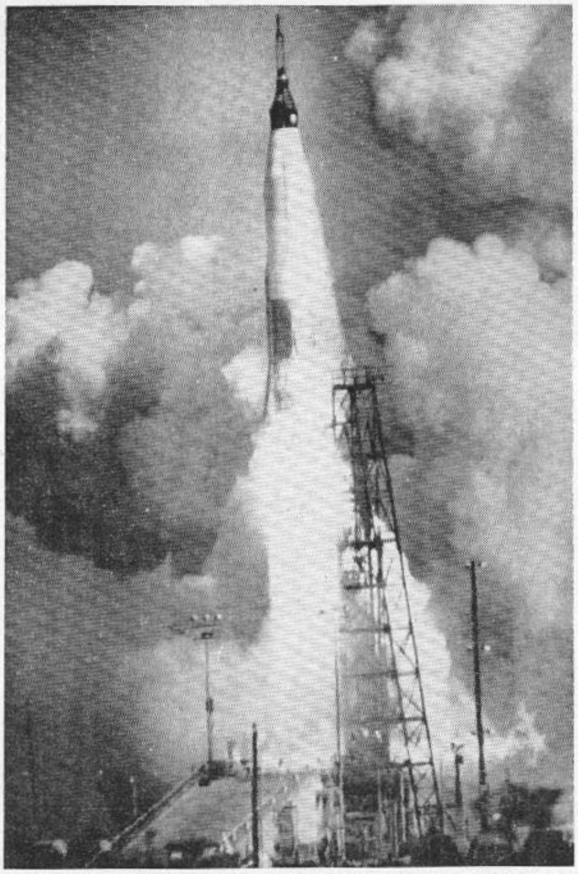
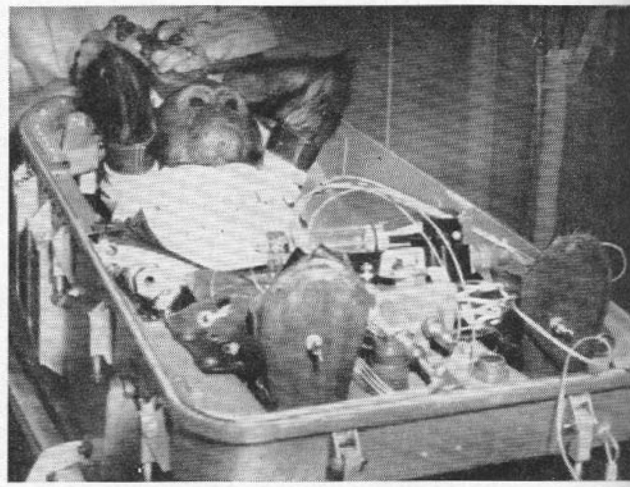


Missiles and Spaceflight

Orbital chimpanzee Enos relaxes in his couch (below) prior to the Atlas-boosted, two-orbit Mercury flight of November 29. Left, the lift-off from Cape Canaveral. As reported on this page, re-entry and successful recovery were effected after two orbits instead of the planned three



CHIMPANZEE IN ORBIT

The occupant of the National Aeronautics and Space Administration's Mercury spacecraft used in the Atlas-boosted MA-5 orbital launch from Cape Canaveral on November 29, a chimpanzee of superior intelligence named Enos, performed his scheduled in-flight tasks efficiently and was recovered safely after two orbits of the Earth. The flight was intended to involve three orbits, but was terminated after two orbits following an attitude-control system malfunction and the apparent overheating of an electric inverter in the spacecraft. It was later announced that the pilot in the first US manned orbital attempt, which might take place later this month, would be Mercury Astronaut John Glenn, a lieutenant-colonel in the US Marines.

APOLLO CONTRACTOR NAMED

North American Aviation Inc has been selected by the National Aeronautics and Space Administration as prime contractor for the initial phase of the Apollo manned lunar spacecraft programme, at an estimated contract value of $400m. The company will design and develop two of the three main sections of the spacecraft—the "command centre" to house the three-man crew, and the section housing fuel, electrical power supplies and propulsion units needed for lunar take-off. A separate contract for the third main section of the spacecraft, containing decelerating rockets intended to lower the craft gently on to the surface of the Moon, is expected to be awarded within six months.

