

There was no lack of rocketry art when Sputnik jolted the US and the free world. The Army, Navy, and Air Force had all been working with missiles for some years, and many rocket specialists had foreseen the future significance of space. But the national capabilities were splintered. As NASA came into being, with a strong need for large-scale program know-how, it was the Air Force, fresh from its missile management experience, that could offer the most useful aid in getting the space program under way . . .

How USAF's Missile Program Helped the Nation off the Pad

BY WILLIAM LEAVITT

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"From this effort has emerged not only the major portion of our national missile force but also the prime base of technology and management skill underpinning the total national space effort. Many of our space accomplishments to date—both military and civilian—simply could not have been undertaken successfully without the prior experience gained in the Air Force missile development program."

—SECRETARY OF THE AIR FORCE EUGENE M. ZUCKERT

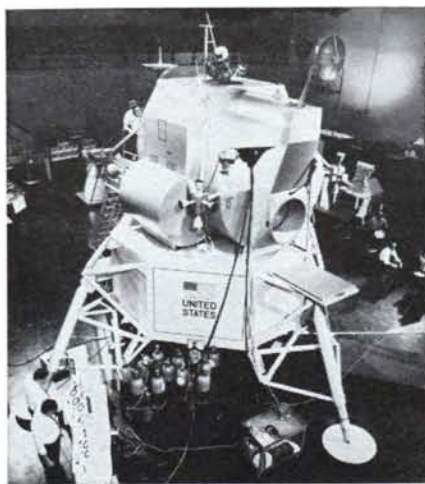
IT IS a fact, documented in the public prints, in congressional reports, and above all, on launch pads and tracking sites around the world, that the US Air Force has made massive contributions of men, hardware, and management capability to the national space effort. This has been true from the shocked moments after Sputnik, when the nation decided to sharply expand its astronautical program, straight on to the present multibillion-dollar Year Seven of the space age.

Just one aspect of this sizable Air Force role has been the large number of Air Force officers who have served the National Aeronautics and Space Administration on direct loan or in supportive Air Force efforts, since the civilian space agency's establishment in 1958.

Today, this large input of Air Force expertise into the space agency is represented on the very highest echelons of the NASA organization: The Air Force officer who successfully directed the USAF Minuteman ICBM program has just come on board at NASA's



Newly on board at NASA is Brig. Gen. Samuel C. Phillips, USAF, who will serve as Deputy Director of Apollo moon-landing program. Earlier he had headed USAF Minuteman program.



Vast funding, crucial technical management expertise will go into development of such items as Apollo Lunar Excursion Module, shown in mockup. USAF management skills will help.



Dr. George E. Mueller, a former vice president of Space Technology Laboratories, which aided USAF missile effort, now heads NASA's Office of Manned Spaceflight, bosses Apollo.



Dr. Wernher von Braun, shown here in early missile days with Army Ballistic Missile Agency chief, Army's Maj. Gen. John B. Medaris, was articulate advocate of space programs long before Sputnik and was urging use of military boosters to beat Russians to the punch with an earth satellite. Army team came to rescue of nation's prestige in early 1958 with first successful US satellite launch, using Jupiter-C as the space booster.

Washington headquarters as Deputy Director of NASA's Project Apollo lunar-landing program. Brig. Gen. Samuel C. Phillips will have operating charge of the complex Apollo effort, under the supervision of Dr. George Mueller, Deputy Associate Administrator of NASA and Director of its Office of Manned Spaceflight. Dr. Mueller is himself a highly qualified import into NASA from Space Technology Laboratories, which played such an important role in the USAF missile program. The Mueller-Phillips team dramatically represents the continuing contribution of the Air Force to the nation's over-all space effort. This contribution is doubly remarkable in view of the existing responsibility, assigned the Air Force in 1961 by Secretary of Defense McNamara, for research and development of military space systems.

Many observers who take a conspiratorial view of history, have interpreted such Air Force-blue coloration of NASA as an indication of Air Force hopes to take over—by a process of infiltration—the entire national space effort. "What could be more obvious?" the cynics have asked, trotting out the old cliché about the camel's nose in the door of the tent.

This theory admittedly has appeal for those who enjoy looking for Air Force colonels under the bed, but it skirts the basic question of why it has indeed been vital to the public interest for the Air Force to play such a significant role in the civilian space effort. The answer from the start has been undramatic but persuasive: Necessity.

