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GENERAL ELECTRIC COMPANY
MISSILE AND SPACE DIVISION

Military Mission in Space

Building a Business

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Fastest Gun . . .

WINTER, 1963

CHALLENGE

Winter 1963 — MISSILE AND SPACE DIVISION GENERAL ELECTRIC COMPANY — Volume 2, Number 4

A Message From The General Manager

The year of 1964 has taken on a new meaning for many people.

A need for all Americans to soberly appraise their roles in the coming year has been emphasized by the recent tragic death of President Kennedy.

We in the space business are particularly situated to contribute to the attainment of many of the goals the late President sought. He displayed utmost confidence in, and unwavering support of, the nation's space program.

Here in the Missile and Space Division in the past year we have come through a difficult cycle in our business. Although we have had continued success with our products in their intended missions and we have had some success with new business, the news has not been uniformly good. We have undergone contract cancellations, program postponements and stretchouts, and personnel layoffs. We still face them. It is not difficult to work with enthusiasm when business is thriving. Now, when the chips are down, we are called upon to put out a full measure of effort to build our business back to the point where the nation can take full advantage of our outstanding capability. I'm confident in 1964 we will do this. Significant steps are already underway.

We now face an even greater reason for renewed effort. Probably no one has done more to give America its place in space than President Kennedy. He recognized not only the importance to national security, but also the benefits to humanity, from the knowledge to be derived from space exploration. We must do our part on our assigned programs to meet the challenges and opportunities he gave us in setting United States supremacy in space as a national goal.

His successor, President Johnson, has that same vision as evidenced in his article in the most recent issue of this very magazine, CHALLENGE.

In tribute to our late President, and in support of President Johnson and of all our mutual efforts in space, I urge upon you an unmatched excellence of effort for the coming year.

H. W. Paige,

General Manager,
Missile and Space Division

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Editor
William Haynes
Manager-Employee Communications
Richard Jackman

General Manager
Hilliard W. Paige

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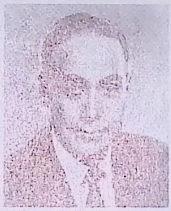

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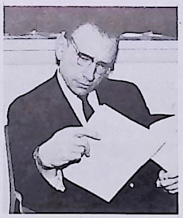

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CHALLENGE is issued quarterly by and for the employees of General Electric's Missile and Space Division, Philadelphia and Valley Forge, Pennsylvania; Burlington, Vermont; and key locations throughout the country. It highlights the people and events that make this the most exciting business in or out of this world.

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Employee Communications Operation
3198 Chestnut Street, Room 1110
Philadelphia 1, Pennsylvania
Ext. 2828

Editor
William Haynes
Manager-Employee Communications
Richard Jackman

Advisory Board
Charles B. Dates
Dr. Leo Steg
Louis J. Lekus
Howard M. Wittner
Richard A. Passman
Robert J. Kirby

General Manager
Hilliard W. Paige

MILITARY MISSION in SPACE

By LIEUTENANT GENERAL JAMES FERGUSON

An objective of the United States, as stated repeatedly by the President, is to maintain peace in space. In this connection the President has directly charged the Air Force to see to it that no nation achieve a position in space which threatens the security of the United States. We must insure that peace is free for the peaceful pursuits of mankind. To do so requires that we develop an ability to deal with threats that may arise in this medium. The maintenance of peace in space may well hinge on the availability of ready strength applicable to this region.

The first reason the Air Force is concerned with space from a National defense standpoint, of course, is this: The Commander-in-Chief has directed that we be so concerned. The second reason for military concern is that the space region constitutes a source of potential danger to the Nation. The most lethal threat posed against the United States today, i.e., enemy ballistic missiles, would approach the United States through space.

Potential Danger

Space is not remote. Vostoks have traversed the United States many times. In doing so, they passed closer to our inland cities than have any enemy craft ever before in our history, by land or sea or air. Space is a medium that hangs over every square mile of the United States. No other medium provides routes for such rapid access to every part of our country as does space. This new medium is, therefore, a potential new dimension of danger, and threat, which we cannot afford to ignore. Space vehicles can carry megaton weapons; Mr. Khrushchev took the trouble to tell us so in plain language. A space vehicle orbiting overhead, carrying a warhead could be capable of executing an attack in half the time of an ICBM flight. Moreover, space is a region particularly well-suited to purposes of observation and communications. The wartime advantage to any nation which could have the exclusive use of space for observation and military communications would be enormous.

Space is an infinite region in which the United States hopes to pursue great scientific explorations for the expansion of knowledge and the betterment of mankind.

Our opponents might conceive it to be in their interests to prevent American space exploration. It is possible that an enemy might try to demonstrate his power by imposing a space blockade, halting U.S. scientific progress into space. Indeed, he might interpret any lack of evident free world strength there as an invitation. Certainly if history conveys a useful military lesson, it is that ready strength is important to the protection of our peaceful interests. This means that military capabilities applicable to the space region should be at hand, though we would hope they would never be used. Indeed, their mere availability may avert the necessity for their use.

BIOGRAPHY

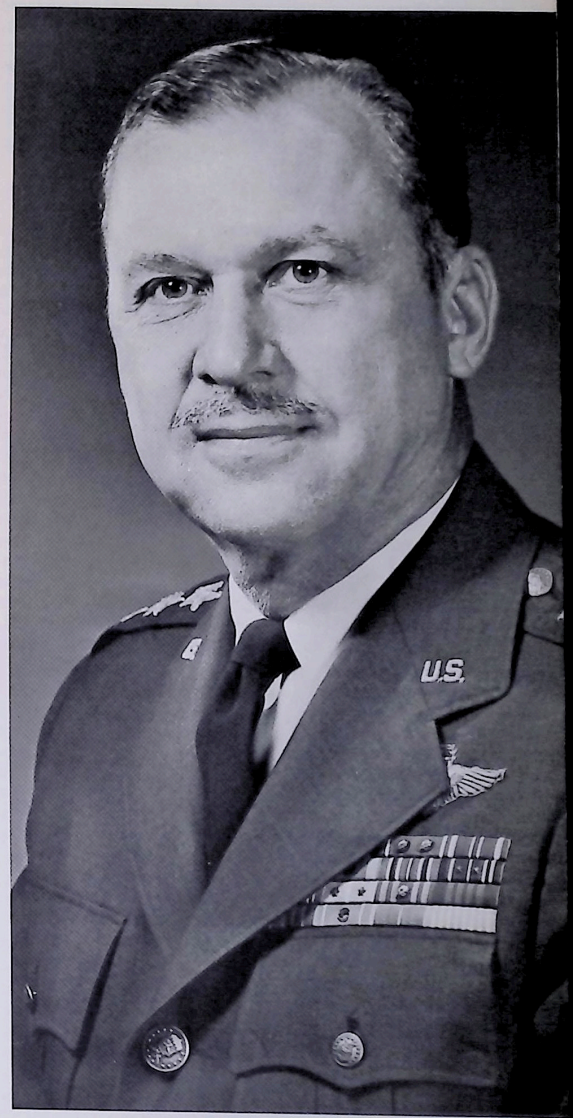
Lieutenant General James Ferguson was born in Smyrna, Turkey on August 15, 1913 of British parents. He became a naturalized American citizen March 1930, completed Fullerton Junior College, California, June 1934, enlisted in the Air Corps October 1934, was appointed a Flying Cadet October 1935, completed flying training June 1936 and received a regular commission as a Second Lieutenant in October 1936.

General Ferguson participated in pre-invasion aerial attacks on Europe and in the final phase of World War II in the Pacific. He returned to the Pacific as Vice Commander of the Fifth Air Force in Korea during the Korean conflict. Between February 1952 and December 1961 he held assignments as Deputy Commander of the Ninth Air Force Deputy Director of Requirements, Office Deputy Chief of Staff for Development, Headquarters USAF, and later as Director; Vice Commander, Air Research and Development Command and of the newly created Air Force Systems Command.

General Ferguson was promoted to Lieutenant General and assigned as Deputy Chief of Staff, Research and Technology, Headquarters USAF on December 1, 1961. His position was redesignated Deputy Chief of Staff, Research and Development on 1 February 1963. His decorations include the Distinguished Service Medal, Bronze Star, Distinguished Flying Cross, Air Medal, Order of British Empire (Honorary Commander), French Croix de Guerre, Luxembourg Croix de Guerre and Korean Medal of Ulchi. He holds a Command Pilot Rating.

There can be little doubt that the Soviet Union has military applications in mind for the space region. In a 1962 publication on Military Strategy, just translated, Marshal of the Soviet Union Sokolovskey has the following to say: "An important problem now is warfare with artificial earth satellites, which can be launched for diverse reasons, even as carriers of nuclear weapons." Marshal Sokolovskey says further: "Soviet military strategy takes into account . . . the use of outer space and aerospace vehicles." Even with the difficulties of translation, the meaning is fairly plain. The basic reason for this Soviet military interest in space is not difficult to understand.

