an answer to the question: What is magnetism? He wanted to find out, he said, just what kind of fingers a magnet has that lets it reach out and pull a piece of metal to it. Also, through research at Washington University and later at the Sloan-Kettering Institute for Cancer Research, he did what he could to aid in the search for ways to prevent and cure cancer. After he retired in 1947, he devoted most of his time to these three endeavors, doing much laboratory experimentation of his own on the first two.

One of the biggest contributions Kettering made to progress was as a vocal advocate of revitalizing changes in industry, not only in his own company but in others as well. In the early years of his activity the need for technological progress was not nearly so well accepted as it is today. "I am not pleading with you to make changes," he kept saying in his many public speeches. "I am telling you you have got to make them—not because I say so, but because old Father Time will take care of you if you don't change. Consequently, you need a procurement department for new ideas."

With Kettering, as with others consecrated to it, the search for new knowledge was a religion. C. P. Rhoads, director of the Sloan-Kettering Institute for Cancer Research, said this about Kettering's views of research, "His principal point is that if one is to have a productive career in research, one must have some well-defined objective. . . . Without objectives, he feels, scientific life is unsatisfactory and scientific work in general unproductive. This point of view is, of course, in sharp contrast to that so frequently enunciated in recent years by those who believe sincerely that there should be no objective in research." But Kettering believed that research not aimed at contributing in some way to human needs, however indirectly, is not justified.

Popular as a public speaker, Kettering made hundreds of addresses and radio speeches. These were full of the wit and wisdom characteristic of him. He had a knack of putting things in direct and simple terms, of using imagery and apt analogy, and of injecting anecdotes and humor to give his talks vividness and vigor. Many of his sayings and epigrams have been widely quoted. "The price of progress is trouble," he would say, "and I don't think the price is too high."

On education Kettering's views were not in complete accord with accepted beliefs. "If we drove an automobile the way we try to run civilization," he said, "I think we would face backwards, looking through the back window, admiring where we came from, and not caring where we are going. If you want a good life you must look to the future. . . . I think it is all right to have courses in history. But history is the 'gonest' thing in the world. . . . Let's keep history, but let's take a small part of the time and study where we are going. . . . We can do something about the unmade history."

Robert A. Millikan said of Kettering, "He is unique in that he combines in one individual the interest in pure science with the practical ability to apply knowledge in useful devices." Willis R. Whitney, too, said of him, "We have never had another man like him in America. He is the most willing man to do things I have ever seen. Benjamin Franklin was a little like him. Both had horse sense and love of fun. If a fellow goes to school long enough he gets frozen in his thinking. He is not free any more. But Ket has always been free."

In 1905 Kettering married Olive Williams, of whom he said that she was a perfect supplement to an absent-minded inventor. They had one son, Eugene W. Mrs. Kettering died in 1946, and afterwards Kettering said of her that she was the only possession of his he had never tried to improve.

Kettering was generous with his time outside his principal field. Among a multitude of activities were his services as president of the American Association for the Advancement of Science in 1945 and of the Society of Automotive Engineers in 1918, as chairman of the National Inventors Council from the time of its formation in 1940, and as a long-time director of the National Geographic Society. From his contemporaries he received numerous distinctions, including more than 30 honorary degrees and many medals and awards.

At the funeral of Kettering's associate, Thomas Midgley, Jr., the minister read the familiar Bible verse, "We brought nothing into this world, and it is certain we can carry nothing out." Afterwards Kettering commented, "It struck me then that in Midgley's case it would have seemed so appropriate to have added, 'But we can leave a lot behind for the good of the world.' "

That comment of his could apply with even more fitness to himself. For what he left behind, when on 25 November 1958 he quit this world at the age of 82, is a vast heritage to the people of the nation from a dynamic, many-sided, and highly creative life.