The cold fact is that, without already available Air Force missile program experience garnered from the early '50s to the day the Russians jolted history with their Sputnik on October 4, 1957, the accelerated American space program could never have gotten under way with any kind of dispatch. To a great degree, the Air Force missile program provided a solid base for the post-Sputnik national space effort.

To say all this is in no way to denigrate NASA itself or its predecessor agency, the old and highly respected National Advisory Committee for Aeronautics. Or the highly skilled and experienced band of ex-German V-2 rocketeers who in 1957 were in place under the leadership of Dr. Wernher von Braun at the Army's Ballistic Missile Agency at Huntsville, Ala. Or the dedicated (and later unjustifiably abused) Navy team that was working on the International Geophysical Year Vanguard satellite—using a nonmilitary booster because of national policy decisions to stress the peaceful aspects of space—at the time of Sputnik.

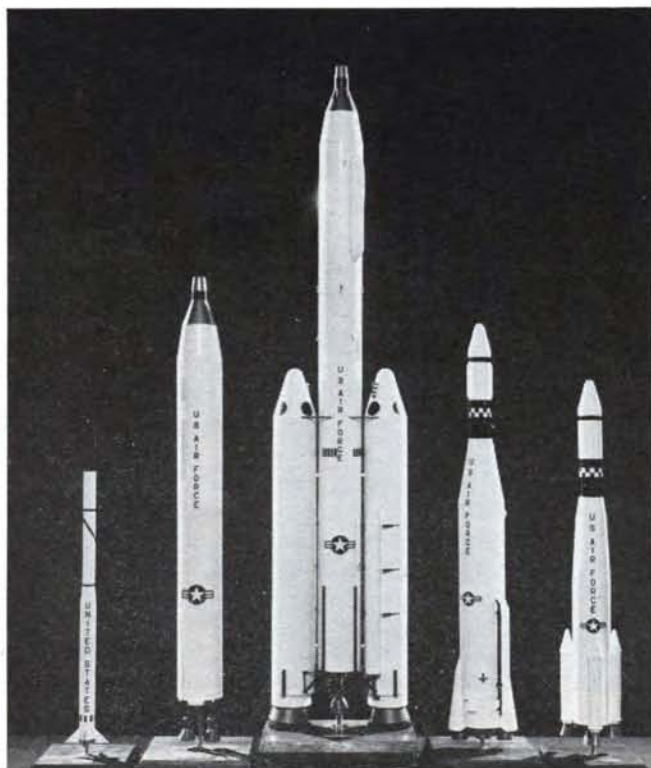
People with vision in all these agencies as well as in the Air Force had seen the potential benefits that would accrue to the US from a large-scale assault on space. The personal files of many of them bulge with pre-Sputnik correspondence on the subject. Of all the pre-Sputnik space prophets, Dr. von Braun was perhaps the most famous public advocate of an American space program that would take US astronauts not only into orbit but on to the moon and to Mars. There is ample evidence that he and others were correctly dubious about the low-level Vanguard program and urged, several months before Sputnik, a crash program to use existing missile capability to launch an American satellite that would have beat the Russians to the propaganda punch. And in February 1957 Gen. Bernard A. Schriever was publicly declaring the space capability of military boosters then under development.

It is painful to shift back in memory to the immediate post-Sputnik period. Yet to do so helps explain the reason why Air Force missile-program experience, then several years old, was so easily transferable to the expanded national space program that was decided on in the months following Sputnik.

That there was no lack of skill in the rocketry art at
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the time of Sputnik is unquestionably true. The three military services were all in the rocket business, to varying degrees, and there was plenty of aerospace industry capability on hand too, as well as R&D know-how in the old NACA. But expertise was not enough, because it was scattered and splintered. What was needed above all was experience, not only in the rocketry art itself, but in the *management* of priority R&D projects—from drawing board to assembly line. And in this field the Air Force was paramount. It had already been doing this kind of massive job for a number of years.