The space administration had previously selected the Instrumentation Laboratory of Massachusetts Institute of Technology as an associate contractor for the development of the Apollo guidance and control system. The three basic Apollo missions will be Earth-orbital flights, circumlunar flights, and manned landing and exploration of the Moon. Earth-orbital flights should begin in 1964-65. Further details of Apollo, as given by Mr Robert Gilruth, Director of NASA's Manned Spacecraft Center, are reported in the article "America's Plans in Space" on pages 874-6.

UN SPACE COMMITTEE MEETS

First meeting of the United Nations Committee on the Peaceful Uses of Outer Space was held in New York on November 27. The session was called by Britain and the USA, after the committee had failed to meet previously because of disagreement over its leadership. This dispute had broadened into Soviet objections to the composition of the committee, although Soviet UN representative Valerian Zorin said that Russia would not boycott the meeting.

At the meeting the US representative, Mr C. W. Yost, said: "The time is ripe for certain initial measures to preserve peace in outer space, and extend to all nations the benefits of exploring it. The United States considers that the General Assembly should take such action now. . . .

"First, we believe that the time has come to acknowledge explicitly that international law and, in particular, the Charter of the United Nations, extends to the outer limits of space exploration. Similarly, we believe recognition should be given to the principle that outer space and celestial bodies are freely available for exploration and use by all States and are not subject to national appropriation by claim of sovereignty or otherwise.

"Second, in order to encourage the open and orderly conduct of outer space activities, we believe that provision should be made for registration of all space vehicles launched into orbit or sustained space transit. . . .

"Third, the United States would like to see initiation of measures to facilitate the international sharing of the benefits of practical applications of outer-space technology which we are developing. . . . The United States proposes that member States and specialized agencies such as the World Meteorological Organization undertake early and comprehensive study of measures to advance the state of atmospheric science and technology and to develop existing weather-forecasting abilities and help member States make effective use of these through regional meteorological centres.

"Fourth, the United States believes that communications satellites can eventually play an important role in the expansion and improvement of international communication and the fostering of international understanding. We recommend that study be undertaken by ways to make this service available to the nations of the world as soon as practicable on a global and non-discriminatory basis. . . ."

VIGILANT AND SEASLUG

The War Office has announced an inventory order for the Vickers Vigilant anti-tank missile. Following extensive evaluation trials in the past year, Vigilant is to become the standard anti-tank guided weapon of the infantry and of reconnaissance units of the Royal Armoured Corps. Many thousands of rounds must be involved, and they will be made by English Electric Aviation at Stevenage, the value of this contract amounting to several million pounds. This is the first purchase of a British surface-to-surface missile, and the first order for a British weapon developed solely with private capital.

The Admiralty and MoA have allowed the main contractors for the Seaslug ship-to-air missile—Whitworth Gloster Aircraft, GEC and Sperry—to announce that "in recent acceptance trials of Seaslug Mk 1, from HMS *Girdle Ness*, a run of 16 consecutive firings resulted in 16 successful interceptions."

Missiles and Spaceflight . . .

AMERICA'S AIMS IN SPACE

BY KENNETH OWEN

THE National Aeronautics and Space Administration is currently looking for 2,000 more scientists and engineers to work in its nine main research centres and in its headquarters offices. US Government spending on space over the next ten years may well exceed fifty thousand million dollars. The first step along the American road to the Moon—an Earth-orbital flight by Mercury astronaut John Glenn—is about to be taken. The year 1961 has been one of changing emphasis and complete reorganization for United States space activity. What overall picture emerges, and what are the lines along which the US space programme is now directed?

A clear outline of the main lines of present thought and future action was given in three panel sessions at the recent American Rocket Society meeting in New York, and in a number of interviews with leading American space authorities in New York and Washington. A logical approach is to discuss in turn the missions, the vehicles employed, and the global effects.

Within the overall objective of the exploration of space, the missions fall into four main groups:—

(1) Scientific research, a continuation of traditional investigations in both the physical sciences and the life sciences but with the measuring instruments placed outside the Earth's atmosphere and beyond the Earth's magnetic fields.

