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Address
by
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"Projects Mercury and Gemini"

Introduction

One year ago this month, President Kennedy in a special address to Congress established manned lunar landing as a National goal. The President's statement followed by only a few weeks the flight of Alan Shepard in a Mercury Spacecraft. Shepard's flight was repeated a few months later by Gus Grissom in a similar Mercury ballistic flight. Then several orbital flights were made - first unmanned - then with a chimpanzee named Enos, and most recently by John Glenn in a 3 orbit flight last February 20th.

These flights of the last 12 months came after an intensive period of research and development which in 3 years produced a manned spacecraft, operational techniques, a world wide tracking and instrumentation network, trained flight and ground crews, and adapted military rockets to manned space flight.

The management organization for this effort was the NASA Space Task Group at Langley Field, Virginia. In October, it was decided to relocate thisgroup at Houston, Texas and to establish there the Manned Space Craft Center for Projects Apollo and Gemini in addition to Mercury. At the present time both Project Gemini and the Apollo Space Craft are being managed out of Houston while the Mercury team is still at Langley Field and the Cape.

In my presentation today I intend to review briefly the Mercury concepts. This is particularly appropriate because of its major influence in the Apollo concepts. Also the role of Project Gemini will be briefly discussed in the same context. The main feature of this presentation, however, will be the showing of a film on the preparations for and the flight of John Glenn in Friendship 7.

PROJECT MERCURY

Project Mercury is well known as this nation's initial manned space flight effort. It used, as basic concepts:

The Atlas launch vehicle and its guidance;

a blunt non-lifting reentry body with retrorockets for

Slide 1 recovery from orbit;

a parachute landing on water;

an automatic escape system (escape tower); and

a progressive buildup of tests.

Slide 2 illustrates the Atlas launch vehicle as well as the two other primary vehicles used in the progressive buildup

of tests. On the left is shown the Little Joe solid-propellant vehicle which was developed for early flight tests of various Mercury systems, including the escape rocket, the parachutes, the environmental system, the structure, and the landing and recovery operations. In the center is shown the Redstone which was used to further qualify the spacecraft and its systems and for introducing man into the total system. This introduction of man into the system covered two areas: One, the pilot aboard the spacecraft in order to determine and verify man's capabilities in space flight; and two, the crew in the control center in order to determine and verify their ability to exercise real-time control over the progress of the flight. The Atlas, on the right, is the vehicle used for orbital flights in which all the flight and ground systems were further qualified and which culminated in our successful manned orbital flight of February 20, 1962.

The parachute landing and the automatic escape system are both illustrated by the next slide (3) which is a sequence of photographs from the Mercury-Atlas flight of April 25, 1961. The two left hand photos show the normal appearance of the flight at an early time. The next panel shows the escape rocket firing when a command destruct signal was sent to the launch vehicle because it was not following the prescribed trajectory. The third photo shows the spacecraft well away from the exploding launch vehicle, and the last picture is that of the spacecraft descending unharmed on the parachute. The same spacecraft was recovered and

later used for the first Mercury orbital flight, MA-4.

Now, let us examine some of the basic problems encountered in Project Mercury. The basic technical problems were:

Slide 4 Development of the spacecraft and its systems,
pilot selection and training,
flight control in real time,
automatic vs. manned control
procedures, and
booster-spacecraft integration.

Under spacecraft and its systems--we found in our initial R and D flight tests that the distribution and level of afterbody heating as shown bythe wind tunnels was not completely accurate and there was a concentration of heating on the afterbody cylindrical section. To solve this the original thin refractory metal panels on the afterbody were replaced by thicker beryllium panels. This was a change that was necessary after one of our first flight tests. Another additional system that we had to provide for beyond the original concept was land landing capability. We had to devise an impact bag to absorb the shockloads in certain conditions of abort wherein a land landing could occur.

Part of the problem with the spacecraft and systems lay in the area of maintenance and checkout. As shown in Slide 5, the Mercury spacecraft is quite compact and the systems are relatively crowded. Generally, only one system could be reached at one time and in order to work on, or check, one system, others had to be

moved and later rechecked. This naturally slowed somewhat the preflight preparations of each spacecraft.

