Tests

LOS ANGELES, CALIF.—The miniature rocket motor pictured here is not much bigger than a shotgun shell but delivers nearly 10 times the recoil. It has been used by the Columbus Division of North American Aviation, Inc., for impulsive excitation during in-flight vibration testing of the Navy's Mach 2 A3J Vigilante. (M/R, July 11, p. 39).

The cartridge is fabricated out of 4140 steel in two pieces. One is a base unit which is bonded directly to the aircraft structure. The other is the motor unit which is attached by means of a shoe fitting to the base.

North American says the two-piece design minimizes the exposure time of both the aircraft and personnel to the live rocket motors. The propulsion units can be stored in a magazine until just prior to the test flight.

• **Versatile design**—The design also permits a high degree of interchangeability as well as simple replacement of the rocket motors after firing.

Propellant (M-2) consists of several cylindrical single-perforated grains. Total charge weight varies from approximately 1.1 grams for short duration impulse units (7 to 9 milliseconds) to 2.8 grams for longer duration impulses (28 milliseconds). This compares to approximately 3 grams of propellant in a typical 12 gauge shotgun shell.

Propellant grains are individually selected by hand to minimize burning irregularities and each grain is oriented in a special direction to the rocket motor.

To achieve a maximum burning rate of the propellant prior to the release of energy, the main propellant is sealed from the combustion chamber by an aluminum disc. Between the aluminum disc, which ultimately ruptures, and the exhaust nozzle is a screen to prevent plugging of the nozzle by propellant particles.

Ignition is by an M52A3 electric primer (lead styphnate) which becomes unstable when an electric current is passed through it and triggers a black-powder igniter charge (type A4BP), which in turn ignites the main propellant.

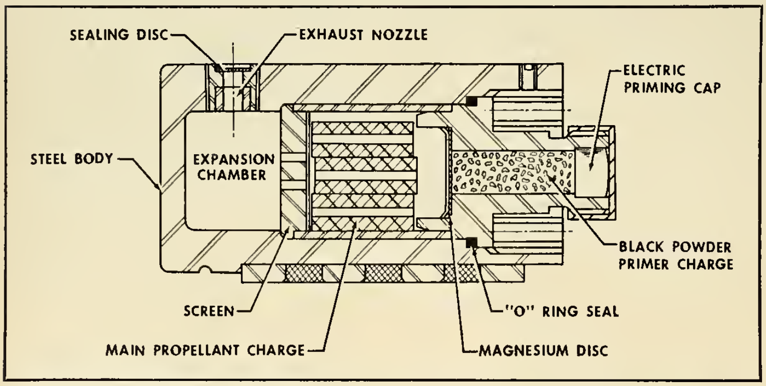
• **Improvement by delay**—A thin magnesium disc separates the igniter charge from the main propellant. By delaying release of the energy generated by the igniter until a more complete burning of the charge occurs, the disc serves to improve the repeatability of ignition time. It also provides a moisture seal for the black powder igniter.

When the seal is ruptured, the igniter sets off the main propellant.

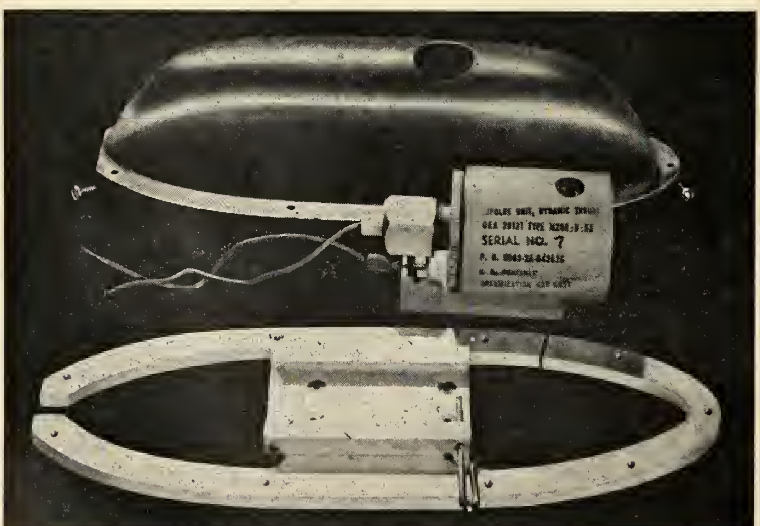
An aerodynamic fairing around the motor reduces drag. Latest units provide peak thrust values between 200 and 800 pounds and thrust durations between 7 and 150 milliseconds. Approximately 700 units have been fired during the program.

V. L. Beals and S. R. Hurley of the Columbus Division reported on the test program at the recent meeting of the Institute of Aerospace Sciences in Los Angeles. They said the use of the rocket motors provide a completely adequate in-flight vibration test. They indicated that problems encountered in Britain and France in development of acceptable rocket motors for this technique have been overcome.

Basic ordnance engineering of the rocket motors was done by Ordnance Engineering Associates, Inc., Chicago, Ill.

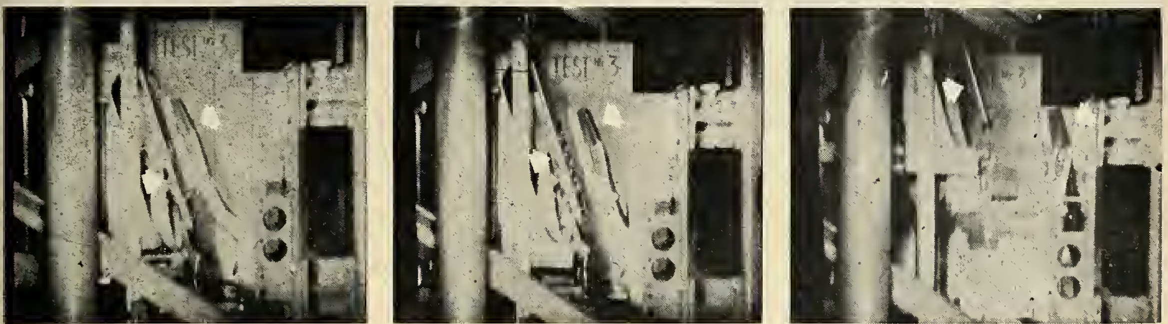


SHOTGUN SHELL-SIZED motor is fabricated in two pieces. Propellant grains are carefully selected and sealed from combustion chamber by metal discs.



EXCITER PRODUCES between 200 and 800 lbs. of thrust for between seven and 150 millisecs, permitting adequate in-flight vibration testing.

Polaris Has Fast Umbilical Cutoff



HIGH-SPEED camera catches umbilical disconnect sequence in 200 millisecs. Photo at left shows connector in pre-launch position. Contact head is free of electrical pins. Connector (right) moves to retracted position.