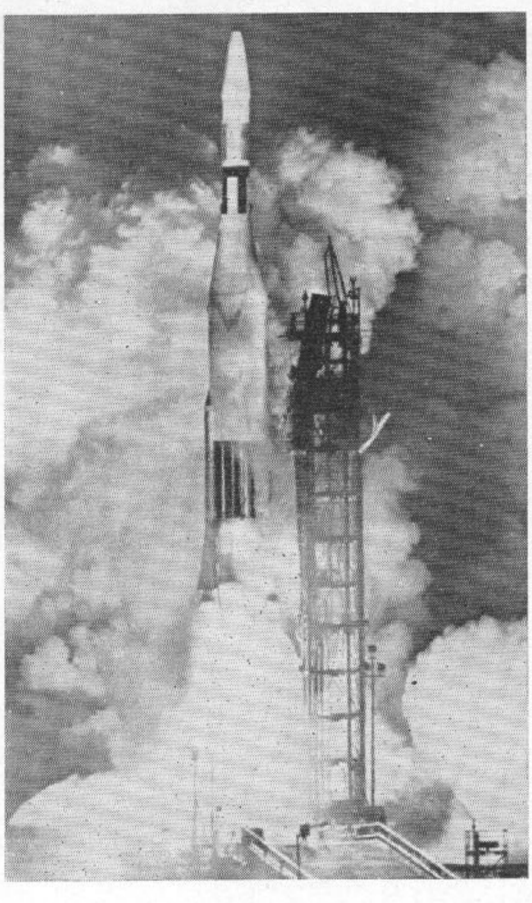
(2) Direct exploration, which could be included under scientific research but which involves the landing of exploratory equipment on the surfaces of the Moon, then Mars and Venus, and then the more-distant planets.

(3) Manned spaceflight, and

(4) The development of immediate-use or "application" spacecraft such as communication, meteorological and navigation satellites.

This view of the mission spectrum has been reflected in the reorganization of NASA into four main offices, which came into effect only last month. The first two groups listed above come under the Office of Space Sciences; there are separate offices for manned spaceflight and for applications; and the fourth of the new offices covers advanced research and technology in both aeronautics and space. As far as space missions are concerned, the situation is not static, and it has been suggested by Dr Arthur R. Kantrowitz, director of the Avco Everett Research Laboratory, that America's ability to conceive new missions will be the pacing factor in the country's space progress. At present the cost of placing satellites in orbit remains high, and only when the cost per pound in orbit decreases significantly will the number of commercially possible missions increase.

Atlas-Agena B launch of Ranger 2 from Cape Canaveral, November 18; mission aborted because of second-stage fault



Scientific Research The sophisticated orbital observatories now being developed for NASA's programme of basic scientific research, it was emphasized by Dr Herbert Friedman of the US Naval Research Laboratory, were building on the foundations laid on a more modest scale in the decade before the launching of Sputnik 1, when a great deal of space-science work had been done by means of sounding rockets. "Thank God for the Aerobee rocket," Dr Friedman commented, showing by means of slides the increased amount of data now obtainable even by the modest sounding rockets (an Aerobee firing in August 1961 had provided an ultra-violet frequency spectrum of the Sun in which 5,000 lines were observable, compared with some two dozen lines in a 1949 firing).

Many scientific unknowns in the region between the Earth and the Sun are now being discovered, identified and measured by means of satellites and space probes. Among the major results have been the discovery of the Van Allen radiation belts, the mapping of the geomagnetic field, the determination of the slight "pear shape" of the Earth, a new insight into the Earth's heat balance, and new information on solar effects on the upper atmosphere and the electron distribution in the upper ionosphere.

A continuing trend in scientific spacecraft is the development towards larger craft carrying more instrumentation. Typical of the advanced equipment now being developed are the Orbiting Solar Observatory, Orbiting Geophysical Observatory family, and the Orbiting Astronomical Observatory. The OGO family is typical also of another trend; towards a standardized vehicle into which a variety of experiments can be fitted as required.

Although not customarily grouped together with the application satellites such as those for communications and meteorology, the scientific satellites and probes mentioned are all essentially communication spacecraft, in that they receive electromagnetic radiations (either man-made or natural), record the information in some way and transmit it to receiving stations on Earth. There is no actual contact with other planets.