Because of the unique requirements of the USAF missile program, which had started in earnest in 1954, the Air Force had devised new approaches to program management which are still having their beneficial effects today. Looking back on the decision, arrived at with no little argument, to place one man in full charge of missile development, and to allow him to gather a team of technically competent Air Force officers, meanwhile arranging for independent systems management of the programs (which was a departure from the time-honored prime contractor approach), it all seems very commonsensical now. But at the outset of the missile program, such approaches flew in the face of tradition. Particularly in the face of the traditional approach being used by the Army at Huntsville, where the style was to build vehicles hand tailored from the bottom up, a custom-tailoring approach in a ready-to-wear era. Those who followed the Air Force-Army missile controversy of the '50s can recall



Air Force family of space launch vehicles has enabled US to put satellites of varying weights into probe trajectories, into earth orbit, and on flights into deep space. Left to right, Blue Scout, multistage solid-fueled vehicle, using three or four solid-rocket motors; the Gemini launch vehicle, a modified Titan II with about 430,000 pounds of thrust, to be used for Gemini manned orbital flights; Titan IIC, with its two strap-on solid rockets, designated for use with Manned Orbiting Lab; Atlas, with Agena spacecraft; and the "thrust-augmented" Thor, cousin of IRBM version.



A vital factor in the success of the Air Force ballistic missile program, once decision to go ahead was made, was designation of one man to have charge of effort, General Schriever. Single-manager approach is gaining ascendancy—against some odds—in the NASA-managed moon program.

the noisy argument over which approach was better, the Army's "arsenal" or the Air Force's "military-industry team" concept. Certainly there were arguments for the Army's approach—in a leisurely era. But the '50s were scarcely leisurely, featuring, as they did, first the frightening realization that the Russians had gotten the jump on us in the long-range missile business and later the fearful shock of Sputnik.

It is an odd but happy quirk of history that the USAF missile management technique was itself the product of initial inadequacy.

There is nothing like starting virtually from scratch to create new approaches to new problems. Thus it was fortuitous that the Air Force, at the outset of the missile program, was faced with building, in the very basic sense of the word, the requisite management and development team and the industrial backup.

Once the argument within the Air Force, the scientific community, Department of Defense, and the Administration over whether a major missile effort ought to be undertaken was settled—and it was quite an argument—the Air Force was faced with devising the management structure and finding the proper combinations of people and industry skill to run a successful R&D plus production effort that would get operational missiles into the inventory by at least the 1960s.

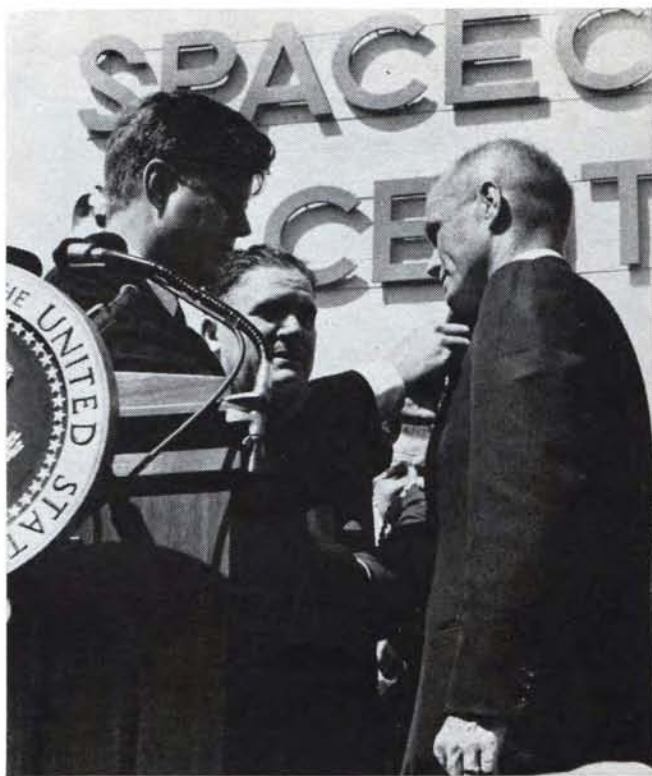
Final success, not cost, was, of course, the primary

criterion, for the Air Force missile effort. Many mistakes and false starts occurred. One has always to bear in mind that the Air Force was nearly in a virginal condition as it set out in the early '50s on a technological adventure that was considered unrealistic and even infeasible by a large segment not only of the scientific community but also of the more traditional elements of the Air Force itself.