Los Angeles—A drastic departure from usual ballistic missile umbilical connector design has been applied to the *Polaris* system by E. B. Wiggins Oil Tool Co., Inc.

The connector—which could be more accurately described as a contactor—utilizes no electrical pins to enter the missile frame. Instead, a sliding plug utilizing spring leaf contacts is used to effect a reliable contact between the missile and its submarine.

Mechanical contact is made between the launch equipment and the flight vehicle through a latch pin in the center of the plug. The plug retracts completely in substantially less than 200 milliseconds within the first half inch of missile movement upward.

Incorporating a large number of unique design features, the unit attaches to the shoulder of the *Polaris,* just above the second stage. Contacts consist of 126 pins (4 through 20 contact size) and two ½-in. water methanol cooling lines for the electronic systems within the missile.

A special wheel-like tool is used to connect the umbilical to the missile, at the same time pulling the internal contact face against the flush-mounted receptacle in the skin.

Release of the latch pin at launch frees the external umbilical to be snapped into its housing by cam action of the missile's shoulder and also allows spring action to disconnect the internal contacts from the inside surface of the receptacle.

Pat Stone, product manager for the system, concedes that this "dead-face" function adds expense to the umbilical, but says this is more than offset by elimination of the need for switches on individual circuits within the missile. The dead-facing therefore serves the function of a master switch bank.

Use of spring leaf contacts was adopted because of the anti-contaminant insurance afforded, as well as the insurance of having at least four contact points available for each connection, instead of the one or two available from a pin and socket design. Upon making contact, the spring leaves wipe the surface of the connector, insuring a clean contact.

The complete device consists of the mounting bracket, cable and spring leaf inserts all molded into a single unit.

Navy Balks at Pre-packaged Torpedoes

NSIA committee urges switch to fixed ammunition concept but service insists that one-shot 'fish' await better reliability

by Donald E. Perry

Some designers are pushing for solid state guidance and the "fixed ammunition" concept as in the *Bullpup* program for torpedo development, but so far the Navy officially doesn't consider the proposals—to use an old torpedo firing phrase—"hot, straight and normal."

A recommendation that Navy torpedoes be pre-packaged under the fixed ammunition concept for immediate use without further testing was made recently by the Anti-Submarine Warfare Advisory Committee of the National Security Industrial Association.

The recommendation was championed and authored by Thomas E. Lynch, general manager of Clevite Ordnance and principal designer of the Mark 43, Mod. 1 torpedo.

It's Lynch's contention that the complexity of the modern homing torpedo is making impractical demands upon the skill and training of shipboard operators. He, and other torpedo engineers, believe that torpedo performance is more degraded than enhanced by the present Navy practice of repeated check-out and testing, where a well-trained shop will produce a good hit record and poorly trained technicians a poor hit record. They further contend there are no technical obstacles standing against an entirely sealed torpedo, featuring primary battery propulsion and solid state electronics.

But Navy acceptance of this is entirely another matter. The ASW Division of Bureau of Weapons' RDTE, takes the position that the torpedo can not be a one-shot weapon with only one firing in its entire life. BuWeaps personnel stress that the one-shot fish is not in sight yet because Navy hasn't achieved sufficient reliability through inwater testing.

• **Checks not enough**—"We have to have more than one run," according to Cdr. L. H. Keater and G. R. Moltrup of the ASW Division. Moltrup, the division's chief engineer, doubts very much if the Navy can depend on just manufacturing checks.

"The key in torpedoes is numbers. If we were building thousands—which we are not—we perhaps could just rely on strict quality control and checkout at the manufacturing site," he said.

So the Navy relies on what is termed production proofing. It has three phases performed at Navy Test Stations. In the first phase, let's say 24 torpedoes are each run about three times. Through this Navy gets a small hint of reliability, the likeness of runs and the characteristics of the lot. This allows the Navy to further firm up proofing specs.

In the next phase, a number of fish are divided into groups with each fish being run once. Out of this might come an allowance of three failures out of, say, 40 firings. In this phase, speed, depth criteria are pretty firmly established for proofing.

Now if the production quantity is large enough, proofing will enter a third phase, a sampling process where, say, 10 out of a lot of 100, will go

(Continued on page 46)

NATO's Standard ASW Plane

France plans to buy 27 Breguet 1150 Atlantic antisubmarine patrol planes within the next four years. Well over 100 of the aircraft will be produced for NATO member countries.

The Atlantic will be a land-type plane with a semi-low wing, having a cruising speed of about 323 knots and able to fly at very low speeds. It will be fitted with electronic gear and the latest ASW kill weapons, and powered by two Rolls Royce turboprops.

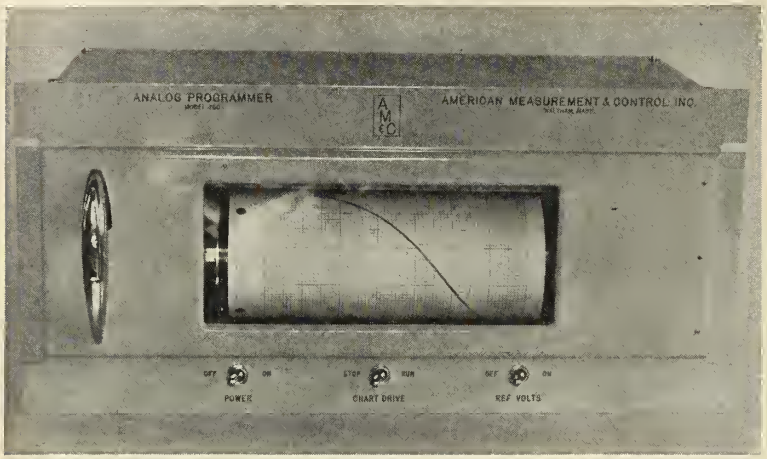
NATO announced last January that the Atlantic was chosen over a British proposal developed by Avro. NATO had opened the competition for a standard ASW aircraft in 1958; some 18 projects were submitted by 26 companies representing eight nations.

When the prototype is completed, Fokker Co. in Holland will take over the entire development of central wing section and nacelles. Dornier in Germany will be in charge of rear section and tail unit. Sud Aviation in France will provide the wing. ABAP in Belgium will be responsible for series production. Breguet will be in charge of nose section, fuselage, general assembly and flight test.