The Soviet Union is faced with formidable free-world defenses relative to the mediums of air, sea, and land. But in space, the new medium, they see no evident and applicable Western world defenses. In this new medium the Soviet strategist may well hope to attain strategic ascendancy. But he can only entertain that hope if we fail to achieve the timely development of military capabilities for space. Both we and the Soviets know that the advent of human space activity exposes an open flank, even though the precise dimensions of the flank are not clearly perceived. Obviously, we cannot afford to ignore such a flank and do not propose to do so.



I have touched upon some of the military threats from space that are within the existing capabilities of our enemies. Yet the foreseen dangers associated with enemy dominance of space are probably minor when compared with those we do not now foresee. Consider the record relative to other mediums. When the first aircraft flew, only 50 years ago, who foresaw the nuclear bomber? When the first submarine put to sea, who visualized the Polaris launcher? But these, air and sea, are limited mediums with which mankind has centuries of experience. How much less likely, then, are we to foresee the military developments that can emerge in a new medium, space, with which we have relatively no experience?

Lack of Experience

Prudence dictates that we move rapidly to learn about the military implications of space and to gain military operational experience in the region. Firsthand experience and knowledge are essential ingredients in performing a military mission. Just consider, if you will, how well we could conduct the Air Defense of this country if we were suddenly called upon with no real experience in that field. Only with experience can we have assurance that we can handle the tasks which national security requires. In space such experience can allow us to gain an elementary basis upon which to erect defenses against those threats which can now be foreseen or against those yet seen only dimly.

The space activities of NASA have produced and will continue to produce highly important data which is available for application to problems of national security. This committee is well aware of the extent of Air Force-NASA cooperation. At the Washington level, we have the Aeronautics and Astronautics Coordinating Board. We also have innumerable staff contacts. And we have a Deputy to the Commander of the Air Force Systems Command, General Ritland, located at NASA Headquarters. He can call upon the full resources of the Systems Command in support of NASA.

In seeking to identify and advance the development of military capabilities for space, the Air Force wishes to take full advantage of the important knowledge NASA acquires. We strongly support, in both thought and action, the necessity and value of NASA's scientific explorations. But it is not possible for NASA to develop military capabilities as such. This is because a military capability consists of a combination of technical knowledge, military organizations with operational experience, suitable military equipment, tactics and doctrine. Most of these are factors which can be developed only within a military service.

At the present time, a joint planning board composed of NASA and DOD representatives is working on the delineation of requirements of both agencies with respect to GEMINI. The Air Force has military objectives relating to manned space flight for which GEMINI can be very useful. We, of course, will not interfere with GEMINI's contribution to the Lunar project. For example, the production of additional vehicles, if that is required, presents no problem. The scope of our participation in GEMINI has not yet been fully defined, but we certainly expect to benefit from it.

Of course, we cannot rely on this to give us all the first-hand operational experience we seek. A military space program is essential for military space capabilities.

To this end, there is at hand a substantial and diverse body of space technology. The success of the Mercury project validated manned space possibilities and many of our intuitive expectations have become realities. These great American achievements were corroborated and more than matched by Russian accomplishments in the longer duration orbits of Titov in August 1961 and the dual launch capability demonstrated in August 1962 by Vostoks III and IV.

Soviet Intentions

These continued successes by the Soviets clearly demonstrate their progress in space technology, and their comments reveal the direction of their thoughts. Listen again to Mr. Khrushchev after Titov's flight:

"If you want to threaten us from a position of strength, we will show you our strength. You do not have 50 and 100 megaton bombs. We have stronger than 100 megatons. We placed Gagarin and Titov in space and we can replace them with other loads that can be directed to any place on earth."

Lest we be tempted to believe that the Communists can be dissuaded from developing the military potential of space simply by avoiding it ourselves, we might consider the lessons of history. The idea of peace without adequate defense has not worked well in the modern world: The United States had no military strength in Southeast Asia before Communist aggression began in that area. There was little evidence of American military power in Korea when the Communists attacked there. When Communist forces invaded and crushed Hungary, they certainly had not been provoked by the presence of powerful military strength.

In contrast, where U.S. military capabilities have been strong and evident and our intent to defend was unmistakable, acceptable peace has been maintained. For example, in the eleven years since the commitment of U.S. forces to the defense of NATO territory, not one inch of Western Europe has been lost to Communist control. A more recent example was the Cuban situation. Our existing, ready military capabilities permitted the execution of the President's decision to take serious action to prevent the Soviet Union from obtaining a position in Cuba which could threaten the security of the United States. Technical knowledge could not have done this: Ready military capabilities were required. Fortunately, the United States had the needed military capabilities at hand ready for instant action.

Lead-Time For Defense

In respect to space, we have not yet attained the flexible military capability for which we strive. We are living in an age of so-called exploding technology, but new capabilities are still not attained quickly. We are concerned, for example, about the lead-time necessary to develop a defense against a possible threat from space which is now unforeseen. This lead-time is usually a matter of years; it is a key reason we seek urgently to attain maximum knowledge, experience, and flexibility through our military space program.

It is axiomatic that we will learn the military meaning of space in one of two ways. Either through exploring the military potentials of space ourselves or by observing demonstrations made by our enemies. In the latter case, it could be too late to make use of our dangerously acquired understanding.

History records that an acceptable peace in any medium has been maintained only through the existence of ready military strength applicable to that medium. Unfortunately, it also records that every medium affording military possibilities has been used for military purposes.

Accordingly, it is the Air Force's objective to develop military capabilities applicable in space which (1) strengthen the general defense posture of the United States, and (2) protect the specific interests of the nation in the space region.

The military space program should develop a broad range of capabilities to operate effectively in this new medium. Greater knowledge of the military possibilities afforded by space should be gained; military equipment designed to deal with these possibilities should be developed; experience in the application and control of space-oriented military capabilities should be achieved. All of these fundamentals should be advanced at a rate consistent with the fact that the time of a space-based challenge to the security of the United States is unpredictable.

The various elements of the proposed Air Force Space Program would combine to form a stream of advance toward useful military capabilities in space, some of which can be realized almost immediately, others being dependent upon further technological progress.

Region of Concern

In general, the military interest in space *at this time* is within the region bounded by the stationary orbit: The Air Force Five Year Space Program seeks capabilities within this sphere.

We wish to learn to operate, on an effective and economical basis, both manned and unmanned systems within the near-earth environment. Operational systems to meet some requirements, such as communications, will extend out to synchronous orbital distances, and we will be concerned with the possibilities of even deeper space environment. However, our principal interest is focused on insuring that the *near-earth* environment is not dominated by a hostile power.

The Specific Objectives of the Air Force Space Program

Over the next five years, the Air Force has proposed efforts toward two objectives:

1. To augment, by use of space systems, the existing military capabilities of United States terrestrial forces.

2. To develop a military patrol capability for the protection of United States interests in space.

A word on each of these. First:

Augmentation:

By use of space devices, we expect to enhance the capabilities of the earth-based defense posture of the United States. For example,

— space-based communications can improve the reliability and scope of command and control systems;

— surveillance of atmospheric weather from space can provide information regarding cloud conditions in target and refueling areas;

— space systems may furnish a means of active defense against ballistic missiles and of

— warning that a missile attack is underway.

And about our second objective:

Military Patrol:

The term "military patrol" refers broadly to an ability to determine at all times what is happening in near-space, whether there is a threat present, and to deal with it if necessary. Military patrol capabilities for the space region could provide on-call protection for U.S. space activities, both scientific and military in event of hostile enemy actions in the space region. This objection includes:

— an improved detection and tracking system.

— a means of inspecting unidentified space devices.

— a means of disabling hostile satellites, if this should be required in the national interest.

— lastly, a system for continually monitoring such space phenomena as radiation and solar flares; the latter being essential for prolonged space operations.

Plus Technical Building Blocks

The Air Force Space Program also includes elements which form the basic R&D building blocks for a military man in space program. Key elements of this group already in development are: the Titan III launching system, Dyna-Soar, and Air Force participation in the GEMINI program. In this connection, I think I made it clear that the NASA/DOD agreement of this January on a joint GEMINI program was most certainly welcomed by the Air Force. Another key element we propose is a military test space station. The technologies represented by GEMINI, a military test space station, Dyna-Soar, and Titan III are fundamental to any future manned military space capability.