T. A. Boyd

1016 Harvard Road,
Grosse Pointe, Michigan

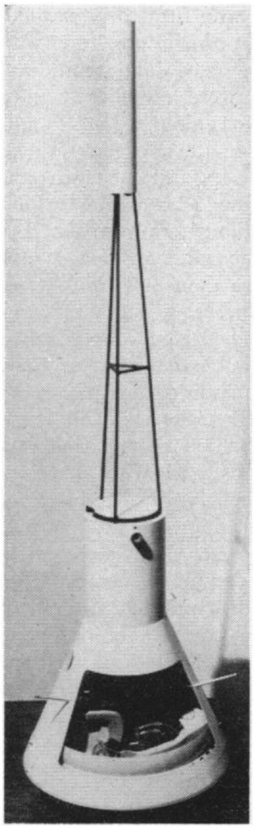
News of Science

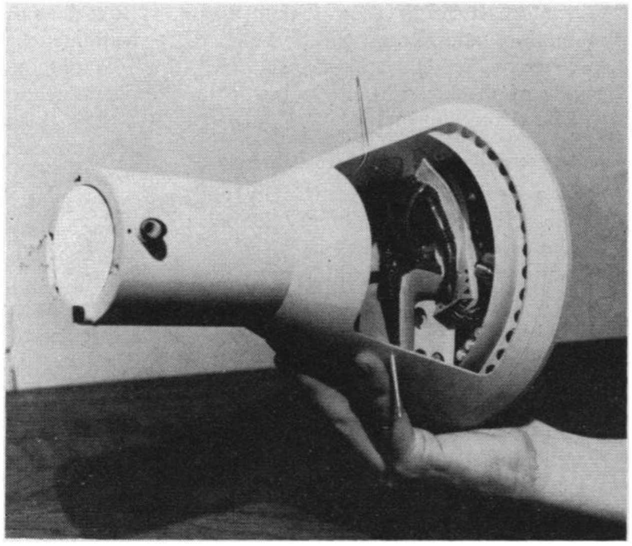
National Aeronautics and Space Administration Has Outline for Manned Satellite Program

The National Aeronautics and Space Administration, the agency responsible for the country's nonmilitary space activities, has released some of the details of Project Mercury, its manned satellite program. Preliminary information on the launching and recovery techniques, the man-carrying capsule, and other details were given with the announcement that McDonnell Aircraft Corporation of St. Louis had been selected as the source for the final design, development, and construction of the capsule. McDonnell, founded in 1939, is currently producing the Voodoo and Demon fighters and is a subcontractor for the Talos missile program. The company's experience in designing and constructing jet aircraft cockpits will have direct application to the capsule design problem that Project Mercury poses.

Space Capsule

The man-carrying capsule, as now conceived, will be in the shape of a truncated cone with a short cylinder attached at the point of truncation. Less pedantically, it could be said to resemble a cathode-ray tube. The base diameter of the cone will be approximately 7 feet, with the other dimensions scaled accord-





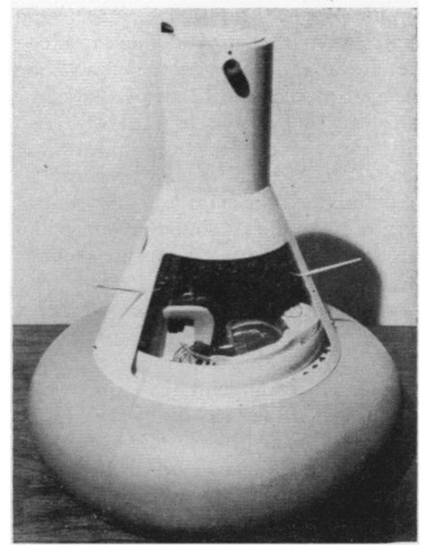


Fig. 1. (Left) Attitude and configuration of Project Mercury man-carrying capsule at time of firing. Capsule will be the payload of an intercontinental ballistic missile. Superstructure and top canister constitute escape system. Fig. 2. (Middle) Satellite showing orbital attitude and cut-away view of pilot and couch. Cylinder at left contains drogue and landing and reserve parachutes. Fig. 3. (Right) Reentry and recovery position. Landing parachute is not out and open in picture. Heat shield and retro-thrust rocket cluster are hidden by impact bag. Bag is one possible form for impact control. Final form will be determined by McDonnell-NASA Research.

ingly. (See Figs. 1 and 2.) A weight of about 1 ton is expected for the capsule, which may be made of nickel alloy or titanium. The satellite will have high aerodynamic drag, will be of the nonlifting type, and will be designed to withstand any known combination of acceleration, heat loads, and aerodynamic forces that might occur during boost or reentry. It will have an extremely blunt leading face covered with a heat shield, probably of beryllium.

Three antennas will project from the sides of the cone, and a port will be so placed as to allow direct observations by the occupant. Other devices will permit the pilot to see portions of the earth and sky.