Special Feature: An ASW Glossary

The following glossary of ASW terminology was compiled as a service to MISSILES & ROCKETS *readers. The editors realize that it may be far from complete, since new words are being coined all the time in this field. Readers are invited to contribute words and expressions—and their definitions—which have been omitted, for listing in subsequent glossaries.*

Able. See Weapon ALPHA.
antisubmarine attack. (1) **coordinated.** General term covering all possible types of ASW attacks involving the coordination of more than one ship, submarine or aircraft. (2) **creeping.** Coordinated attack involving a noiseless approach wherein all target information is furnished by an assisting ship. (3) **deliberate.** An attack on a submarine made when the tactical situation allows time to obtain accurate attack data. (4) **urgent.** A harassing attack on a submarine delivered with maximum rapidity, made when the enemy submarine is in an immediately menacing position.
antisubmarine screen. Arrangement of ships or aircraft, or both, around a force or convoy to protect it against submarine attack.
array. A group of hydrophones arranged so that incoming signals may be processed and/or correlated.
Asroc. Minneapolis-Honeywell surface-to-underwater rocket-assisted torpedo or depth charge for deployment on destroyers and cruisers.
Aster. Ford Instrument ASW rocket launched from surface ships; marriage of **Terrier** and torpedo.
Astor. Westinghouse underwater-to-underwater rocket torpedo, nuclear warhead.
ASW. Antisubmarine warfare.
bathythermograph. Device that automatically records water temperature as a function of water depth.
BDI. Bearing deviation indicator. A system that permits a sonar operator to determine with a single echo whether his transducer is trained to right of target, left, or squarely on target.
Betty. Airborne atomic depth charge.
bottom bounce. A technique for increasing sonar range by directing the transmitted signal down so that it reflects off the ocean floor, thereby minimizing refraction losses.
covitation noise. Sounds from collapsing voids or cavities in water. Propellers "cavitate" as a function of speed and depth.
classification. Examining the sonar and other data inputs and determining their probable origins, particular attention being given to enemy submarine sources.
datum/dotum time. The last known position of a submarine is the datum, and the time at which the submarine was at the datum is datum time. If a ship has been torpedoed, and no additional information is available, the position and time of the torpedoing are respectively used as the datum and datum time.
detection. Process of determining presence of submarines.
ensonify. To sensitize a sea area with sonar detection gear.
fixed system. Group of hydrophones arrayed on sea bottom, terminating in a shore facility that processes the incoming data. System used for ocean area surveillance.
Hedgehogs. Multiple ahead-thrown bombs generally used by destroyers to lay out a bomb pattern.
Hold down. An operation designed to keep a submarine submerged, thereby limiting it to its submerged capabilities for gaining intelligence and for communicating and winning attack position, and also forcing the vessel to use up battery power.
HUK operations. Hunter-killer operations. Offensive ASW operations in a submarine probability area, combining the best available searching, tracking and attacking capabilities of air and surface units in a coordinated action.
hydrophone. Underwater transducer for converting acoustic energy to electric energy.
hydrophone effect. Impingement on hydrophone of underwater sounds originating from own shipboard sources, sounds such as screw beats, machinery noises, etc.
layer depth. Depth from ocean surface to the top of a water layer of sharp temperature gradient.
layer effect. Interference with echo-ranging detection by a water layer of sharp density gradient resulting from a pronounced temperature and/or salinity change. Targets in or below this layer are partially or completely obscured.
localization. Pinpointing the position of an enemy submarine.
MAD. Magnetic airborne detection; magnetic anamoly detection. Detection of magnetic materials in the sea through the distortion they produce in the normal magnetic field of the earth. Although MAD gear has a relatively short range of initial detection, the equipment is useful for developing contacts originally made by other means of detection or intelligence.
Mark 37. Westinghouse acoustic-homing torpedo.
Mark 44. General Electric acoustic-homing torpedo.
Mark 57. Submarine-laid antisubmarine mine.
RDT. Rotational direction transmission. A modification to existing fleet sonar equipment which, by concentrating the outgoing acoustic energy, increases the detection range of the equipment.
refraction. Bending of sound waves owing to changes in water density, salinity or temperature.
reverberation. Energy returned to the listening transducer or hydrophone by reflectors other than the target, for example, by the ocean's floor, surface, etc.
SAR. Search and rescue. Use of aircraft, surface craft, submarines and other equipment for search and/or rescue of personnel.
SAU. Search attack unit. Surface unit composed of two or more ships separately organized or detached from a formation to localize and destroy submarines.
scattering. Loss in propogation of acoustic energy caused by reflections by foreign bodies in the medium.
shadow zone. Region where refraction excludes an echo-ranging signal.
snorkel. A retractable air-intake and exhaust tube permitting submarines that operate on diesels to charge batteries while craft cruises at periscope depth.
Sofor. Signaling method. Aircraft or ships in distress drop small charges set to explode in a sound channel. Hydrophone listening in same channel can pick up acoustic energy as far as 2000 miles away from its source.
sonor. Sound navigation ranging. A system analogous to radar in which underwater acoustic energy is used chiefly for detection and locating underwater objects, and for communications.
sonar, active. Echo-ranging sonar which sends out a single short pulse of acoustic energy, usually at an ultrasonic frequency. Upon striking a target, the energy is reflected back to the source as an echo. Time taken for transit is a measure of the range.
sonar, possive. Direct-listening sonar which depends upon the target to generate its own sound, usually in the form of machinery noise, propeller cavitation, flow noises, etc.
sonor projector. Underwater transducer for converting electric energy to acoustic energy, and then radiating this energy out.
sonor ronge, effective. Range used for selecting screen plans and for determining sonar sweep width. It is based on predicted range but represents a reduction of predicted range (200 to 500 yards under average conditions) to compensate for human errors, ship's speed and weather conditions.
sonar screen spacing. Distance between ships in sonar screening and search operations. The standard plans for both screening and search call for a ship spacing of 1¾ times the effective sonar range.
sonobuoy. A buoy-mounted instrument used for detecting underwater noises and transmitting them for radio reception.
sound channel. Horizontal water zone bounded by layers where the speed of sound is greater than any place in the zone. Zone traps and channels acoustic energy. Phenomenon accounts for instances of extremely long-distance sonar ranges.
submarine operoting depths. (1) **periscope depth.** Operating with periscope or radar exposed. (2) **semi-surfaced.** In the process of diving or surfacing. (3) **snorkeling.** (4) Operating with the snorkel exposed. (5) **submerged.** Fully below water surface. (6) **surfaced.** Fully above water surface.
submorine speeds. (1) **high.** Capable of submerged speeds of 20 knots or more. (2) **medium.** Capable of submerged speeds up to 20 knots. (3) **slow.** Capable of maximum submerged speed of about 9 knots, the speed of conventional early World War II submarines.
Subroc. Goodyear underwater-to-surface-to-underwater missile, nuclear warhead.
Tenoc. Ten-year contract research program on oceanography started by Navy in fiscal year 1960.
turn count. Method of estimating target's speed through the water by counting the rpm of the vehicle's propeller. Sonar equipment brings in the propeller noise.
VDS. Variable depth sonar or echo-ranging sonar. System uses a transducer at end of cable.
Ventriloquist. An ASW countermeasure.
Weapon ALPHA. Avco 500-pound surface-to-underwater rocket-propelled depth charge deployed on destroyer escorts. Formerly called **Able**.