The aforementioned portions of the Air Force space program have primarily considered short-term objectives; however, there are other efforts which must be pursued *now* to advance basic technological disciplines if future objectives are to be realized. These efforts involve such subjects as advanced air breathing propulsion, electromagnetic warfare and countermeasures equipment, possible space weaponry, space applications of nuclear power, basic research, and studies and analyses aimed at finding solutions to military problems through the use of space systems. We are working very closely with NASA on certain of these technological efforts. As an example, NASA and the Air Force reached agreement this past fall on a joint two-year program of hypersonic research; such research can contribute much to the aerospace plane concept the Air Force is pursuing. The hypersonic research program includes aerodynamics, propulsion, structures and materials. We know that joint endeavors such as this one will contribute significantly to the achievement of the necessary technical basis for broader space activity, and thereby can assist us in attaining military space capabilities.

The military space program we have proposed would be expensive, and it involves expenditures substantially beyond the current level of military space effort. Although it includes a number of projects that are now underway, it also includes others, some of which may involve considerable R&D technical difficulties.

Nonetheless, I consider the program a prudent one in a dangerous world. If we are to insure that peace is maintained in the space region, the United States must acquire a range of military capabilities in that region. We should do this with deliberate speed, since we do not know and cannot predict the time of need.

and now...

SPACE POWER

MORRIE ZIPKIN
"... reach beyond"

(Space Power and Propulsion Manager Zipkin just finished combining with one of his staff members, Russ Edwards, in the editing of a special book of technical papers on space power.)

In Evendale, Ohio, some ambitious minds are seeking to put MSD at the top of the Space Power Field—and their record so far is an impressive one.

It's not often that a Company going into a new product field gets 50 years to prepare for it.

But that's what has happened with General Electric and the space power field.

Many firms breaking into a new technology have little or no background to rely upon, and must get involved through costly trial-and-error efforts.

In providing nuclear power and electrical propulsion systems, General Electric has five decades of dedication and proven success to back its bid.

"It's a natural business for us," said Morris Zipkin, Manager of the Space Power and Propulsion Section for the Missile and Space Division's Re-Entry Systems Department, in speaking about power for advanced spacecraft. From his office at MSD's Evendale, Ohio, facility, Zipkin points to the past and present:

"General Electric has 50 years of steam turbine, mercury turbine and gas turbine experience. We were pioneers in the jet engine business in the United States. When you take the best of these technologies and combine the experience and knowledge we've gained, you find that our people and our facilities are ideally suited right now to take on this job."

Add to that fact that since 1960 Zipkin has personally been supervising a Company-backed effort to stake out a claim in this field and you have a combination that will warrant all kinds of consideration in the future placing of space power business. The emphasis is on "future" because the kind of things they're working on in Evendale are for the post-Apollo era.

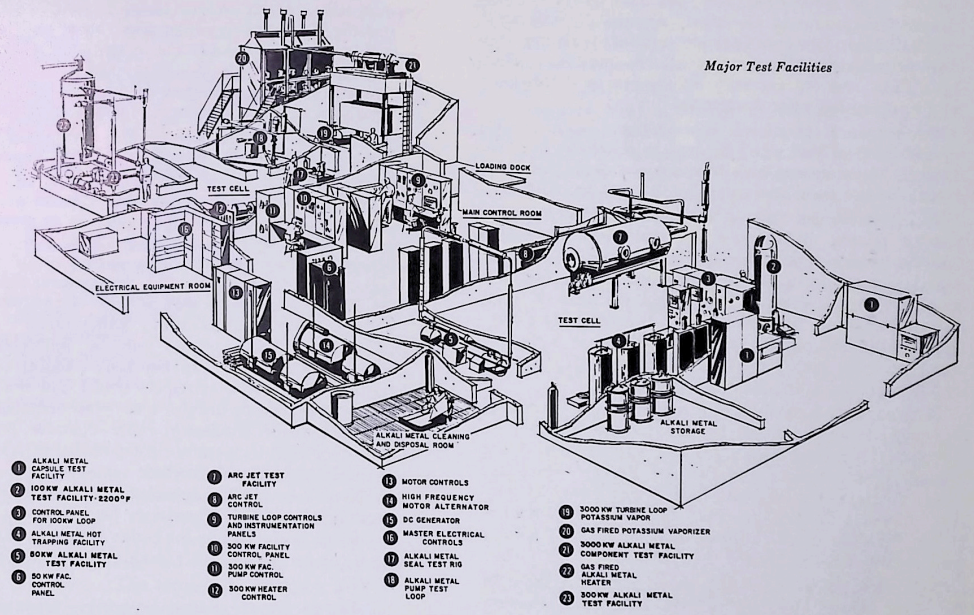
What Zipkin and his people are doing is seeking to provide the power to run spacecraft equipment on extended missions. So far this job of providing power within the space capsule has been provided through the use of batteries and solar cells. Fuel cells will follow and then the nuclear power systems.

"After the successful moon shot we're almost certain to see many deep space probes to Mars, Venus and other points," Zipkin said. "This ambitious space exploration is going to require large and efficient space power systems. On whatever man has done, he has always wanted more and more power. It will be his key to survival in space."

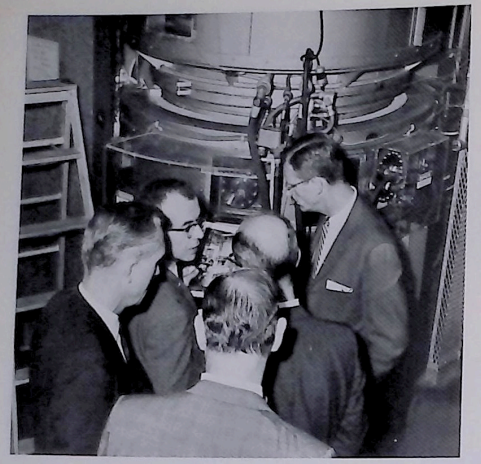
"To carry off our mission properly we must be able to supply a space vehicle with hundreds, thousands, and even millions of watts of electricity, and the system must be efficient and reliable so as to last over a long period of time, say like a year or even two at a time. The technical complexities of such an undertaking are staggering. In the power business man has never really been faced with such a requirement before, especially in the reliability area."

Nuclear-powered space electrical systems involve the same components as a central power station, but such systems must operate at higher temperatures, with alkali metal working fluids and a dramatically reduced weight.

Zipkin expands on some of the complications: "The normal components of an earthbound power station, such



This drawing indicates some of the elaborate facilities that have been set up in Evendale to help MSD seek a prominent role in the space power field.



Joe Longo, Manager, Heat Transfer Components, describes the function of the 100 KW Columbium Heat Transfer facility, part of the impressive network of operating equipment for the space power business in Evendale. Division General Manager Hilly Paige with other Company officials toured the facilities.

as the boiler, turbo-generator, condenser, and pumps, are required in these space systems, but their design is complicated by the use of the highly corrosive, alkali-metal working fluids, the presence of nuclear radiation, the absence of gravity forces in space, the need to radiate waste heat, and the necessity for start-up and long-time reliable operation while unattended."

"Maintenance, of course, is a problem. Chances are for awhile there just won't be any, so reliability must be assured. If the system fails in space you don't just bring it back to the shop and repair it. It's got to work."

Facing up to this task is welcomed by Morrie Zipkin and his people. When you talk with them about the individual work steps required you may hear uninspiring, non-glamorous words like heat transfer, boiling and condensing, turbine pumps — They're not the kind of terms that choke you up with excitement. But when they comment on the end product and what it'll do in furthering man's quest for space knowledge, it's easy to get interested and to share their abundant enthusiasm.

They not only have their own eagerness and knowledge plus some funding support by the National Aeronautics and Space Administration's Nuclear Systems and Space Electric Power Offices and the Air Force's Aerospace Power Division, but they also have strong Company support. General Electric has been quick to invest money in the Evendale space facilities, making Zipkin's section uniquely equipped to pursue their efforts.

"Of course, we're confident about gaining a share of the space power business," Zipkin said. "But General Electric's investment represents more than confidence. It's a matter of future business planning in a field we're eminently qualified for. To consider an alternative for a moment the illogical thing for us to do would be to stay out of it and to fail to capitalize on those 50 years of know-how."

"We're certainly encouraged by what we've discovered about applicable alloys, about our thousands of hours of successful testing in alkali-metal boiling and condensing, about our component developments."

The Space Power Laboratory in Evendale makes available to both NASA and the Air Force the finest in facilities. Zipkin's section has already outgrown its original test laboratories, a building formerly used in the Flight Propulsion Division's high energy fuel program. Major test facilities located in Evendale now include:

—50 KW, 1600°F Alkali Metal Test Facility — this dual-loop system with a maximum operating temperature of 1600°F is presently in use for the investigation of alkali metal boiling and condensing heat transfer and for materials corrosion studies. Preliminary data on the effects of temperature and pressure on alkali metal condensing will be obtained.