Life support system. A couch, fitted into the capsule, will support the pilot during acceleration. The pressure, temperature, and composition of the atmosphere in the capsule will be maintained within allowable limits for human beings. Food and water will be provided; because of the short orbit time, 24 hours or less, problems of pilot maintenance are expected to be met by the techniques now used in jet fighter aircraft. Medical instrumentation, possibly including a television camera, will evaluate the pilot's response to space flight; data will be recorded in flight and telemetered to ground recorders.

Other instrumentation. Devices other than those directly concerned with the pilot's welfare will be a two-way voice radio, instruments to measure and monitor the internal and external capsule environment, and devices to make other scientific observations as space and weight limitations permit.

Control procedures and mechanism. A dual system of control procedures will allow for control of the capsule by the pilot, or the ground station, or both working in conjunction. The pilot will have the option of manual or automatic control during orbital flight. Small pitch, yaw, and roll jets will allow the pilot or the ground station to establish the proper attitude for orbit.

Launching

Project Mercury's man-carrying capsule will be thrust into orbit by an intercontinental ballistic missile. No specific information has been released on the vehicle and booster, but it can be assumed that the country's basic hardware, such as the Atlas, will be used with the modifications that will come up during the 2-to-3-year lead time that the project will require. Standard firing and phasing practices will be followed to take the missile's payload from the launching pad up to an orbiting altitude of roughly 100 to 150 statute miles. In the event of faulty ignition or improper lifting of the vehicle, however, an elaborate escape device will go into action.

Abort procedure. Projecting from the smaller end of the capsule will be a frame superstructure which will support a thin rocket canister. (See Fig. 1.) In a successful launching this device will have no function other than determining the center of gravity of the payload. In a faulty launching it will be the means whereby the pilot and capsule can be saved from destruction. If, during ignition and lifting, the ground crew becomes aware of any malfunction, it can initiate escape procedures by firing the rockets in the canister. These will lift the capsule up and away from the booster. Once clear of the carrier and at a sufficient altitude the superstructure and canister will be jettisoned, the parachute which would have been used in a normal reentry will be drawn out of the short cylinder attached to the cone, and the capsule will return to the surface where an impact bag will diminish the shock of landing.

Normal flight. If the launching succeeds, the satellite will separate from the carrier at the proper altitude, the escape-system superstructure and canister will be discarded, small reaction jets will shift the orientation of the long axis of the capsule from the vertical to the horizontal, and the satellite will go into orbit in the attitude shown in Fig. 2.

Reentry and Recovery

At any point during the capsule's flight, reentry and recovery techniques can be initiated by either the pilot or the ground-control personnel. In rough outline the procedure will be as follows.

By use of the reaction controls—the small jets placed around the capsule—the attitude of the container will be changed so that the firing of the retrothrust rockets at the base of the cone will start the capsule back toward the earth. The eventual impact area can be predetermined because of this control over the capsule's point of reentry into the atmosphere. As the capsule reenters the earth's atmosphere and slows to a speed approximately that of sound, a drogue parachute will open to stabilize the vehicle. At this time radar chaff will be released to pinpoint the capsule's location. When the velocity of the capsule decreases to a predetermined rate, a landing parachute will open. The parachute will open at an altitude high enough to permit a safe landing on land or water. The capsule will be buoyant and stable in water.

The nature of one element of the recovery system has not been definitely decided upon. This is the impact bag which appears as a large doughnut-shaped object in Fig. 3. Several approaches are being weighed by NASA personnel at the Langley Research Center, Langley Field, Va. One would have the impact bag an inflatable structure which would be tightly compressed under the heat shield during reentry and then expanded after the shield had been dropped and the parachute had opened. A second approach would have the impact bag made of a material similar to that which is used in air-dropping supplies and vehicles during air-borne operations. Such a material would have a very fine honeycomb structure to control the rate of collapse and thereby protect the capsule and pilot. Decision on this point, which will come of cooperation between NASA and McDonnell Aircraft Corporation, will determine the final configuration of the satellite.