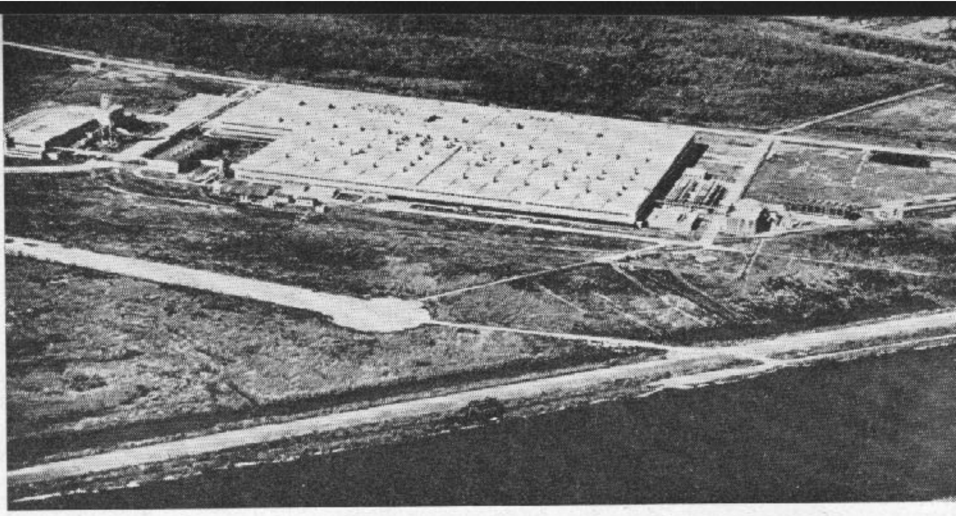
In this type of spacecraft the main effort goes into the instrumentation that is carried to do these jobs. The craft themselves are generally placed in relatively simple orbits—either circular, elliptical or highly elliptical—around the Earth, around the Sun, or conceivably around the Moon or the other planets. The next step is the more difficult job of landing spacecraft first on the Moon and then on the planets, for what might be considered a more massive-scaled exploration of the solar system.

Direct Exploration NASA's programme of unmanned exploration of the lunar surface, using the second-generation spacecraft Ranger, Surveyor and Prospector, was summarized by Dr William H. Pickering, Director of the Jet Propulsion Laboratory, Pasadena, as shown below. The dependence of any spacecraft on its launch vehicle, incidentally, was illustrated ironically by Rangers 1 and 2. Both of these extremely sophisticated spacecraft, developed and built by JPL, were unable to complete their planned missions because of defects in the second stage of the Atlas-Agena vehicle. (Dr Friedman, whose own satellite payloads are usually dependent not only on the launch vehicle but also on getting a piggyback ride on another satellite, spoke of "the traumatic experience, as a space scientist, to have one of my experiments on a vehicle that fails.")

NASA LUNAR PROGRAMME SUMMARY

Objectives: (1) to assist and support manned operations; (2) space technology and lunar science

Ranger (*Atlas-Agena B*) rough impact	Spacecraft development; survival capsule; high-resolution approach reconnaissance	Nine flights, 1961-63
Surveyor (*Centaur*) soft landing	Scientific stations: reconnaissance orbiter	Seven flights, 1963-65
Prospector (*Saturn*) precision landing and return	Mobile surface craft; logistic support craft for manned programme	Unknown number of flights, 1966-70



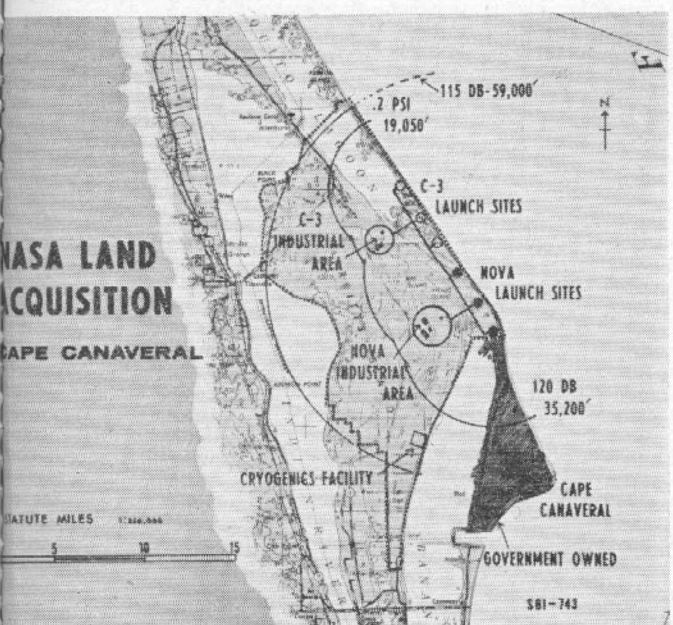
The next generation of NASA's big boosters will be built at Michaud ordnance plant, 15 miles east of New Orleans, which should begin operation next year with the manufacture of Saturn stages

Nevertheless, Dr Pickering reported, a considerable amount of scientific information had been obtained from the early Pioneer probes and the more recent Ranger 1. Looking beyond the lunar flights to the exploration of the planets Venus and Mars, the launch times would be critical because of the limited and infrequent periods during which near-planetary shots would be possible. The first probes launched in the planetary programme would be designed to "fly-by" Venus or Mars and to make *en route* observations. The spacecraft used would be Mariners, followed by the Saturn-launched Voyagers.