Pilot selection and training was a problem, but I would say here that the original concept was very good, we are well satisfied with the techniques used and we are well satisfied with the criteria we established. We are using test pilots, experienced test pilots. We feel that this has been wise, and I would say that pilot training is one area in the future work in our space flight programs where we can come close to predicting lead time.

The next item, flight control, is a whole story in itself. In launching a manned satellite the problem is a bit different than in an unmanned one in that you want to know the orbit parameters and trajectory in real time and whether or not you are achieving a good orbit. This problem, of course, led to the development of a control center at Cape Canaveral and the worldwide tracking and instrumentation network. Basically, the problem is one of giving the Flight Director on the ground, a picture in real time of the trajectory and alsothe behavior of the onboard systems. If an abort is indicated, he can so advise the pilot immediately for example, if as you lift up to 60,000 feet, if the pilot has not recorded that the systems are all good and if the Flight Director sees a loss of oxygen pressure, he would command an abort. Another problem was that of automatic versus manned control. In Mercury we had to provide a completely automatic system because, of course, we had to fly animals first. At the same time we wanted to use as much of the same hardware as possible when we got

the manned flights and we wanted to give the man as much override as possible to take advantage of the extra reliability he can provide. This gave us a problem of complexity which would not exist if we could have gone with a manned vehicle all the way.

Operating procedures were another problem. We were dealing with a new area of manned flight. For example, we had to develop procedures for use on the launch pad to rescue the man in case of trouble there when we did not want to use the automatic escape system or if for some reason that malfunctioned also. There are many, many details that must be worked out in a manned flight operation.

The last item is booster-spacecraft integration. It would be hard to conceive of a simpler type of spacecraft to integrate with a booster than Mercury. It is symmetrical, small, and no lifting surfaces and yet this is an area where we experienced considerable trouble. We had a structural dynamics problem between the spacecraft and the booster which was not anticipated as being a problem when we started.

To summarize, then, our present position, we have taken Project Mercury from a concept to the actual hardware and trained flight and ground crews. The specification manned orbital flight occurred on February 20, 1962. Another such flight is now imminent. Manned flight in space has become, with President Kennedy's public announcement on May 25, 1961, a National Goal. I would say also that acceptance of new concepts by both the public and by the technical community has been largely achieved. Many of these

concepts are being used directly in Projects Gemini and Apollo.

PROJECT GEMINI

Project Gemini isan intermediate step between Mercury and Apollo, the manned lunar-landing project. The program is designed to extend our studies of man's capabilities in space to include long-duration missions of days rather than hours, and to include studies of man's abilities to rendezvous in space by locating another vehicle, maneuvering it and his spacecraft until they are in close proximity and then joining the two. (Slide 6)

The Gemini spacecraft and launch vehicle are illustrated on the next slide (7). Basically the spacecraft is quite similar in shape to the Mercury spacecraft but is enough larger to house a two-man crew in order to permit the long-duration missions. The launch vehicle is a Titan II second-generation ICBM propulsion unit which is being produced for Gemini by the Space Systems Division of the Air Force. The spacecraft will rendezvous and dock with an Agena stage launched by an Atlas similar to that used in Mercury.

In Gemini we are exploring advanced concepts in system engineering for Space Vehicles based on Mercury experience. Every effort is being made to reduce systems interfaces - to package systems to facilitate their development - access - and checkout - and to minimize problems of final assembly and maintenance. The general interior arrangement is shown in Slide 8. This experience should have a direct influence in Apollo design.

As indicated earlier our problems in the area of pilot selection and training were not great and are felt to be well in hand. No particular problems are anticipated for Gemini and, in fact, the provision for a two-man crew will allow more pilots to acquire actual space flight experience.

The problems of flight control in real time for Gemini should be intermediate in severity between those for Mercury and Apollo. Our experience with Gemini in controlling long-duration missions and in launching two large vehicles at precise time intervals as required for satisfactory rendezvous experiments should contribute both knowledge and actual operational experience that will be valuable to the solution of Apollo flight-control problems.