As the manned capsule approaches the impact area it will be the focus of a variety of location and recovery procedures. By the fact that control will have been exercised over the timing of the reentry, ground equipment, presumably computers, and capsule equipment will be able to predict the general area of impact. To this information will be added the exact pinpointing allowed by the release of radar chaff—metallic tinsel of the type used for radio jamming. Triangulation on radio signals from the satellite will offer a supplemental means of location, as will visual observation if the reentry occurs during the daylight hours. Once the capsule is down, recovery aids such as tracking beacons, high-intensity flashing light systems, the two-way voice radio system, and, for water landings, sofar bombs (for sending underwater impulses) and dye markers will begin operation. In an operation of this nature, it can be assumed that ships, submarines, and aircraft will be assigned to cover the predicted impact area. Recovery of the capsule and its occupant will be virtually assured.

Responsibility for Project Mercury

In a project of the complexity and significance of Project Mercury the contributions of many federal agencies, the military services, and industry must be joined. Areas of responsibility for the many aspects of Project Mercury are as follows. Program management: National Aeronautics and Space Administration with the aid and assistance of the Department of Defense's Advanced Research Projects Agency. Technical direction: National Aeronautics and Space Administration. Capsule: McDonnell. Booster: industry. Launching and flight operations: National Aeronautics and Space Administration, military services, and industry. Supplemental research: government laboratories and industry. Crew selection, training, and in-flight evaluation: the aeromedical community.

Underground Nuclear Test Data

On 16 January the Department of Defense made public some details concerning the new seismic data on underground tests that have so affected the negotiations at the International Conference on Nuclear Test Control that is taking place in Geneva [*Science* **129**, 200 (23 Jan. 1959)]. The information released is that which was given to the Soviet and United Kingdom delegations at Geneva on 5 January, when the conference resumed after a Christmas recess.

Background

Since the conference of experts in Geneva reached its conclusions on 20 August 1958, the United States has conducted a series of underground nuclear explosions which were completed prior to 31 October 1958. There have been available to the conference of experts data on only one nuclear explosion—that of Rainier, 1.7 kilotons. In order to approximately augment the Rainier data for the purpose of more thoroughly understanding the problem of detection and identification of underground explosions, the yields of the recent underground tests were selected to fill in the range from 0.1 to about 20 kilotons. Each of the tests was extensively monitored with seismographs. As a result, data bearing on the detection and identification problems are now available.

While these new data are still undergoing evaluation by United States experts and only preliminary interpretations are at present available, the basic data and preliminary interpretations are felt to be sufficiently firm to permit derivation of certain conclusions.

To obtain the new data, temporary seismic stations were established at a number of locations along a line extending eastward from the Nevada Proving Ground to Arkansas and thence northeastward to Maine. The nearest station was about 100 kilometers from the shot points, while the most distant station was slightly more than 4000 kilometers distant. Each operating site was carefully selected by a team of geologists, who located suitable outcrops of hard rock remote from sources of man-made noise. Some 16 stations in all were equipped with Benioff short-period vertical seismographs and with auxiliary equipment for assuring proper interpretation of the recordings.

Seismographic recordings were made at these stations for the Blanca event on 30 October 1958, which had a yield of about 23 kilotons equivalent; for Logan on 16 October 1958, with a yield of about 5 kilotons equivalent; and for Tamalpais on 8 October, which had a yield of about 0.1 kiloton equivalent.

Conclusions

The following preliminary evaluation of the data obtained for these three events was given:

1) In the range of yields of 0.1 to 23 kilotons equivalent, the amplitude of the seismic wave varies approximately as the first power of the kiloton equivalent yield of the explosion.

2) The Blanca and Logan explosions produced artificial earthquakes equivalent in size to shocks of magnitude 4.8 and 4.4, respectively, on the Richter earthquake magnitude scale. The earlier estimate of the magnitude of the Rainier explosion was too high because it was based on a selection of data from a few stations which typically give larger-than-average amplitude. Consequently, the revised magnitude of Rainier is about 4.1, rather than 4.25 as previously estimated. It therefore appears that the previous estimate of the number of earthquakes per year equivalent to a given yield in kilotons requires revision upward.

3) The principal method recommended by the Geneva conference of experts for distinguishing earthquakes from explosions is of less utility than was thought prior to the three recent underground nuclear explosions—for example, the determination of the direction of first motion is much more difficult than had been anticipated at Geneva. It appears from the recent data that first motion is not usable as an identification characteristic of earthquakes that are equivalent to 20 kilotons or less when recorded at distances between 1100 and 2500 kilometers from the burst. At a distance of 200 kilometers the amplitude of first mo-