For interplanetary exploration just as much as for, say, communication satellites, Dr Pickering emphasized, one needed a spacecraft lifetime measured in years. A large technological effort must be directed towards ensuring long life. Vanguard 1 was still transmitting after more than 3½ years, he remarked, which in this respect was very good.

Manned Spaceflight Much of the immediate interest in Dr Pickering's unmanned lunar spacecraft stems from their significance in relation to President Kennedy's accelerated programme to place three men on the Moon, and return them to Earth, by 1970 (this remains the official date, although individual NASA scientists are hopeful for 1967). The manned lunar mission, expressed simply, involves the following approximate velocities: 17,000 m.p.h. to achieve Earth orbit, an additional 7,000 m.p.h. to go to the Moon, a decrease of 1,500 m.p.h. to go into orbit around the Moon and a further decrease of 4,000 m.p.h. to land on the Moon. Repeating these steps in reverse order brings the spacecraft back to Earth. This does not imply that the manned lunar flight will necessarily be made in these stages; merely that a total velocity change of approximately 25,000 m.p.h. is needed in the vehicle (from Earth orbit back to Earth orbit).

A review of the whole area of manned spaceflight was given by Mr Robert R. Gilruth, Director of NASA's Manned Spacecraft Center (now located at Langey Field, Virginia, but soon to move to a new installation at Houston, Texas). This included an appraisal of the achievements of Project Mercury and the plans and problems of Project Apollo; because of its importance and technical interest this contribution merits extensive reporting here.



In Project Mercury today, Mr Gilruth said, we were approaching "the end of the beginning." Although modest in comparison with currently planned programmes, Mercury had been a difficult but inspiring task. In the three years since its inception, the project had passed through the stages of research, development, engineering, design and manufacture, and was now "deep in the qualification flight-test phase."

The challenge in Mercury was, first, to investigate man's capabilities in the space environment; and secondly (but concurrently) to develop manned spaceflight technology for use as a basis for the conduct of much more ambitious undertakings, including manned exploration of space and the planets. Mr Gilruth went on to list the following major accomplishments:

(1) A major management resource had been developed, and was now being expanded, for the conduct of manned spaceflight research activity.

(2) The design of the Mercury spacecraft had been selected and verified in flight.

(3) A family of launch vehicles—Little Joe, Redstone and Atlas—with which to carry out the flight programme had been selected.

(4) Industrial know-how and capacity for the design and manufacture of very complex spacecraft and related systems had been developed and expanded.

(5) A progressive build-up of flight operations had been drawn up and was now well underway. Included in the flight programme [which at that time, prior to the MA-5 flight reported on page 872, had included flights by 22 Mercury spacecraft] were flights by "two small rhesus monkeys, a friendly chimpanzee named Ham, and two friendly fellows named Shepard and Grissom."

(6) An earth-girdling tracking, data collection and flight control network had been built.

(7) A pool of trained space pilots had been developed.

All of this experience and capability is in being now [Mr Gilruth continued]. We as a nation are now confronted with a new and tremendously more complex challenge. It is the challenge spelled out by President Kennedy before the Congress on May 25, 1961. It is the national goal which he set of sending man to the Moon, accomplishing a successful landing on the Moon and return to Earth in this decade . . .

The manned segment of the lunar landing programme is known as Project Apollo. I would like to underscore here that Apollo is only the manned segment. It is by no means the only project involved—nor can we accomplish the desired end-result alone. . .