—100 KW, 2200°F Alkali Metal Boiling and Condensing Test Facility — this is a single loop system which can operate up to 2200°F. The loop has been designed primarily for high temperature experimental investigation of boiling. Operation at these high temperatures requires the use of a high strength refractory alloy containment material, which in turn, requires that the loop be protected from atmospheric contamination. For this reason, the test loop is enclosed in a high vacuum chamber.

—300 KW, 1850°F Alkali Metal Boiling and Condensing Test Facility — this alkali metal test facility will operate continuously at temperatures to 1850°F. The initial use of this two-loop system is in the investigation of boiling and condensing heat transfer characteristics of alkali metals in segments or simulated portions of space power boilers and condensers. Physical arrangement and enclosure provides ample space for sizable test sections and components.

—3000 KW Alkali Metal Component Test Facility — This is a single closed-loop boiling and condensing system operating on the Rankine Cycle. The boiler-superheater will produce high quality alkali metal vapor for driving high speed development turbines up to full scale prototypes in tests of performance and operating characteristics. Vapor quality, flow, temperature, and pressure can be independently controlled. The large capacity and versatility of this facility will provide extremely useful and desirable means of evaluating full size space power components such as radiator, condensor, vapor separator, pumps, and other high temperature components, in addition to complete turbo-generator sub-systems. This facility will be initially operated at a maximum temperature of 1600°F. Provisions have been made in the design of the facility for higher temperature operation (up to 1900°F) after modification of the facility boiler.

A number of other excellent supporting facilities are available which provide background capabilities. Among them:

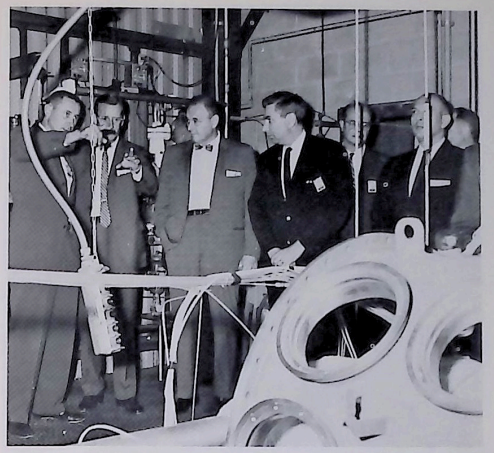
—A completely equipped metallurgical laboratory where studies of alkali metal corrosion on potential space materials are conducted at temperatures up to 2200°F under vacuums of 10^{-9} torr; where studies of the purification of alkali metals by hot trapping, cold trapping and distillation are conducted. The laboratory has demonstrated capability in high temperature technology, alloy development, alloy processing, mechanical testing and joining of refractory materials.

—Alkali-metal chemical analysis facilities in which standard techniques for measuring contaminants in alkali metals are being improved and new, more accurate techniques are being developed.

—Computer facilities with unique programs for the design of turbines, pumps, and other high speed rotating equipment, mission analysis, heat transfer, ion optics, to name but a few.

—A Hydraulics Laboratory set up for water or steam testing of pumps, boilers, separators, turbines, bearings and seals prior to alkali metal testing.

—A 1400°F Seal Test Facility — A multi-purpose system capable of evaluating high speed alkali metal seal configurations.



The vital turbine facility at Evendale gets its moment in the spotlight as Test Project Engineer Spud Eckard explains the operation to MSD General Manager Paige, Re-entry Systems Department General Manager Mark Morton, and Space Power and Propulsion Manager Morrie Zipkin.

Development of these test facilities has given Zipkin's people a leg up on the investigation of critical problem areas that must be defined and solved before large space power systems become practical.

Zipkin's claim to a share of this space power business is based on sound considerations.

"Over the past three years we've put into operation the most advanced two-phase alkali-metal facilities in the nation. Our 50 KW, 100 KW and 300 KW facilities, now producing alkali-metal boiling and condensing data for NASA have accumulated thousands of hours of successful operation in providing data of unmatched quality. The experience isn't based on paper studies or unproven theories, but on actual experimental operation."

"Secondly, the large alkali-metal component test facility now in operation is unique in its ability to provide engineering data. It's the only industrial facility of its kind."

"A third point — time and cost — General Electric has spent over three million dollars and three years of time to establish and prove its facilities. Repeating these facilities in other places at similar costs would be unnecessary."

"In short, with our proven technical capability, and our extensive experimental facilities, we are in an excellent position to compete and contribute in all phases of nuclear space power work."

Though our studies and experiments have been encouraging, Zipkin acknowledges that problems still remain.

"Right off I guess you'd have to point to the technical problems which are rather immense. What's required is a considerable advance in the state of the art beyond what's been done. The testing, the exacting designs, the delicate nature of the equipment, the reliability factor, all of these create technical hurdles which must be overcome gradually and skillfully.

"A second major problem is a management one. You've got to decide how much to commit in the way of dollars and manpower to this kind of pursuit. We've got to keep in mind that the demand for this kind of equipment is some years away, so we must balance off our enthusiasm for successful discovery and test with some practical considerations of just when this equipment will be needed by the customer.

"A third problem is personnel. The people you have must be highly qualified and motivated. Keep in mind that you may work for years in this field without seeing the end product. You're working here with new materials, with new components, with endless testing, and to keep motivated during these years requires a particularly dedicated kind of person."

That Morrie Zipkin has found such people is evident.

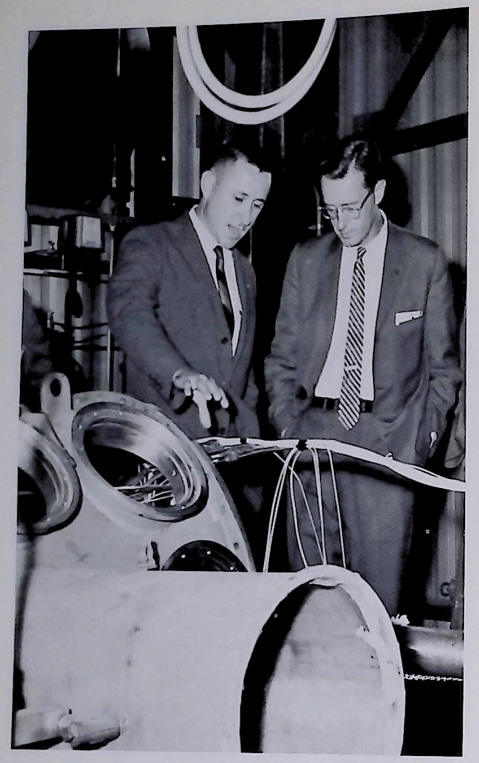
"They're easily the best damn team in the space power business. They are the most competent people I've ever worked with."

The feeling is mutual among Zipkin's people. They have an unusual respect for this man, especially in a business where disappointment can be a steady diet, where thoroughness and detail are constant requirements.

Says one associate, "You can't help but be impressed by his approach to this whole business. He's completely confident, extremely thorough and does not panic. He has a group here that will back him all the way."

Morrie Zipkin didn't just stumble into his managerial skills. He's a two-degree holder in engineering, picking up a bachelor's degree in mechanical engineering from Newark College of Engineering and following that with a masters in aeronautical engineering from Case Institute of Technology.

He worked with the National Advisory Council for Aeronautics, (forerunner of NASA) and with Goodyear Aircraft where he did work on the cooling of reciprocating engines, theoretical and experimental studies of jet engines



Test Project Engineer Spud Eckard describes the vortex boiler operation to MSD General Manager Hilly Paige through use of a plastic model in the Hydraulics Laboratory.

and analyses of engine applications and engine component development.

With General Electric in Evendale he was a manager of Thermodynamics in the Advanced Propulsion Operation, later went on to manage the Advanced Propulsion Systems, responsible for developing new propulsion systems. With General Electric's emergence into the space power field in 1960, Zipkin was named manager of the space power operation responsible for the development of a nuclear reactor-turbogenerator space power systems.

He credits success so far to unfailing support from the Company ("Mark Morton, Hilly Paige, Dave Cochran, the whole Company has given us solid support.") and to the skill of his team. His staff includes: Dr. Marvin Bromberg, Manager-Electrical Space Propulsion Projects, Russell Edwards, Consulting Engineer-Power & Propulsion Planning, Robert Wettach, Manager-Manufacturing, Facilities & Test, Dr. J. William Semmel, Manager-Materials & Processes, Bob Brooks, Manager-Space Power Systems, Hal Brown, Manager-Mission Analysis & Evaluation, Erwin Schnetzer, Manager-Development Engineering, Al Wilson, Manager-Marketing, and Russ Clark, Manager-Accounting & Administration.

"These men have demonstrated the two things we require most in this business—enthusiasm and vision. They know space power and they believe in it.