Voltage Generated From Graph

The Model 750 Analog Programer manufactured by American Measurement & Control, Inc. is an arbitrary function generator wherein any single valued function (Y) drawn on graph paper with conductive ink is converted to a proportional voltage as a function of time (X). The unit has an accuracy of ± 0.5% and a response time of less than 10 microseconds to full scale.

An external reference voltage is applied across the potentiometer and a portion of this voltage is picked off at the point of contact between the potentiometer and the drawn, conductive function curve. Thus, at any specific instant of time, the output voltage (Y) is proportional to the drawn curve.

The X axis varies linearly with time when the drum is driven by the constant speed synchronous motor provided. However, a servo motor can be incorporated to provide the driving force and the drum position can then be a function of an independent variable.

Circle No. 225 on Subscriber Service Card.

Component Heaters

Constant-temperature component ovens for computer and test equipment applications are available from Palmer Instruments.

A stability of ±1°C is assured in a range of -20°C to 10°C below setting temperature.

With a maximum power consumption of 15 watts, heaters can be wound to accommodate input supplies of from 20 to 115 volts. Boosters are also available.

Circle No. 226 on Subscriber Service Card.

Dual Output Battery

A new, dual battery in a single case is available from Cook Batteries. The two battery sections in the Model P82A provide for a heavy peak current demand as well as a steady power supply for equipment with non-fluctuating requirements. One section handles fluctuating loads with less than 5% voltage variation.

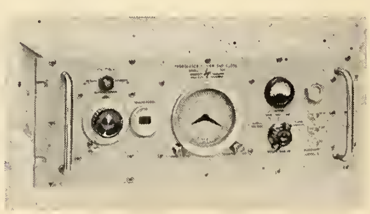
A 20-cell section provides a current of 25 amp. at 28 v. Maximum current is 100 amp. with a discharge time of 4 min. at 25 amp. Capacity is 1.7 amp./hr.

The second 20-cell section supplies 28-volt power at 46 amp. Maximum current is 125 amp. Discharge time is 4 minutes at 46 amp. Capacity is 3 amp./hr.

Circle No. 227 on Subscriber Service Card.

Frequency Divider & Clock

A frequency divider and clock, which makes possible precise time comparisons between stable oscillators and standard WWV or other transmitted time signals, is now available from Hewlett-Packard Co.



The clock has a 10 microsecond time comparison capability, resulting primarily from the use of a directly calibrated, precision phase shifter and a unique, jitter-free optical gating system. Regenerative dividers, a phase-stable motor and precision gear train provide fail-safe operation not attained by pulse counting systems.

Circle No. 228 on Subscriber Service Card.

Blind-Mounting Locknut

A blind-mounting aircraft and missile locknut is being marketed by Standard Pressed Steel.

Called the Davis Press Nut, this one-piece self-locking threaded fastener is installed from the one side in a single drilled hole by a simple pressure tool. The nut is embedded flush in one surface of the metal while gripping the other by a swaging action.

Made of austenitic stainless steel, it is intended for use with 125,000-psi tension and shear bolting such NAS 333,517 and 1303 and AN-3 series.

Circle No. 229 on Subscriber Service Card.

Tiny Pressure Transducer

A pressure transducer only three-fourths inch in diameter, one-third inch high and eight grams in weight has been developed by the Transducer Div. of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

Pressure ranges are from 10 to 100 psi absolute, 2 to 100 psi gage, and ± 2 to ± 50 psi differential. Pressure limit is 1.5 times rated pressure without calibration shift and two times rated pressure without permanent damage.

Circle No. 230 on Subscriber Service Card.

Rosette Strain Gage

A single plane rosette strain gage has been developed by Electronics Instrumentation Division of Baldwin-Lima-Hamilton Corp.

It is a very thin gage thus minimizing errors encountered in bending measurements. It has a maximum of sensing elements in a given area.

The gages are made from materials specifically selected and treated to minimize temperature effects when bonded to several different types of materials.

Circle No. 231 on Subscriber Service Card.

Pressure Regulators

Grove Valve and Regulator Co. has available a line of compact, light-weight pressure regulators which are designed to handle an unusually broad range of pressures.

The new regulators are available for pressure reducing, back pressure, and combination pressure reducing and relief service.

Pressure reducing models, produced in sizes ranging from ¼ in. through ½ in., can be used for inlet pressures as high as 10,000 psi and adjustable controlled pressures up to 6000 psi.

Circle No. 232 on Subscriber Service Card.

Tiniest Gearhead

A tiny "size five" gearhead and speed reducer unit weighing only a few grams and measuring three-fourths in. in length, has been developed by Bowmar Instrument Corp. It is capable of producing step-up or step-down ratios of from 10:1 to 2025:1.

Circle No. 233 on Subscriber Service Card.

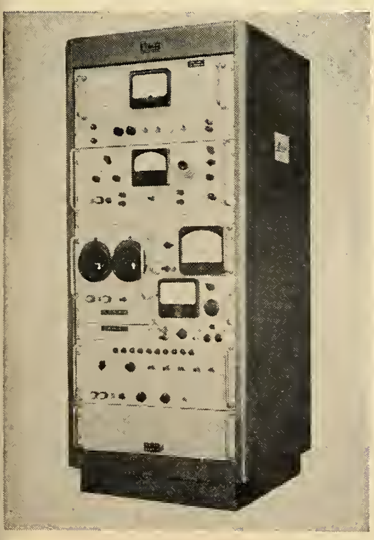
Pressure Relief Valve

A valve, model PRV-29, which relieves excess pressure in small solid-propellant gas generators, is available from Marotta Valve Corp. It features close cracking-to-reseat characteristics and an adjustment which allows the valve to be set at any cracking pressure between 1250—1650 psig, with operating line temperatures to 2000°F. The outlet fitting can be positioned to any angle in a plane parallel to the base of the valve.

Circle No. 234 on Subscriber Service Card.

Test Console

Kearfott Division of General Precision, Inc. is producing a semiautomatic console which performs tests on 400 cycle resolvers, synchro transmitters, differentials, and control transformers. The unit consists of a phase sensitive voltmeter, filtered vacuum tube voltmeter, relay module, signal module, transformation ratio module, and power supply module.