By 1957, the gamble had begun to pay off, and the country was well on the way to the ICBM and IRBM capabilities it enjoys today. Gray hairs, ulcers, and all the other concomitants of the famous "Black Saturdays" at which the missilemen had wrestled monthly with costs, configuration control, schedules, and the thousands of other elements that went into the research and development, testing, site planning, and training associated with the oncoming weapon systems, had taken their toll. But out of it all, at the time of Sputnik, there had emerged a capability in terms of management skill, people, and aerospace industry base that was naturally applicable to the newly-decided-on space program. It is no reflection on the policy decision to invest prime responsibility for peaceful space exploration in the civil agency created by the 1958 space act to say that the Air Force, deep into its missile program experience, could have, with the requisite money and assigned responsibility, taken on the overall space job too, had such a national policy been decided on.

That, of course, did not happen. There were too many political considerations, domestic and international, to allow it to happen. And in retrospect, it was probably a good thing for the country and for the Air Force that it didn't happen because, despite the obvious crossovers in technology and management between the existing missile program and the embryonic space program, the missile program, for security reasons, had to retain its top priority. An Air Force doubly involved with direct responsibility for both strategic missile development and nonmilitary space operations would probably have become a highly splintered Air Force.

But what didn't happen directly happened indirectly. Air Force input was evident from the beginning, not only in terms of personnel but also in terms of philosophy. NASA immediately adopted the government-industry team approach that had served the Air Force missile program so well, a point that is illustrated today by the repeated assertions by NASA Administrator James E. Webb that more than ninety percent of NASA funding is spent with industry. Along with the government-industry team development concept went what was essentially, with some modifications by NASA, the same systems-management concept that had been employed in the USAF missile effort. In the area of procurement and the crucial man rating of the Atlas that was modified for a mission not originally planned—orbiting a man—NASA, lacking any in-house experience, leaned heavily on the existing Air Force-industry Atlas team. In fact, a separate Air Force-NASA-industry operation was set up alongside the existing Air Force Atlas organization, with offices down the hall at the Air Force Space Systems Division headquarters and at other crucial locations, to produce the man-carrying missiles. Air Force of-



The massive effort, assisted to a great degree by the experienced Air Force-industry team, to man-rate the Atlas ICBM as a safe man-carrying rocket, was crowned with successful orbital flight February 20, 1962, by Mercury Astronaut Lt. Col. John H. Glenn, USMC, shown being decorated by President Kennedy at Cape Canaveral, Fla.

ficers who worked on the Atlas development still remember the skull sessions with Air Force counterparts on loan to NASA and NASA specialists whenever questions of needed modifications came up. And they did, often.

The direct and indirect aerospace medical support by the Air Force of the Mercury program has been frequently cited as a prime example of how the Air Force fed unique and vital skills into the national space program. At the outset of the Mercury program, NASA had virtually no aerospace medical capability, while the Air Force and Navy had major capability in laboratories across the country. The Air Force had, in a small way, been in the *space* medical business per se since as far back as 1949, when a persistent band of civilian and blue-suited aeromedical specialists, led by Dr. Hubertus Strughold at Randolph AFB, Tex., had started and kept cooking on a back burner the Department of Space Medicine at the USAF School of Aviation Medicine. SAM has grown into the School of Aerospace Medicine at Brooks AFB and is a major element of today's Air Force Systems Command. The Mercury program itself was, for all practical purposes, a latter-day version of the 1958 Air Force Man in Space program (see "Blueprint for Tomorrow's Spacecrews," AIR FORCE, May '58) which, in cooperation with the old NACA and with the blessing of the Defense Department, had been formulated in the immediate post-Sputnik period. When NASA was established and the policy decision was made to assign to it the responsibility for what became the Mercury program, the Air Force fed medical men and monkeys,
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Longtime aerospace medical contribution to manned space-flight by Air Force, which antedates Sputnik by almost a decade, still goes on. Current efforts include experiments, such as this one at Brooks AFB, Tex., Aerospace Medical Center in which five volunteers spent forty-seven days in MOL simulator, breathing pure oxygen for thirty days.

hardware and procurement know-how into the new national effort. Those were the unhappy days when, for reasons of Administration policy, the contributions of the Air Force to the NASA program were so underplayed that, for example, touring reporters visiting the Air Force's "monkey farm" at Holloman AFB, N. M., where the first orbiting chimpanzee was trained, were asked not to mention that the simians were Air Force types. "Policy," the briefing officer would mutter.