"They can see its future and its many requirements."

Are there any down-to-earth uses for the work being done?

"Well, there's use for this kind of a power system as topping equipment for a central power station. Like most other things that involve space, there are almost certain to be benefits right here on earth from the work that is being done to help improve our knowledge of outer space."

Some people wonder why Zipkin has an outpost in Ohio while most of the Missile and Space Division is located in or near Philadelphia.

It's another "natural" as far as Zipkin is concerned. Evendale is the home of the large jet engine business. It was where the technology evolved. It has extensive facilities especially suited for supporting the space power effort.

Like most everything else these days, the space power business is getting competitive — almost by the hour. More and more firms are beginning to get active in the space power field.

"To stay ahead of competition we must exhibit success on our current efforts. The success we in industry and government have on this program has a bearing on whether or not there will be large dynamic power systems."

Easily visible in the future is the use of these advanced space power systems for "permanent" space stations, on service vehicles, for manned moon stations.

Morrie Zipkin can see all of this, and he's quietly doing something about it. He's an uncomplicated person with a deep personal involvement in his work. He is highly religious, a devoted family man, and a guy who puts in an enormous amount of effort on his job. He nourishes a considerable curiosity about the unknown.

"Real satisfaction comes from doing those things beyond what you already know. I'd like to think that our people here in Evendale have been, and will be making, a contribution to the nation's leadership in space exploration."

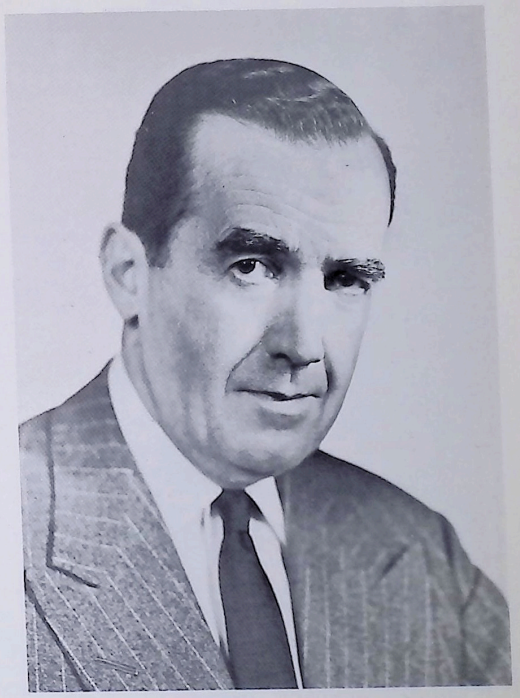
They have — and they will. They have 50 years of success backing them up.

USIA tells the SPACE STORY

For just over a decade, the United States Information Agency has served as a spokesman for America around the world. Its men and women, assigned to 239 posts in 106 countries employ many techniques of communication to explain the people and policies of the United States to overseas audiences in languages, climates and cultures far different from our own. USIA is in the front line of the ideological confrontation with Communism — ensuring that our way and our point of view are understood abroad.

To get a first hand report on how the U. S. space program is being communicated abroad and the response of other peoples to American scientific achievements, Challenge *interviewed USIA Director, Edward R. Murrow.*

* * * *



EDWARD R. MURROW

Newspaper readers in Istanbul, Turkey, were presented a dramatic confrontation of opposing ideologies this spring. A United States Information Service release, entitled *The Choice*, consisted of side-by-side photographs of President Kennedy and Premier Khrushchev and captioned with a quotation from public addresses made by both heads of state.

The quote from the President's State of the Union message read:

"We seek not the worldwide victory of one nation or one system, but a worldwide victory of man."

The Khrushchev quote was from a speech made the same day in East Germany in which he said:

"The future belongs to Communism. For others — get out of the way. Death is waiting for you."

Twelve Instanbul newspapers carried *The Choice* — giving their readers an insight into the cold war.

Another example of how the Agency operates took place in February when a number of African students angrily left Bulgaria. The students said their defection from the University at Sofia, Bulgaria, was compelled by intolerable racial discrimination and abuse.

USIA reported the incidents fully through press, radio and film on a worldwide basis.

The Voice of America, USIA's global radio network, initiated daily coverage to Africa in English, French, Swahili, and Arabic as soon as the news was known. Worldwide English broadcasts and those in foreign languages gave prominence to the unfolding events and eyewitness accounts by the students of the mistreatment they had received.

The Agency's Wireless File carried the story in full to 111 posts abroad and reported student interviews and editorial reactions from each country to the rest of the network. Photos and taped interviews with the students were made available worldwide to commercial media. A motion picture of Ghanaian students in Amsterdam was filmed and released to overseas newsreel distributors.

Youth organizations around the world issued protests against Communist treatment of the students and denunciatory cables were sent to Sofia from a number of countries.

Few Friends in Moscow

These and numerous other examples of USIA's activities help to explain U. S. policies and expose weaknesses in the Communist system. Naturally they make few friends in Moscow's Official circles.

MSD COOPERATES WITH USIA

The Missile and Space Division has a long-standing policy of cooperation with the United States Information Agency — and the Agency has broadcast and published information about many of MSD's technical and scientific achievements.

During the past year, for example, more than a dozen stories about the work conducted by Division engineers and scientists has received such world-wide dissemination. Also, two foreign language brochures prepared by USIA for distribution overseas carried photographs and descriptions of MSD activity.

In addition, several MSD scientists have tape recorded interviews for USIA to use in broadcasts back to their native countries behind the Iron Curtain.

For example, in June, *Radio Moscow* lamented that USIA "provokes sleepless nights in Socialist countries." In the Soviet Plenum later that month, Party First Secretary Leonid Illichov told his audience that "Western imperialists have seen the folly of relying on military or economic superiority to subdue the Socialist world and have instead turned to psychological and ideological warfare."

The principal journal of the Communist Central Committee, *Kommunist,* charged that the USIA "uses the entire arsenal of the means of mass influence over the minds of men." *Komsomolskaya Pravda,* the daily mentor of Soviet Communist youth, called USIA officers in Africa "specialists in the psychological seasoning and the ideological corruption of the population."

The Space Story

"To remove the guesswork from communicating with people overseas, USIA constantly surveys public opinion abroad. Knowing the reaction to U. S. policies is always important as a guideline in formulating the Agency's operations," Murrow said .

The field of space exploration is a good example of how such surveys are used in planning future programs.

Periodic surveys have long been made to evaluate trends in Western European attitudes toward a variety of issues and problems. Dramatic shifts in opinion often result from events that capture public imagination.

Popular views on space exploration vary in the public mind there, and the relative progress of the Soviet Union vis-a-vis the United States hinges, upon occasion, on which of the two has recently achieved a dramatic advance.

In 1960, for instance, most Britons believed that the USSR led the United States in all five classes of space development, despite a long series of American space conquests. What are the facts?

"The Russians did lead in ability to launch the biggest and heaviest satellites. However, the United States had orbited a greater number of satellites. In addition, those launchings had produced far more scientific information than the Soviet shots. Similarly British respondents thought the Soviets were ahead of the U. S. when measured by dependability of rockets and effectiveness of missiles, yet, at the time, information publicly available was insufficient to determine the issue.

"These misconceptions," Murrow continued, "underlined the fact that the American space story was not getting across in England and that the popular British view of Soviet leadership was based largely on inadequate knowledge. To remedy the situation, the USIA greatly increased its output, through all media, of persuasive factual information about American space achievements. Surveys subsequently showed more understanding of the facts."

European awareness of U. S. strength in space soared when Telstar, the communications satellite, relayed television programs between the United States and Europe. That feat produced an extraordinary impact on public opinion throughout Europe and elsewhere. It showed conclusively that the U. S. does more than just match other space achievements; in certain fields it demonstrably excels and leads the Soviet Union.

Cooper Shot Project

"Earlier this year, the USIA went all out to provide extensive worldwide coverage of the two-day orbital flight of Astronaut Gordon Cooper. As a result the flight attained greater dramatic impact than any previous space event," Murrow stated.

The *Voice of America* was on the air with the story continuously for 36 hours — a new milestone in its lifetime and a first in the history of broadcasting. The normal 4-hour-a-day transmission of the Agency's Wireless File was extended to 18 hours to recount the running story.

Two *Voice* teams provided the bulk of this coverage, one at Cape Canaveral and the other in the Washington studios. Their work was augmented by special reports on overseas reaction from VOA reporters stationed around the world, other correspondents, interviews with Congressional leaders, and background material voiced by three NASA officials who worked in shifts around the clock. At Cape Canaveral, teams of VOA reporters broadcast live coverage in English, Russian, French, German, Spanish, and Malay.