Since our Mercury flights have shown that man can, indeed, operate satisfactorily in a space environment and since the second Gemini crew member will provide backup for the first, it is planned that Gemini will have less automatic sequencing of flight modes than did Mercury. Operations with man in the role of mode selector and acting as sensor operator in the rendezvous missions should again provide experience and knowledge that will increase our confidence in the role to be played by man in Apollo.

In the interim period between Mercury and Apollo the requirements to operate Gemini will do much to improve the development of operational procedures.

The problems of booster-spacecraft integration between the Titan II and Gemini should be somewhat less than in the Atlas-Mercury program. For one thing, we have our Mercury experience

to guide our thinking. For another, Gemini will not have a long heavy escape tower on the front to change the structural vibration modes of the combined booster and spacecraft. This does not mean, indidentally, that we feel we no longer need a launch escape system. On the contrary, we feel we will need some means of escaping from a malfunctioning launch vehicle for at least several more generations of boosters. On Gemini this escape means is provided by ejection seats, much like those used in present-day high-performance aircraft. Our studies to date show that such seats will be suitable for Gemini because of the much lower explosive yield of the storable hypergolic fuels used in Titan II as compared to the yield of the cryogenics used in other launch vehicles.

One last problem to discuss is that of land landing. We must consider both the ability to land the spacecraft safely on land rather than water and the ability to land at a preselected point on the earth'ssurface. Both of these ends must be achieved before we can feel that the terminal phases of space flight have been satisfactorily developed. The achievement of point-landing capability requires that throughout the reentry phase of flight the pilot must be able to apply controlled amounts of lift to the vehicle to change its course in order to correct for navigational errors, winds, etc. In Mercury we felt that we did not need this capability since for an initial exploratory program we could satisfactorily account for dispersion from the pre-planned landing point by disposition of the recovery force aircraft and ships. This course of action

assured us of the quickest and simplest means of getting on with the job. In Apollo, however, this control of lift during reentry will be required to permit safe entry into the atmosphere at the very high speeds associated with the return from the lunar trip. In order to gain experience with this type of operation, the Gemini spacecraft will be built with an offset center of gravity so that it will tend to trim at some finite value of lift rather than at zero lift as in Mercury. The direction of this lift vector and thus the direction of the course corrections will be controlled by rolling the spacecraft with small reaction jets. With such control the Gemini pilot should be able to reach any landing point within about 100 miles to either side of zero-lift line of flight and several hundred miles up- or down- range from the zero-lift landing point.

Even with controlled lift during reentry, if a parachute is used for the final stages of letdown, one still faces the problems of wind drift in the lower atmosphere, of avoiding local hazards such as rocks, cliffs or trees, and of attenuating the final landing shock in any except a directly vertical landing. To provide solutions to these problems on Gemini we plan to use the Rogallo wing or paraglider illustrated on the next slide (9). Until ready for use in the lower atmosphere, the wing is carried folded and uninflated in the small neck of the spacecraft. When the spacecraft has completed its entry and slowed to subsonic speed, the paraglider is deployed and inflated as illustrated in the small sketches on the lower part of the slide. The pilot then has

the ability to glide to landing strips, counteract rather high winds that would blow a parachute off course, avoid local hazards, and finally flare out to reduce his vertical velocity to zero and land with a reasonable horizontal velocity on the skid-type landing gear shown on the small sketch at the far right.

CONCLUDING REMARKS

In summary, manned space flight has come into its own as a major part of our total space flight program.

Project Mercury has provided the initial step upon which our future program is being built. In bringing Mercury to this stage we have acquired a large fund of both general and detailed knowledge that should do much to help advanced manned flight programs. In particular, we feel that we have adequately demonstrated man's capability and utility in space flight and have given initial solutions to basic space problems.

Project Gemini is in the design and construction phase. It has been planned to utilize the lessons learned in Mercury and to provide significant increases over Mercury in space flight duration and maneuver-ability. Gemini will provide flight experience and technical knowledge that will be applied to Apollo and to more advanced space flight missions.