Fortunately, reexaminations of policy allowed eventual recognition of these and many other blue-suit contributions to the NASA effort. Such early attitudes



Air Force Col. John Paul Stapp risked his life on the rocket sled at Holloman AFB, N. M., to prove man could withstand violent G-forces. Colonel Stapp's work and that of colleagues during the '50s paved way for the surety that US plans to orbit men could proceed with calculated risks.

unfortunately fed the fires of controversy and encouraged widespread adherence to the view that the American space effort is not a race with the Russians but rather a lengthy skirmish between the Air Force and the National Aeronautics and Space Administration. This view serves neither the nation nor the space program nor the Air Force nor NASA. It is true that many observers, including this writer, have argued for a greater sense of balance between military and civilian space projects. But such views are geared to the conviction that technology, including space technology, will probably continue to play a crucial role in world conflict in the future, in the same way it has in the past. These opinions are not expressed in denigration of the really sizable achievements of NASA during its short history.

But what of today's and tomorrow's Air Force contribution to the national space program, over and above such specifically military efforts as the surveillance satellites and the Manned Orbiting Laboratory?

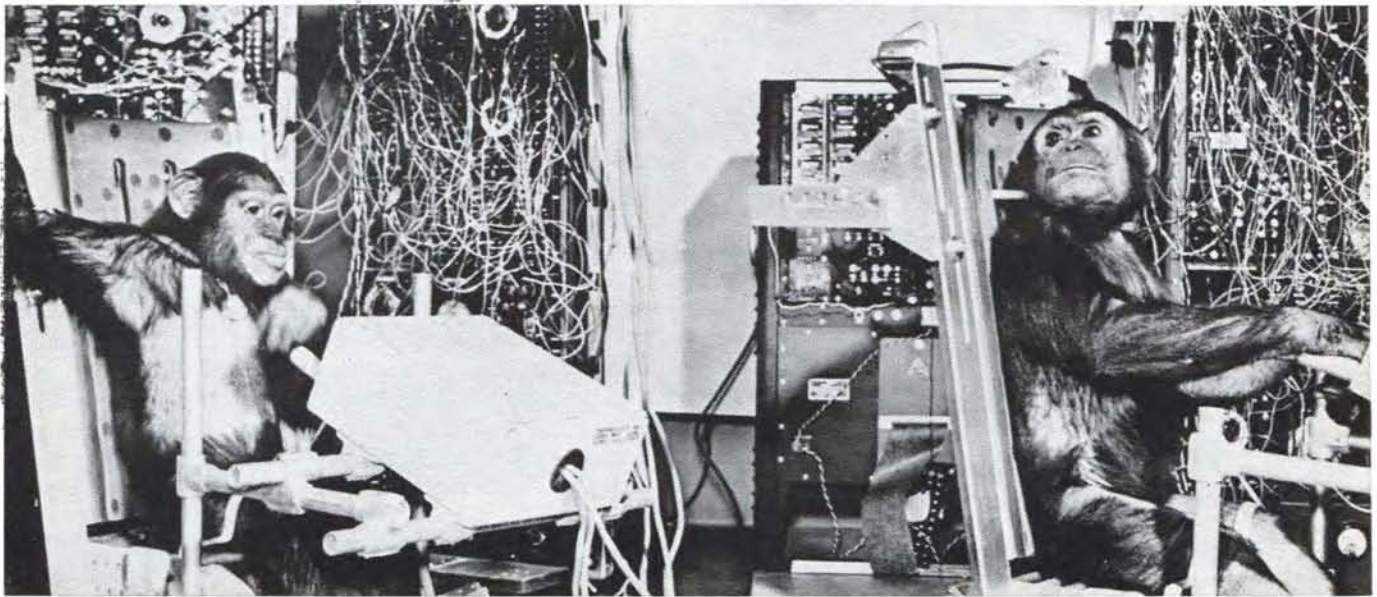
There is little question that the inflow of Air Force developmental experience and talent into NASA will



Modern USAF history of interest in space medicine goes back to 1949 establishment, under leadership of Dr. Hubertus Strughold, of Department of Space Medicine at old School of Aviation Medicine at Randolph AFB, Tex. Dr. Strughold is still at this work.