VOA employed the largest radio network ever assembled, with 55 transmitters at strategic points around the globe and a total power output of 5,673,000 watts, equal to the aggregate power of 113 of the largest U. S. standard radio stations.

It was estimated that the event drew the largest overseas radio audience in all history. Direct feeds were made by VOA to the national networks of Denmark, Finland, France, Germany, Greece, Iran, Israel, the Netherlands, Spain, Turkey, and many African countries. In addition, individual stations throughout the free world were supplied by air with a total of 3,235 reels of tape recordings from both English and foreign language VOA programs, a production output which kept 55 high-speed tape recorders fully occupied during the peak period — turning out some 730 miles of taped programs.

Compared with the previous orbit, twice as many stations abroad picked up and rebroadcast VOA's running account of the Cooper flight. In Latin America alone, 230 stations in Bolivia, Brazil, Colombia, Guatemala, El Salvador, Uruguay, and Venezuela rebroadcast on mediumwave the Spanish and Portuguese newscasts.

A half-hour TV program about Astronaut Cooper had been preshipped to posts abroad. Copies of a world map in

Bolivian school boys stop and pause while on their way to school to get their first glimpse of fantastic space stories coming to life. They look at the USIS produced exhibit on the 4th U. S. Astronaut in Space. The Cooper in orbit exhibit attracted much attention throughout the three days that it was on display in the heart of La Paz.

color, on which the paths of the planned 22 orbits were traced, updated a 7-panel full color exhibit called U. S. Astronaut Orbits Earth, which had been sent in advance of the shoot.

The Agency's TV service also provided coverage to networks and stations around the world and sequences were included in Panorama Panamericano, the weekly news and feature show presented at peak viewing times in 48 Latin American cities.

A 10-minute film, Profile: Gordon Cooper was quickly released to 500 theaters abroad. Additionally, a 6-minute edited version was sent to newsreel theaters in 36 countries, and included in the Agency's monthly news magazine, Today, shown in some 2,400 African theaters.

The Agency's printing plants in Manila, Beirut, and Mexico City, along with many individual posts, produced leaflets and pamphlets dealing with the flight, the Mercury program, the preparations for the event, and the training of the astronaut. Thousands of color pictures of Cooper were mailed to posts where they were used as covers for a pamphlet telling the story of the flight and distributed within 24 hours after Cooper completed his historic and brilliant feat.

Posts abroad reported enthusiastically about use made of the full and speedy coverage. Ankara signalled: "Thanks for the exceptionally fast Cooper coverage which enabled USIS to dominate front pages of all Turkish papers." USIS Bonn cabled: "Our German output based on this file was heavily used by DPA (German Press Agency) and thereby distributed by teletype nationwide."

The post at Sao Paulo reported: "Placed 2,644 column inches of 84 items plus 65 photos, most on front pages or first inside. Several full pages of USIS material." USIS Rome said: "Speedy complete coverage Cooper flight . . . wrap-ups, chronology particularly useful. Most gratifying press utilization of text and pix material."

Far East posts reported equally heavy play on the story. Canberra said: "Australian interest high in Cooper flight. Media giving story very extensive coverage." Manila wrote that each of 4 papers front-paged a different color picture of Cooper, supplied by USIS, before the launch. Tokyo related that the story "commanded the front pages of all editions and spilled over onto the inside pages of some."

From Phnom Penh came the report that Radio Cambodia's interest in the flight exceeded expectations and even more material was requested. Seoul said that the flight coincided with a Korean national holiday and that thousands of viewers saw the USIS exhibit in the City Hall plaza where local army teams were putting on a military drill. It added that crowds continued to pack sidewalks and streets in front of the USIS library late at night watching an exhibit of Faith 7.

In Latin America, Agency radio, TV, exhibits, and press materials were widely used. As the astronaut's re-entry time approached, crowds gathered in front of a USIS downtown office in Santo Domingo, the Dominican Republic, to view a special exhibit, follow teletyped dispatches displayed in the windows, and hear a special Voice Spanish broadcast over loudspeakers in the street.

An excited laborer made an emotional speech saying that this was clear evidence of the difference between the U. S. and Russian way of doing things. "Here we are in Santo Domingo, in front of the cultural and information section of the U. S. Embassy, listening to every step of this flight and hearing about difficulties with automatic controls," he said. "We know this is really true. How do we know the Russians really sent somebody up there." The crowd enthusiastically applauded.

Saturation coverage by all media was reported by posts throughout Bolivia and resulted in what was described by USIS La Paz as "a positive identification of Bolivian public opinion with a major Western effort." The post reported "the Cooper flight thus became the pride and delight of Bolivians. Burning kerosene pots, stretched for a mile along the slopes of a mountain adjacent to La Paz, and visible to everyone in the city, spelled out the words, "Cooper en Orbita. Salud."

All USIS posts in India reported that news coverage far exceeded that of previous orbital flights. Hundreds of phone calls with questions and congratulations clogged switchboards. The Government of India's central telephone exchange in New Delhi told USIS that its own special service section was unable to handle the calls, so the post rushed over a full file of releases and other informational materials to the exchange. Record interest was evidenced throughout India at USIS exhibits and window displays. Editorials and columns were replete with phrases such as "copybook flight," "pinpoint landing," "man's triumph," and "magnificent flight."

The USIS teletype operator in Colombo, Ceylon, received a call from a maternity hospital soon after the launch. The caller wanted confirmation that the flight was underway and said he was "just blessed with a son and was going to name him Cooper."

In Africa, interest was also widespread. USIS Salisbury reported extremely high curiosity on the part of the general public and all media. The Federal Broadcasting network of Rhodesia remained on the air for 2 days to carry the full *Voice* relay and the Cooper message to Africa. All papers ran headlines and photos. The Daily News stationed one of its own editors in the USIS newsroom to expedite relay of Wireless File materials. Crowds attended a special film showing and an exhibit at a specially constructed Space Information Center.

More than 12,000 people congregated at a special ceremony in Nairobi to await the astronaut's message to Africa. When direct transmission via the Zanzibar tracking station failed owing to atmospheric conditions, a *Voice* recording of the message was broadcast to the highly enthusiastic gathering.

"He Is Up Above" was the headline in a popular West Berlin daily. For more than 2¼ million people there, and the rest of Western Europe, no further identification was needed for Astronaut Cooper. From Rome to London, Oslo to Paris, all media hailed the flight. As the Spandauer Volksblatt in Berlin editorialized:

"The free world has a front row seat whenever an American astronaut is lifted into orbit. Instant and open communication will tell the world the results of an American space venture, be it successful or not, the moment the results are known."

Twin 20mm Vulcan cannon pods (VULPOD) slung under wings of an Air Force F-100 during in-flight f[illegible]est evaluation, together pump out rounds at a rate of 12,000 shots per minute. Spent cartridges can be seen tr[illegible]ng behind the jet aircraft.

A quick-change specialist, the VULPOD can be rapidly fitted to — and taken off — high-performance jet aircraft. The tactical situation determines the weapon and VULPOD permits easy conversion for the aircraft's role as a day superiority fighter to a close support gun platform or to a light bomber by simply switching pods.

A Century-Old Patent . . .

The VULPOD with its six revolving barrels is a curious mixture of past, present and future.

It is based on the Civil War's famous Gatling gun that was patented in 1862.

Single-barrel machine guns soon overshadowed the Gatling, despite its effectiveness, and the principle was, in effect, retired for nearly one hundred years. However, after World War II, as jet aircraft accelerated beyond the speed of sound, conventional aircraft armament was inadequate in terms of mission requirements.

In 1946, the Army Ordnance Corps initiated a weapon General Electric team then brought the multi-barrel study development program and the Army Ordnance/-Gatling idea out of retirement, modernized it, and developed the Vulcan. It went into production in 1957.

Even then, many thought that the Vulcan would be the last machine gun to be developed for the Armed Forces. The age of tactical and nuclear rockets was at hand and conventional weapons were supposedly headed for museums, alongside the crossbow.

But, limited war, brushfire engagements, guerrilla action and counterinsurgency have extended the life and use of conventional weapons.

A New Perspective . . .

According to John Ulrich, Manager-Armament Sales, "The SUU-16/A is designed to give high firepower plus versatility to aircraft operating in close support of front line troops or counterinsurgency forces.

Rated for 6000 shots per minute, the VULPOD's steady-state rate is 6400 shots per minute during factory firing tests. The gun has tested satisfactorily at 7200 shots per minute. There is no cook-off hazard for the 1700-pound, fully-loaded gun pod since the weapon is automatically cleared after each burst and is automatically reset on the next burst."

Versatility Vital . . .

In addition to the flexibility gained by switching from one type of pod to another, the VULPOD has its own inherent versatility. Choice of ammunition used with the VULPOD — armor-piercing or high-explosive — make it effective against fortified locations and troop concentrations.