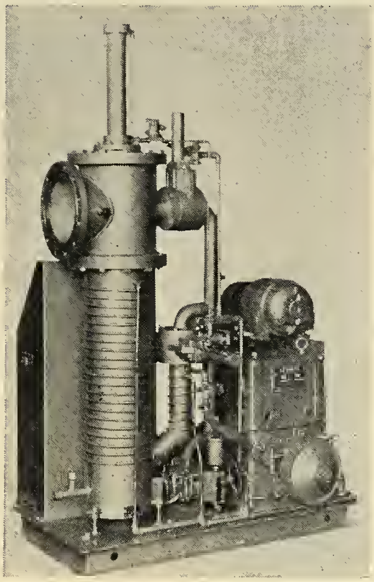


Circle No. 235 on Subscriber Service Card.

Packaged Vacuum Pumps

A series of "packaged" vacuum pumping systems is available from F. J. Stokes Corp.

The systems are composed of an oil-diffusion pump or an oil-booster pump, plus a mechanical backing pump, mounted together on a common baseplate, along with a fully-instrumented control console and all interconnecting to the customer's water, air, and electricity supply lines.



Circle No. 236 on Subscriber Service Card.

DC Power Supply Unit

The Potter Company has available a high voltage dc power supply unit that provides infinitely variable output from 0 to 30,000 VDC at 1.0 MA rated current output. Designed for operation up to 85° C, the unit, model PHV30-1M60V, has all components immersed in high quality oil and sealed to insure long life, minimize corona and provide dependable operation.

Circle No. 237 on Subscriber Service Card.

Molding Composition

Crane Packing Co. is producing a molding powder of DuPont's Teflon 100-FEP Resin compounded with inorganic reinforcing materials.

Very similar to Teflon-TFE, Teflon 100 has been primarily developed for injection molding.

Circle No. 238 on Subscriber Service Card.

new literature

FLAW DETECTOR—Ultrasonic flaw detection is the subject of Bulletin T200, offered by Branson Instruments, Inc. The booklet includes operation, techniques, and a complete list of specifications for the Sonoray® 5 flaw detector. In addition to describing techniques, such as use of straight beams, angle beams, and surface waves, the bulletin discusses application of contact, immersion, and water column testing methods. All recognized pulse inspection techniques are applicable to the Model 5 Sonoray, and some of the most commonly used are tabulated for easy reference.

Circle No. 200 on Subscriber Service Card.

ELECTRON BEAM WELDING—A 12-page catalog has been released by Air Reduction Sales Co., Special Products Dept., on its newest welding technique, electron beam welding. Illustrated throughout, the brochure covers all of the salient features of electron beam welding, how the process operates, the principal advantages, and the equipment required. A full page schematic drawing of the electron beam gun is of particular interest.

Circle No. 201 on Subscriber Service Card.

ALLOY PREFORMS—A booklet on Designing for Alloy Preforms is available from Lucas-Milhaupt Engineering Co. More than a booklet, it is actually a treatise on design considerations and examples of metal joints which lend themselves to use of brazing alloys in preformed shapes.

Circle No. 202 on Subscriber Service Card.

CHEMICAL MILLING—Reprints are available of a comprehensive article on the state of the art in chemical milling from Chemical Contour Corp. The four-page, two-color reprint describes how chemical milling is now used in processing steel and other metals on a mass-production basis.

Circle No. 203 on Subscriber Service Cerd.

AIR FILTERS—A booklet describing the uses of air filters in the missile industry has been published by the Cambridge Filter Corp. Definitions, schematic drawings and specifications are included. High-efficiency filtration techniques are described.

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ELECTRICAL CONNECTORS — A series of Electrical Connectors designed and developed for heavy-duty environmental usages under military standards is described in Bulletin 2711 from Crouse-Hinds Co. Engineering data and charts are included.

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(Continued From Page 42)

through a stipulated number of runs. In many fish, Navy says higher performance comes in the third run. All proofing is separate testing before fleet evaluation by Commander Operational Test and Development Force.

Many torpedo designers, on the other hand, agree that proofing supplies data, but add it's merely because many torpedoes have been run. They say there is little or no data supporting a conclusion that torpedoes are better or more able in their final job becausing of this proofing.

• **Proofing activity**—Some designers agree that proofing allows the Navy to know more about them, a very desirable asset. However, they say the training and confidence is built up in the wrong place—in the proofing activity rather than with the users, the fleet.

These designers recommend that more fleet runs be made. If the torpedo is pre-packaged and expendable there is no problem, they contend. And even if it isn't, it could be sent back to a shore establishment for reworking. They add that performance data should be done in Navy's Operational Test and Development Force because proofing will not do it.

Lynch believes if production must be monitored it could be done with a 10% selectivity. This 10% would be assigned to a fleet quality control activity, capable and assigned to derive from the proofing runs a projected performance level. Fleet experience would then be checked against this derived level. "Oh, what a wonderful set of figures you would obtain," he said.

Navy says the cost of torpedo proofing varies widely and with limited production quantities—300 to 400 in a lot—proofing can not be eliminated. They point out that the torpedo's targets require longer range and faster running and the expensive Cadillac-type torpedo is needed for the kill.

With more cost involved to get this kill capability, production numbers will be going down rather than up, Navy says. And with a dependence on internal storage of data, expendable torpedoes have budgetary considerations against them.

On the other hand, designers say Navy must face the fact that when a torpedo fails to work when it should, it is indeed expensive. They say the question is not the dollar and cents saving which would be inherent in the encapsulated torpedo. They maintain the question is whether function—which is influenced by the budget—is better served by the concept of fixed ammunition.

• **More torpedoes per dollar**—It is also the opinion of some designers that the number of torpedoes per dollar would be nearly doubled if the fixed ammunition concept were adopted, and torpedoes were designed solely for function. They say this approach could be particularly attractive if used torpedoes were salvaged, permitting recovery of expensive components.

Navy today, however, is buying some of the fixed ammunition concept because of the difficulty in training and adequately equipping the fleet-at-sea to handle the newer and more complex devices. It feels that torpedoes should be delivered to launching vessels without further checkout. Even on tenders and shore stations, Navy says it doesn't want its personnel performing repairs on critical items such as gyros, depth mechanisms, etc. Rather it wants critical items furnished, preferably for modular replacement.

But some in the Navy—the designers term them "graybeards"—question whether solid-state electronics is far enough advanced for torpedo guidance. Nevertheless, Navy is conscious of the problem and today has two solid-state torpedoes in early development stages, although not fully encapsulated. While industry is maintaining Navy should make a quick shift to encapsulated solid state torpedo components, Navy, on the other hand, maintains it is doing as much as possible, within complex circumstances of the problem.

But design engineers still maintain that a solid state device permanently encapsulated is about as dependable and foolproof as the hand and mind of man can produce. They cite the swing to the solid state device by the computer people, the telephone people, and yes, the military. But they add there's reluctance by the Navy for such acceptance in torpedo development.

Designers say there are no circuits in modern torpedo guidance and homing which cannot be done in solid state, with the possible exception of the transmitter where the power level may be a bit high. And even here they question whether transmitter power should be vacuum tube developed, feeling there are newer and better ways.