continue. It is likely, too, that the NASA organization will take on, in its management approach to such monumental tasks as the Apollo moon-landing program, an increasingly strong resemblance to the Air Force missile program. Certainly under the leadership of Dr. Mueller, the ex-Space Technology Laboratories scientist who heads Apollo, and his new Deputy, General Phillips, the search for Air Force officers with project management experience who can be loaned to NASA for Apollo will continue apace. Concurrently, we may expect increased applications of what in management jargon is called "the functional matrix approach" to the Apollo program. Already, as Dr. Mueller has pointed out, NASA is going the same route as the USAF missile men of the early '50s by concentrating on "an early identification of the problem." To the lay observer of the Apollo program, it may seem surprising to hear such an expression, since everyone knows that in 1961 the problem had been proclaimed: getting to the moon. But that is the point; in such large programs as Apollo, months must be devoted to analysis of the various technological possibilities, the design of basic components, and the decisions on the

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Two Air Force space pioneers, trained at the "monkey farm" at Holloman AFB, N. M., were chimpanzee Enos, right, who orbited the earth November 29, 1961, and Ham, left, who made a suborbital flight January 31, same year. The two simians are shown in what seems a playful mood during psychomotor tests at Holloman lab. Here Enos seems to be watching Ham.

scientific experiments that will be performed. Such analysis is crucial to successful preparation of facilities, planning of the mission, and, most important of all, the creation of the plan for the integration of all these activities, systems, and subsystems.

In the case of the USAF missile program, Space Technology Laboratories served as systems integrator in tandem with and under over-all management of the Air Force's Ballistic Missile Division. The analogy with NASA's current management technique for the

Apollo program is not exact but is certainly close and getting closer. Dr. Mueller describes it in terms of NASA being its own systems integrator through his Office of Manned Spaceflight.

History never repeats itself exactly. This truism applies to the NASA situation today as measured against the USAF missile experience of yesterday. But there are striking parallels and the probability is that similar solutions will continue to be applied to similar
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There are still plenty of aerospace medical questions to be answered about manned orbital flight. Capt. Eugene Degner, USAF (MC) at Brooks AFB, has been working on experiment in connection with MOL project that is exploring question of danger of "bends" to astronauts transferring from their ship to space.



Magnitude of components in moon effort, such as these bulkheads to be used for separation of propellants in Apollo Saturn V booster, shown here under development at North American Aviation, illustrate need for space-age adaptations of successful management techniques of AF ICBM effort.

problems. NASA has its own headquarters-versus-field problems just as did the Air Force. NASA's field centers—especially at Cape Kennedy, Huntsville, and Houston—have from the start plagued NASA Washington headquarters by acting annoyingly like independent dukedoms. It has already taken a series of reorganizations of NASA from virtually the top down to even begin to bring this unacceptable situation under some sort of control. A firm measure of central control is crucial to successful achievement of the difficult Apollo project, and although we will probably not see quite the same pattern in Apollo management that was developed for the USAF missile effort, it is inevitable that lessons learned during that program will be applied in NASA by men with the backgrounds of Dr. Mueller and General Phillips. Already the pattern of designating project officers with responsibility for major elements of the manned spaceflight program has picked up pace.

As one major NASA official has put it, comparing the USAF missile and NASA space experience:

"NASA's origins were different. It has grown rapidly, and its techniques of management have been different, but I believe we will see more shifts to the USAF approach as time goes on. The old NACA operation was research-oriented. They didn't have much reason to develop any large management capability, such as is going to be needed for programs of the Apollo type.

"NASA's growth has been enormous. The Apollo decision was a presidential decision to take a giant step, and overnight Apollo was born. Consequently, there was pressure on NASA to get its hardware under contract, even before the nature of the requirements were worked out. Only now is the program definition that's vital getting into shape.

"We need to decide what's wanted, and we need enough of a plan so that everyone can go in the same direction. And that calls for over-all systems specification and a really unified approach to requirements."

The last paragraph above could have been a description of the situation that obtained at the outset of the USAF missile program. Although many of the technological problems that plagued the early missilemen have long since been solved—to the benefit of today's space planners on both the civilian and military sides—the problem is essentially the same, one of fusing technology, industry, and *will* into a purposeful manageable whole.

In the final analysis, probably the most crucial gift of the Air Force to NASA and the nonmilitary space program—more important than the men, skills, industrial base, and hardware that have already been pumped into the civil agency's bloodstream—is the historical example of the impossible effort that succeeded—the USAF missile program, the tenth anniversary of which we mark this month.—END



The final, greatest Air Force gift to space effort was demonstration that the impossible was possible. And now new impossibilities are being achieved like recent successful Titan II boost of Gemini capsule. Here they are on pad.