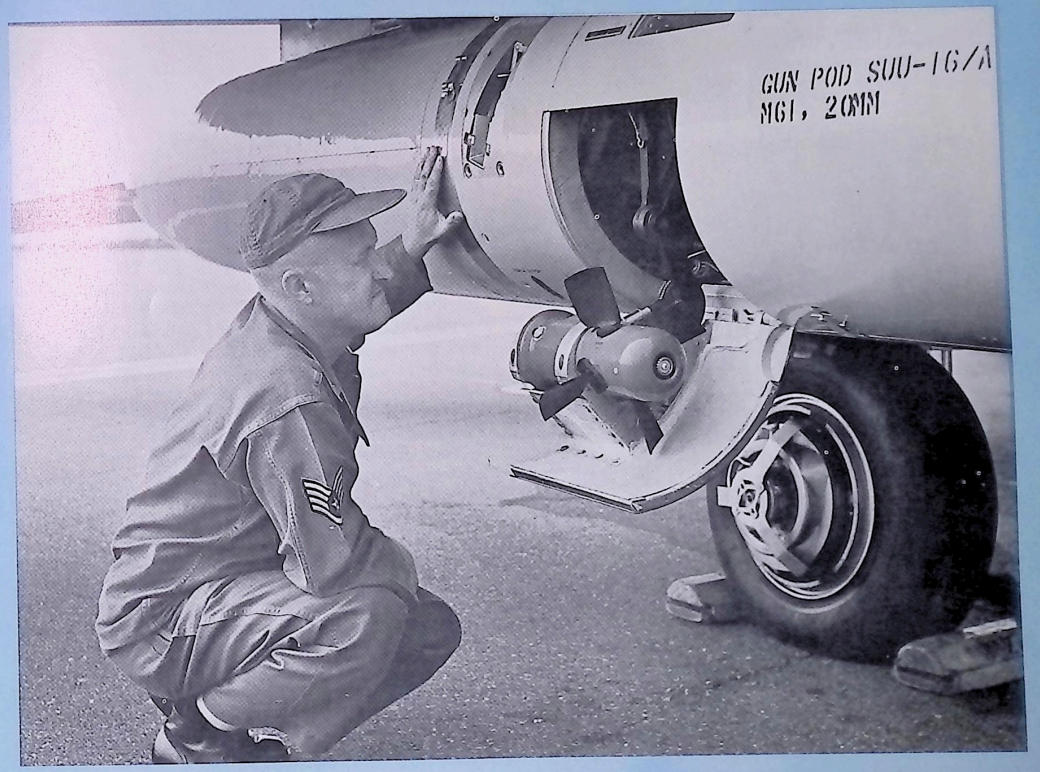
The VULPOD feed system is essentially the same, yet simpler than, the linkless feed now in use on the Republic F-105D jet aircraft. It is basically a conveyor belt that carries ammunition to the gun. Reliability is substantially better than other high-rate feed systems.

The self-contained power supply, a ram-air turbine, extends from the pod into the airstream as the pilot prepares to fire. It brings the M61 Vulcan gun to its 6000 shots per minute firing rate in less than .25 seconds. Control power is provided by the aircraft.

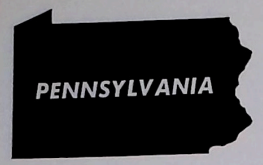
General Electric engineers emphasize that the new VULPOD SUU-16/A, utilizes the same M61, 20mm Vulcan cannon now in world-wide service. The linkless feed system is a development of the standard system but reduced in diameter to minimize aerodynamic drag.

Also In the Family . . .

General Electric has incorporated similar principles in the Minigun which is now under development. The seven-foot Minigun pod weighs less than 750 pounds, fully loaded, and fires 7.62mm ammunition at rates up to 6000 shots per minute. With a minimum of weight, and a maximum of reliability, the Minigun is especially designed for lighter aircraft.



Ram-air turbine automatically extends from VULPOD, 20mm Vulcan cannon in a detachable pod, when pilot prepares for firing run. Turning at a constant 12,000 shots per minute, it transmits power to the gun and feed system, bringing the gun to its 6,000 shots-per-minute firing rate in 0.4 seconds.



SCIENCE and TECHNOLOGY COUNCIL

FACELIFT FOR THE FUTURE

Governor William W. Scranton

Facing a new age of science and technology, Pennsylvania has embarked on some ambitious new programs to provide a technological facelift.

The programs are designed to mobilize the state's resources in a vigorous campaign to bring new science-oriented industries into the state and inject new vitality into traditional manufacturing operations.

A key part of this effort is the host of tasks confronting the Governor's Council of Science and Technology—a group of twenty-two of Pennsylvania's leading scientists, engineers, educators, and executives of new science-oriented industries.

Purpose of Council

Set up by Governor William Scranton in April this year, the purpose of the Council—in the governor's own words—is this:

"The Council will provide for new and existing industries, information concerning availability of technical and scientific personnel for employment or consultants, and laboratory or other facilities. . . . (It will) also be responsible for developing a program to support and encourage scientific and advanced technological activities and to create new employment opportunities in the fields of electronics, biology, space, the nuclear sciences and related fields."

To achieve these objectives, the governor assigned the Council, chaired by University of Pennsylvania president Gaylord P. Harnwell, some fourteen tasks.

These tasks range from preparing inventories of scientific and technical personnel, facilities and natural resources in the state to suggesting ways to improve the climate for the production and commercial exploitation of new ideas in science and technology—as well developing mechanisms which will systematically bring together venture capital, management skills and new inventions and technology.

One vital part of the Council's work is to develop and implement programs for the establishment of science research complexes which combine the total resources of industry, government and education.

Such centers, according to Governor Scranton, "now hold great promise to keep Pennsylvania in the forefront in the new sciences and to spawn industries and jobs related to these new sciences. . . . Occupants of such research and technological facilities would be not only university personnel but industrial research personnel from the great and small Pennsylvania corporations, and members of the profit and non-profit science and research foundations in Pennsylvania."

One such center, for example, is being planned for the University City of West Philadelphia—close to the University of Pennsylvania and the Re-Entry Systems Center of the Missile and Space Division.

Committees Established

The Council has set up six committees to accomplish certain immediate objectives contained in the Governor's charge. The Council also recognizes that basically the development of appropriately trained and educated personnel is the key to encouragement and support of science and technology. For this reason, committees of the Council are concerned with the promotion of technical and scientific education and the identification of future trends in research that offer promise of important economic potential in the future.

Scientific Industry Promotion Committee: to explore all types of associations, mechanisms and financing programs for promoting research and development capabilities in Pennsylvania and recommending ways in which government support at all levels and the resources of universities, technical institutes and research corporations can be related to one another and focused upon promoting scientific and technical industry in the Commonwealth.

Members are Messrs. Litchfield (chairman), Bonnell, Hanson, Paige, Price and or Simpson, and Roddis.

Personnel Inventory Committee: to locate the names of knowledgeable scientific and technical personnel in the State so that the Council is able to reach, in turn, for advisory and technical purposes, those persons in the State who are specialists in their particular areas who would be available to assist in any problems that arise. Also, to study the kinds of scientific personnel data that should be available and the methods of assembling these.

Members are Messrs. Perlis (chairman), Chambers, Halliday, and Isard.

Atomic Energy Legislation Committee: to consider, with Deputy Secretary of Commerce Jones, the problems involved in Pennsylvania's atomic energy legislation.

Members are Messrs. Roddis (chairman), Chambers, Shapiro, and Simpson.

Education Committee—Post High School and Graduate Research: to consider the relationship of educational institutions in the State to the purposes of the Council—in two broad aspects. One, the availability of persons who have had post high school education qualifying them for technical and scientific aide positions. Two, the relationship of the services rendered in the field of the Council's interest to research and senior technical consultation and advice.

Members are Messrs. Warner (chairman), Dessen, Farley, Isard, Kraus, and Walker.

Screening Committee: to consider the names of persons who would be likely candidates for federal scientific advisory committee appointments as well as ways and means to present these names to the appropriate appointing officers.

Committee on Research Trends with Future Important Economic Potential: to assess the potentialities of presently known fields of science and technology as well as new and emerging technologies which hold potential and to identify those which present large or unique opportunities for the immediate and more distant future, as well as to consider what steps, if any, would be appropriate to assess these potentialities and prepare for them.

Members are Messrs. Fox (chairman), Price, Shapiro, and Williamson.