The problem of the encapsulated, solid-state torpedo has many sides. Many designers feel torpedo development within 10 years will be all fixed ammunition and solid state guidance. But the "when" of starting the task, they say, will have to be decided by the Navy.

—contracts—

NAVY

$1,700,000—Telecomputing Corp., Los Angeles, for airborne radar systems.
$195,135—B. F. Goodrich Aviation Products, Rialto, Calif., for labor, material and facilities to load and assemble 5 in. rocket motors.
$144,305—Ampex Data Products Co., Los Angeles, for magnetic tape recorder/reproducer.
$65,814—Northrop Corp.'s Radioplane Division, Van Nuys, for target drone engineering services.
$52,075—United Electrodynamics, Inc., Pasadena, for telemetry system for *Terrier* fuze.
$48,345—CalVal Research and Development Corp., Woodland Hills, Calif., for services, material, facilities for research study on launching systems.
$44,983—Measurement-Standards, Inc., Phoenix, to design, develop and evaluate clectrical, electronic, electro-mechanical and optical measurement systems, techniques and apparatus.
$40,000—Leach Corp., Inet Division, Compton, Calif., for precise power generating equipment to check out instrumentation of missiles.

AIR FORCE

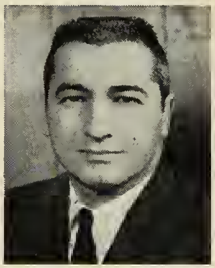
$2,400,000—General Electric's Electronic Specialty Capacitor Products Section, Irmo, S.C., for research and development of materials and methods to produce extreme-high-reliability capacitors for the *Minuteman*.
$1,200,000—The Marquardt Corp., Pomona, Calif., for development of two missile launch trains for the *Green Quail* and the *Hound Dog*.
$283,000—General Precision, Inc., GPL Division, Pleasantville, N.Y., for modification of radar navigational sets.
$125,334—Aerojet-General Corp., Sacramento, for design and development of special LOX H2 injectors and thrust chambers.
$125,000—Leeds & Northrup Co., Philadelphia, for highly specialized temperature and dew point indicators and resistance thermometers to be used in a network of weather stations. Subcontract from The Winslow Co.
$96,226—Bendix Corp., Pioneer Central Division, Davenport, Iowa, for propellant utilization systems.
$75,000—Hughes Aircraft Co., Culver City, for engineering services and supplies for F-106/MA-1 SAGE integration program.
$52,059—Thiokol Chemical Corp., Elkton, Md., for universal metal container applicable to the *IM-99* missile.
$38,720—Thiokol Chemical Corp., Reaction Motors Div., Denville, N.J., for propellant shutoff valves.
$33,000—General Electric Co., Cincinnati, for uncooled rocket thrust chambers.
$28,800—The Garrett Corp.'s AiResearch Mfg. Co. Division, Los Angeles, for LOX converters.
$27,380—Aerojet-General Corp., Azusa, for rocket thrust chambers.

ARMY

Nuclear Development Corporation of America, White Plains, N.Y., for an investigation of speeialized methods of thermal protection or rocket nozzles. Amount not disclosed.
$18,000,000—Western Electric Co., New York City, for furtherance of work on the *Nike-Zeus* missile system.
$181,088—Cornell Aeronautical Laboratory, Inc., Buffalo, for research and development services covering the study of properties of ultimate ballistic missile target.
$149,027—The W. L. Maxson Corp., New York City, for preparation of the technical manuals for the XM90E1, *Hawk*, adaption kit.
$138,730—Eastman Kodak Co., Rochester, for missile infrared acquisition system including scanning optics system.
$138,668—Hayes Aircraft Corp., Birmingham, Ala., for engineering, design, computation, illustration and drafting services on rocket and guided missile systems.
$111,580—Melpar, Inc., Falls Church, Va., for application of dynamic testcr T12 to *Nike* system.
$106,992—Western Electric Co., Inc., New York City, for *Nike* spare parts and components.
$105,000—ITT Laboratories, Nutley, N.J., for modifications to ground stations for *Courier* communication satellite system.
$100,000—California Institute of Technology, Pasadena, for developmental engineering program relating to the *Sergeant* missile system.
$98,100—Librascope Div., General Precision, Glendale, Calif., for prototype, digital computer.
$95,378—Lockheed Aircraft Corp., Missiles and Space Div., Sunnyvale, Calif., for basic research in field of fucl cells.
$89,990—The Martin Co., Orlando, for *Lacrosse* engineering services.
$84,975—University of Southern California, for research program on "Radiation produced by hypersonic objects in the upper atmosphere."
$83,743—Telemetric, Inc., Gardena, Calif., and J. Arnoux Corp., Los Angeles, for camera remote control programer system for use with "Drone Program."
$76,524—The Martin Co., Orlando, for technical representatives for *Lacrosse* weapon system.
$76,140—Western Electric Co., Inc., New York City, for *Nike* spare parts and components.

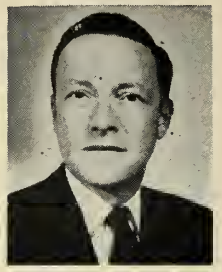
names in the news

HOPKINS

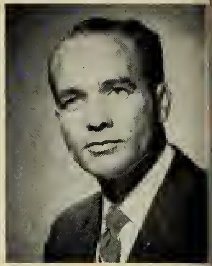


DELUCA

HULL



TINDALL



REA

Gene Hopkins: Named vice president-marketing for Avien, Inc., responsible for all marketing operations including aero-space, undersea and missile systems programs. Was previously executive vice president of the Electrada Corp., and prior to that corporate manager of the midwest office of the Martin Co.

Frank P. DeLuca, Jr.: Who joined Acoustica Associates, Inc., in 1957 as project manager for the company's *Atlas* missile program and more recently executive vice president, elected president of the corporation and its subsidiaries.

Frederick B. Hull: Joins the Process Equipment Division of the Bethlehem Foundry and Machine Co. as a process engineer. Was formerly a chemical engineer in the research department of the U.S. Naval Propellant plant at Indian Head, Md.

Kenneth V. Tindall: Recently appointed systems marketing specialist for Data-Control Systems, Inc., has been placed in charge of the firm's new Washington, D.C. office.

J. R. Rea: Named manager of the Joplin, Mo. plant of the Aero Hydraulics Division of Vickers, Inc., a division of Sperry Rand Corp. Previous activities included production management of the *Nike Hercules* missile APU program, *Goose* missile generator drive program and the *Minuteman* missile APU program.