As a step toward the three-man Apollo mission, we feel at this time that considerably more manned spaceflight experience is desirable. I am thinking here of an expanded manned orbital flight development programme, probably with Mercury-type spacecraft,

EVALUATION OF LAUNCH SITES

	National ownership	Launch vehicle impact hazard	Over-flight hazard	Water transport	Interrupt intra-coastal waterway	Adjacent to existing capabilities	Relative facilities cost index
Brownsville, Texas	US	yes	yes	yes	yes	no	1.07
Cape Canaveral	US	no	no	yes	no	yes	1.02
Christmas Island	UN	no	no	yes	—	no	3.00
Cumberland Island, Ga	US	no	no	yes	yes	no	1.07
Hawaii	US	no	no	yes	—	no	1.87
Mayaguana, Bahamas	GB	no	no	yes	—	no	2.41
White Sands, New Mexico	US	yes	yes	no	—	yes	1.00

A major expansion of NASA launch facilities is planned at Cape Canaveral, as indicated on this map, which shows the existing launch-site area in heavy shading. Above, factors influencing the choice of launch site for the space administration's Saturn-class vehicles

Missiles and Spaceflight . . .

This kind of interim activity would give us much-needed launch experience, more knowledge in depth about manned inputs into these kinds of systems, and in particular could give us answers to questions about manned operations in space during rendezvous, midcourse trajectory changes and similar operational experiences.

This kind of activity would and should be undertaken concurrent with and in support of our work on Project Apollo. It would be a highly productive undertaking which would take maximum advantage of our Mercury experience and know-how and provide new experience and capabilities for application to Apollo.

The mission of Apollo is threefold. First, we will undertake extended-duration Earth-orbital flights; then we will proceed to circumlunar exploratory flights; and finally, we will go on to lunar landing and return.

The detailed configuration of the Apollo spacecraft has not as yet been completely defined. The spacecraft design will be determined partially by the industry design competition now underway and more completely by subsequent NASA/contractor detail design efforts. Basically, it will consist of a three-man command module attached to advanced propulsion modules for lunar landing and take-off. The launch vehicle will be a large multi-stage chemical rocket of the Nova class.

Project Apollo began almost two years ago when a small team within the Space Task Group was set up to define the mission and to develop working guidelines for the effort. All of the NASA research and spaceflight centres and resources were brought into the programme to ensure that sound basic research would get underway in order to assure the availability of a solid technological basis for the programme. . .

The primary propulsion systems for launching Apollo are under study. Saturn, the predecessor of the Nova-class rockets, is now about to enter the flight-test phase with the first test vehicle now on the pad [since successfully launched] at Cape Canaveral . . .

Major Apollo Problems

As is the case in any major advance in technology, there are a multitude of complex problems involved in the Apollo flight mission. I would like to outline some of the major problems.

Re-entry dynamics. First, there is the problem of protection of the spacecraft and its crew from the searing heat of re-entry at velocities of 36,000ft/sec. Here we must dissipate a kinetic energy per pound weight that is far greater than the chemical energy of any known compound. . .

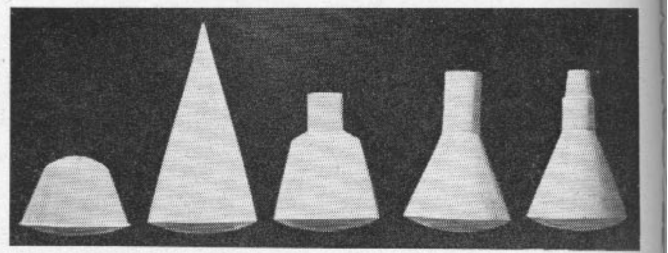
Earth landing capability. The problem of Earth landing capability includes the ability to avoid local hazards and to control the final touchdown point. Some degree of lift ability in the vehicle itself plus adaptation of either steerable parachutes or the Rogallo kite (paraglider) may provide the solution to this problem.

Lunar landing. In the manned lunar landing we must achieve a genuinely "soft" controlled landing in a vacuum and on a surface about which we know almost nothing. The lunar sciences programme should provide us with many of the answers we need here. However, a large engineering undertaking will be required.

Performance. The performance problem facing us is basically related to the size of the step to be taken. Project Mercury requires a launch vehicle capable of putting about 1½ tons in low Earth orbit. For the lunar landing and return, Apollo will require a basic launch vehicle capable of putting one hundred times that weight in low Earth orbit. For flights to the Moon and the planets, the ratio of take-off thrust to spacecraft weight will approach 1,000 for chemical rockets. Because of the extremely large vehicles which might result, it may well be that rendezvous techniques will provide the only means of accomplishing the mission with launch vehicles of considerably smaller proportions. It also seems clear that we shall soon have to progress to the more exotic forms of propulsion such as nuclear or nuclear-electric if we are to engage in planetary exploration with relatively reasonable thrust-to-weight ratios.