Dr. Stanley Grand: Former director of research and development for the Radiation Research Corp. joins Vitro Laboratories as head of the Chemistry and Arc Research Dept. **Richard W. Griffiths** has also been named director-western marketing and will head the firm's newly established west coast facility in Los Angeles.

Lyle A. Jakus and **James C. Evans:** Appointed senior scientists in the newly formed systems laboratory at Hughes Aircraft Company's ground systems group. Jakus will be in charge of the laboratory's communications systems staff and Evans is assigned as the system laboratory's technical field coordination office representative to USAREUR headquarters, Germany.

Richard G. Walsh: Former director of engineering elevated to vice president-engineering at Titeflex, Inc. Prior to joining the firm was manager of engineering test and design engineering departments of the Aircraft Engine Division of Ford Motor Co.

John F. Scully: Appointed manager, Computer Systems Design Department, Information Technology Division, Lockheed Electronics Co. Previous posts: Group leader of the Digital Systems group of Vitro Laboratories and special projects manager of Monrobot Laboratory.

A. Franklin LaBarbara and **John C. Schmidt:** Appointed Customer Liaison Engineers for the Military Products Division of Tempo Instrument Corp.

Dr. Nicholas E. Golovin: Elected vice president and general manager of Rabinow Engineering Co. Inc. Dr. Golovin has been Deputy Associate Administrator of NASA.

Charles W. Bozarth: Joins Telemeter Magnetics Inc. as sales manager of their Components Division replacing **R. David Miner,** resigned. Was formerly with Sanders Associates, Inc. and Minneapolis-Honeywell Regulator Co.

C. Harold Hannan: Promoted to the position of director of research at Miniature Precision Bearings, Inc. directing activities of the firm's new Research and Development Laboratory and the Special Engineering Dept.

David M. Snow: Joins American Electronics, Inc. as corporate director of industrial relations, succeeding **Robert L. Mathews,** who has resigned. Was formerly director of administration for Hallamore Electronics Division of The Siegler Corp.

D. G. Wilson: Appointed manager of the Torrance, Calif. plant of the Aero Hydraulics Division of Vickers Inc. division of Sperry Rand Corp. Was formerly industrial engineering manager of the firm's division in Detroit.

Murray Ginsberg: Named chief engineer, development, for Loral Electronics Corp. Previously held engineering management positions with Republic Aviation Corp. and project engineering and advanced planning posts with Weapons Systems Division of Wright Air Development Center.

George Clement: Formerly with the National Aeronautics and Space Administration, re-joins the staff of The Rand Corp. as assistant to the president in the Santa Monica offices. He spent one year with NASA as scientist for vehicle design in its office of Program Planning and Evaluation.

Richard P. Gaunt: A senior member of Space Electronics Corp.'s technical staff for the past 12 years, elected assistant to the vice president.

Howard B. Van Dagens: Joins Century Electronics & Instruments, Inc. as assistant chief engineer. Was formerly associated with the Instruments Division of General Time Corp.

Daniel E. Keller, Jr.: Joins Amcel Propulsion Inc. as the firm's Washington marketing representative responsible for technical liaison on missile and ordnance programs with contractors and government agencies. Was formerly chief of the Propellants, Fuels and Lubricants Branch, Propulsion Division of ARDC.

Richard J. Hanschen: Former field sales manager, named marketing manager for Texas Instruments Inc., succeeding **James F. Carland,** now head of the Semiconductor-Components division, International Operations.

Vice Adm. Harry Sanders (USN-ret.): Member of MISSILES AND ROCKETS editorial advisory board for Underseas Technology, promoted at Chance Vought Aircraft to corporate director of ASW Engineering, responsible for ASW in CV's five divisions.

James R. Kerr: Named executive vice president of Avco Corp. in charge of a newly formed Defense and Industrial Products Group which include the company's Crosley, Lycoming, Nashville and Research and Advanced Development divisions.

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editorial . . .

How Bold, How Imaginative?

THERE has been a great deal of talk in recent political forums, and there will be a great deal more, about the need for "bold imagination" in the free world today.

To put things in proper perspective, here are Webster's definitions:

Bold: "Forward to meet danger; venturesome."

Imagination: "The power to form mental images of things not present."

Since the phrase "bold imagination" is almost invariably applied to national survival—military, economic and ideological, a composite definition might be:

"The power to sense new and unknown dangers and to meet them with attack (rather than mere defense)."

We offer for consideration an idea:

Let's equip our proven allies with atomic weapons sufficient to enable them to do their share in defending the freedom of the world—while we devote more of our time and money to exploring and defending the freedom of space.

Too bold? Too imaginative?

For several years the United States reigned supreme as the only atomic power in the world. Then Russia stole the secret; today she probably at least equals our nuclear strength. Britain became the third atomic power, and this year France joined the club.

Now, we are reliably informed, Sweden is imminently expected to announce that she has developed a nuclear capability.

Neither Britain, France or Sweden are wealthy nations, compared to the United States. But we stood by and let them spend the money necessary to develop atomic power.

The fact that they did this seems ample proof that almost any of our NATO allies, at least, could achieve the same development on their own, if they so wished. Should we, then, stand stiffly aside and let them go it alone—or should we use a little bold imagination and help them?

Working either through NATO (M/R, July 25, 1960) or with member nations individually, we could create a free world nuclear force so diverse and so widespread that no enemy could either wipe it out or defend against it.

Overly cautious planners might argue that increasing the number of nations with atomic weapons would intensify the danger of a general, nuclear war. We do not believe that this fear is realistic, when applied to our NATO allies.

Is Belgium, for instance, or France or the Netherlands, more likely to precipitate a nuclear attack than we are? Knowing the certain consequences—and with their first-hand knowledge of war's horrors?

After the initial expense of proving that we trust our friends, the United States should be able to reallocate a sizeable chunk of the defense budget into exploring and, if you will, conquering space.

VIRTUALLY all military men believe that the nation which controls space will find some way to use that control to dominate the world. We don't want to dominate the world—certainly not by force, but neither can we permit anyone else to do so. We must always be strong enough to prevent any other nation from denying us free access to space. One way to do this is to get established there first. This takes money—money and bold imagination.