Reliability. Many factors tend to mitigate against high reliability in large space-vehicle design. But one factor—Man—requires that the reliability must be high. We must achieve an order-of-magnitude reduction in failure rates in our launch vehicle to approach the required values of stage reliability necessary for manned flight. Possibly the desired order-of-magnitude reduction is launch-vehicle failure rates can be achieved by order-of-magnitude increases in previously used measures of simplicity, redundancy, quality control, and the human input to control the system. This will not be an easy task, but it is one worthy of our most intense efforts [Mr Gilruth concluded].

Although the subject of this article is the NASA programme of "civilian" space exploration, it is relevant to record the views of the Commander of the USAF Systems Command, Gen B. A. Schriever, who has said "As a military commander who shares the responsibility for the defence and security of the nation, I am convinced that we must be prepared to operate in space in order to preserve the peace."



Stages in the design of the Mercury spacecraft: (from the left) (1) simple shape was unstable, (2) more stable shape was too weak and heavy, (3) shape planned for interior requirements, (4) as specified for space and structure, (5) final shape to take antenna and escape tower

In the past, Gen Schriever claims, US space efforts have been carried out under an "unnecessary, self-imposed restriction"—i.e., the artificial division between space for peaceful purposes and space for military uses. There is very little technical distinction between the two, in the general's opinion: the same hardware and techniques used to launch an orbiting scientific capsule can also be used to orbit an early-warning satellite. The same techniques that can send a man into space as a scientific observer may also send him there in a military role.

Gen Schriever added at a press conference in New York that he was not claiming a military function on the Moon at the present time, although there might be one in the future.

Application Spacecraft In the field of "application" spacecraft, the outstanding examples are meteorological and communications satellites, both of which not only have been shown to be feasible but have been put to work with directly useful results.

Thanks largely to rocket and satellite developments, the Chief of the US Weather Bureau, Dr F. W. Reichelderfer, has said, "We are now approaching a new era where meteorology will become an increasingly quantitative science." Each day now, he remarked, two weather maps were computed "without contamination by human hands," and as a further example he quoted September 11, 1961, on which day Tiros 3 revealed no fewer than seven tropical storms—one over Africa, hurricanes Debbie and Esther in the Atlantic, Carla crossing the Texas coast, Nancy and Pamela near Japan and an embryo tropical cyclone in the Pacific.

Data obtained from meteorological satellites includes stratospheric, tropospheric, cloud-top and surface temperatures; information on atmospheric constituents such as water vapour, ozone and carbon dioxide; the motion, type and ground-cover of clouds; and heat-budget items such as solar radiation, reflected solar radiation, and radiation from the Earth and the atmosphere. In addition to improving and extending weather predictions, Dr Reichelderfer has said that the US operational satellite programme [described in last week's issue] "may afford the opportunity to establish initial 'causes' from which might develop a truly scientific weather-modification effort."

Even more impressive in immediate-use implications is the massive and varied effort which both NASA and the US Defense Department are putting into the development of a family of communication satellites. It may not be generally realized in this country that six separate communication-satellite programmes are underway in the USA at present—at least four of which will involve satellite launches next year. The British GPO may find this of interest.

NASA is involved in five of the six projects. Another orbital launch of an Echo passive communication satellite will be made next year, and this will be followed by Rebound, in which three passive satellites will be placed in a 1,500-1,700 mile orbit. Active repeater satellites comprise Relay (low-altitude orbit at 1,000-3,000 miles), Telstar (in co-operation with American Telephone and Telegraph, similar orbit to Relay) and Syncom (24hr synchronous satellite at 22,300 miles), all of which will be launched during 1962.

The Defense Department's main communication-satellite programme is the active-repeater Advent, to be launched into synchronous orbit initially by Atlas-Agena B and later by Centaur. The Department also has an interest in passive systems, to which the recent West Ford launch was intended to be relevant.

As indicated, both passive and active systems, and both high and low orbits, are being investigated prior to any thoughts of "freezing" a particular design or system. Dr John R. Pierce, director of research of Bell Telephone Laboratories (an A.T. and T. company) has suggested that satellite and component reliability is the most important single problem to be tackled. Communications satellites will be useful and will make good commercially, he emphasizes, only if they "keep going for years." To obtain reliability one should use well-tested components, few in number, and use actual flight testing to discover whether the anticipated life could be achieved.

(*to be continued*)