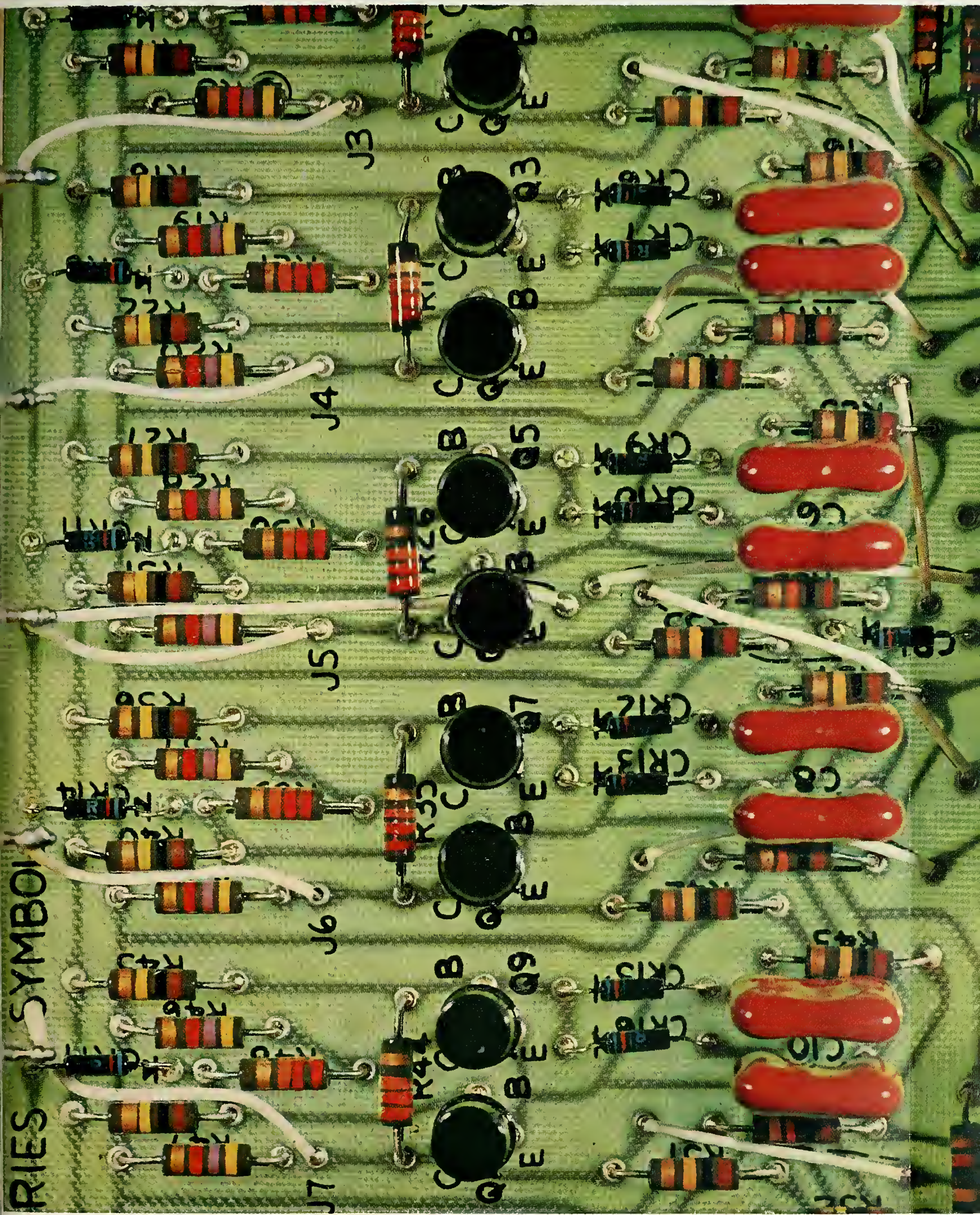
We have NATO and SEATO. We listen to plans for group defenses. Are any of these really worth a whoop as long as we, unimaginatively, keep most of the real strength locked in our own forces?

Is it too bold, excessively imaginative, to say to our allies, "We'll help, but you hold off Russia for a while—and we'll concentrate on space exploration for all of us"?

Think about it.

Clarke Newlon

At 00^{h} 00^{m} 01^{s} GMT, August 1, 1960, Martin logged its 624,156,000th mile of space flight



Without electronics it is impossible to design, build, test, launch, guide, track or communicate with a missile. That is why 40% of Martin's 7,500 engineers are electronic/electrical engineers.

MARTIN

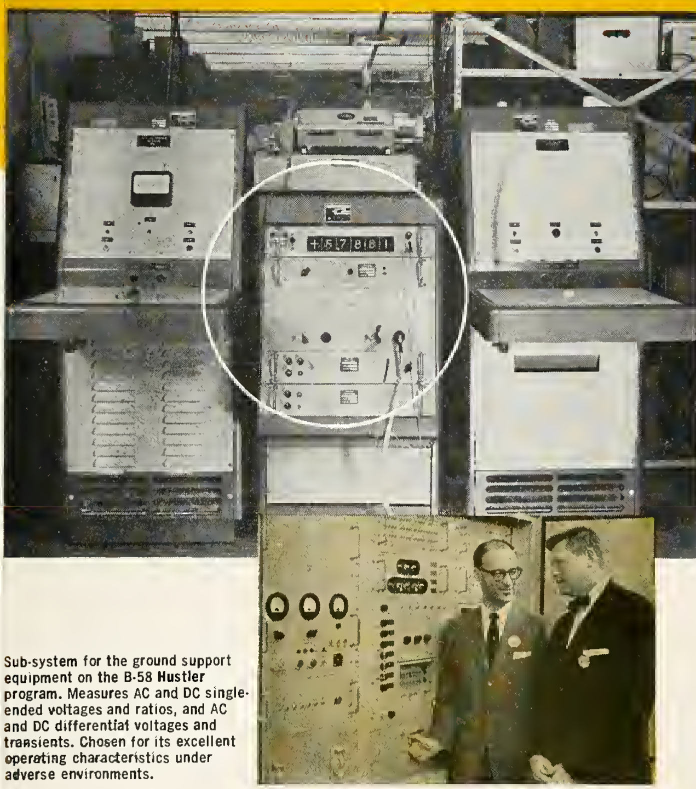
ELECTRO INSTRUMENTS can meet your systems needs NOW... with HARDWARE, NOT PROMISES!

Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers...to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.

Why not talk over your digital system requirements with your EI Sales Engineer? His system experience will be a valuable help in solving your problem.

Multi-purpose digital system for measuring a variety of transistor parameters while the transistors are being subjected to environmental testing.



Digital read-out sub-system of a large, automatic, transistor production checkout system.

Sub-system for the ground support equipment on the B-58 **Hustler** program. Measures AC and DC single-ended voltages and ratios, and AC and DC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.

you get MORE with EI systems!

MORE VERSATILITY—AC and DC voltages, AC and DC voltage ratios, ohmic resistances, capacitance, frequency, phase, inductance, time, or combinations of these basic input quantities can be accepted by the EI system.

MORE RELIABILITY—Maximum use is made of solid-state and MIL-type components which are designed into conservatively-rated, field-proven circuits. All vendor-supplied parts are exhaustively tested and evaluated.

MORE FLEXIBILITY—Expansion of the EI system can be made by simply adding appropriate new modules. This approach eliminates new engineering development costs each time needs change; minimizes system obsolescence.

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