COUNCIL MEMBERS

Dr. Allen T. Bonnell	*Vice President, Drexel Institute of Technology, Philadelphia, Pennsylvania*
Dr. Carl C. Chambers	*Vice President for Engineering Affairs, University of Pennsylvania, Philadelphia, Pennsylvania*
Dr. Edgar L. Dessen	*President, Hazleton Community Area, New Development Organization, Northeastern National Bank Building, Hazleton, Pennsylvania*
Dr. Eugene S. Farley	*President, Wilkes College, Wilkes-Barre, Pennsylvania*
Dr. Thomas G. Fox	*Mellon Institute, 4400 Fifth Ave., Pittsburgh, Pennsylvania*
Dr. David Halliday	*Dean, Division of the Natural Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania*
Mr. Frederick E. Hanson	*Western Electric Company, 555 Union Boulevard, Allentown, Pennsylvania*
Dr. Gaylord P. Harnwell	*President, University of Pennsylvania, Philadelphia, Pennsylvania*
Dr. Walter Isard	*Wharton School of Finance and Commerce, University of Pennsylvania, Philadelphia, Pennsylvania*
Mr. Gerald Kraus	*Dean, Gannon College, Erie, Pennsylvania*
Dr. Edward H. Litchfield	*Chancellor, University of Pittsburgh, Pittsburgh, Pennsylvania*
Mr. Hilliard W. Paige	*General Manager, Missile and Space Division General Electric Company*
Dr. Alan J. Perlis	*Computation Center, Carnegie Institute of Technology, Pittsburgh, Pennsylvania*
Mr. Gwilym A. Price	*Chairman of the Board, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania*
Mr. Richard P. Price	*Vice President, Hammermill Paper Company, Erie, Pennsylvania*
Mr. Louis H. Roddis, Jr.	*President, Pennsylvania Electric Company, Johnstown, Pennsylvania*
Dr. Zal M. Shapiro	*Nuclear Materials and Equipment Corporation, Apollo, Pennsylvania*
Mr. John W. Simpson	*Vice President, Engineering and Research, Westinghouse Electric Corporation, 3 Gateway Center, Box 2278, Pittsburgh, Pennsylvania*
The Honorable John K. Tabor	*Secretary of Commerce, Commonwealth of Pennsylvania, Harrisburg, Pennsylvania*
Dr. Eric Walker	*President, The Pennsylvania State University, University Park, Pennsylvania*
Dr. J. C. Warner	*President, Carnegie Institute of Technology, Pittsburgh, Pennsylvania*
Dr. Merritt A. Williamson	*Dean, College of Engineering, The Pennsylvania State University, University Park, Pennsylvania*

From Campbell Avenue to Cape Kennedy . . .

BUILDING A BUSINESS

When national security is at stake, wise men don't gamble.

And in 1955 the United States Air Force was not in a gambling mood. It knew that the nation's safety depended upon the designing and building of an effective long range missile system.

But it also knew that it was faced with a problem in building this system that many experts said was "insoluble."

The problem? To develop a missile nose cone that would survive extreme conditions of pressure and temperature when it re-entered the earth's atmosphere after its ballistic flight—temperatures higher than the surface of the sun, and aerodynamic pressures approximately 100 times greater than that exerted on piloted aircraft.

The press referred to the development of re-entry vehicles as "an industrial challenge unequalled in modern research and manufacturing". Air Force General Bernard Schriever described the return and recovery of vehicles from orbit as the most complex development ever undertaken in this country.

A myriad of technical problems had to be solved—and solved fast—in many phases of this top priority missile program, but none caused as much concern as the re-entry problem.

Resources and Reputation

With scientists divided in opinion as to whether or not re-entry could be achieved, the Air Force needed a contractor that was:

(1) able to provide the across-the-board depth of technical and scientific know-how in the variety of disciplines involved in the re-entry problem; in new technologies such as aerothermodynamics; aeroballistics and hypersonics (generally applied to speeds in excess of Mach 10) and in more traditional fields such as chemistry, physics, metallurgy and electronics.

(2) willing to stake its engineering and scientific reputation on its ability to come up with the right answer within a crash time schedule.

It was not a time for the timid. Backed up by half-a-century of engineering and scientific leadership, General Electric felt it had the resources necessary to tackle such a problem.

The Air Force found in General Electric in 1955 an outfit willing to invest its vitality and resources in solving these new problems so essential to the security of the nation. General Electric's participation was inevitable.

The Men

About that time five engineers were spread out around the country following varying pursuits. There was one working on jet engines in Cincinnati; another getting a reputation in the atomic research business in Hanford, Washington; a third one adding to a long career with General Electric at Johnson City, New York; one in Pennsylvania becoming a missile expert for the Navy; and the fifth man was in the right place (Schenectady) at the right time (1955).

The eight years between then and now have brought these five together in a joint leadership role which they fulfill with the Missile and Space Division. And the names Paige, Beaton, Ridgley, Morton and Cowles are familiar ones to all employees. Of the five Logan Cowles, now General Manager of the Advance Space Projects Department, was the only one in on the start in '55.

"I don't think any of us back in 1955 ever dreamed that the space program would get as much of the national effort as it has," Cowles said. "The programs the nation has underway now were beyond the most optimistic expectations we had then.

"I think I've learned two important things in this business. One, you should never say something can't be done, because it usually can and if you don't do it, some competitor will come along and see that it gets done. We have learned to foresee or expect the impossible. Secondly, you must maintain flexibility. This is a business of change. What stands out most in my mind about this business is the growth which has provided an environment to help people meet many new challenges."

There are a lot of names to drop if you were going to give credit to each individual who helped get General Electric into the missile and space business. They go back much further than 1955 and you couldn't name them all. They go back to the closing days of World War II in the mid-forties and they bring up names like Hosmer Norris, Dick Porter, Art Robinson, and a lot of others. Norris, the man who became an explorer of caves, specifically one cave where a good deal of data on Germany's V-bombs was available. Porter, the man who led a five-man General Electric delegation into Europe and compiled considerable data before being invited by the Russians to pack his bag and "get the hell out" of the eastern part of Germany in a hurry just after the war ended. Robinson, now Manager of MSD's Advanced Requirements Planning Operation, the man who stayed home, and built enthusiasm, new facilities, and a confidence in the future of the business.

A First For General Electric

The work these men did, and others, and the data they accumulated made it possible for General Electric to move into the Hermes Program. The Hermes contract was certainly one of the first—if not the very first—prime contract with industry for guided missile research and development.

By mid-1945, with the war in Europe already ended and the war in the Far East coming to a close, Project Hermes was already on its way. The team of scientists headed by Dick Porter had made a thorough study of Germany's V-2 rocket program and equipment. In Schenectady, experimental rocket motors had been designed, built and tested and theoretical investigations were underway on the aerodynamics, electronics, thermodynamics and the structure of rockets and guided missiles.

White Sands Proving Ground in New Mexico in the Spring of 1946 was the scene for the launching of the first large missile flown under the Hermes Program. It was a German V-2. Five years later when the V-2 phase ended 67 rockets had been fired with a success percentage of nearly 70%. But mostly, the V-2 effort provided valuable missile design data, experience in handling and firing large missiles, and a vehicle for operational tests of future missile components.

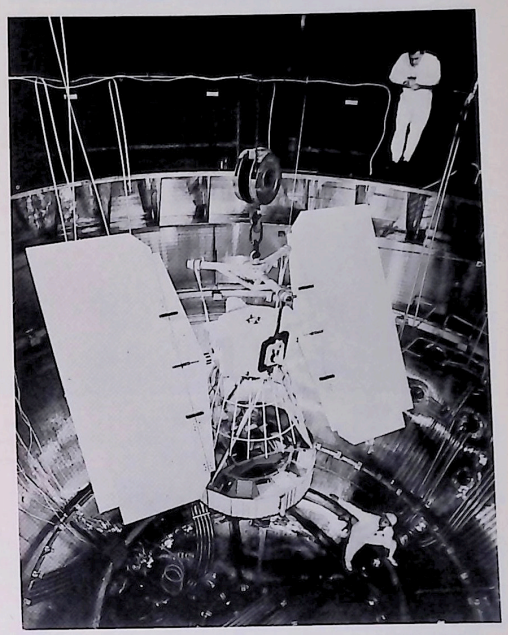
Next step for America and the Hermes Program was the Bumper Project which started in 1946 and four years later resulted in the first launching at Cape Kennedy (formerly Canaveral). That was in July of 1950 and the Project Engineer was General Electric's Bob Haviland.

"Cape Kennedy was little more than an isolated sandy stretch of land between the Banana River and the Atlantic Ocean," Haviland recalls. "The only structures on the strip were a lighthouse, a few houses and the wood and tarpaper blockhouse erected for the firing. It seemed like you were firing from the middle of a desert."

Haviland, now one of MSD's leading space scientists, said the Bumper Project which General Electric managed for the Army, gave us valuable data, for example, on such things as the use of plastic in the nose cone. It led to further use of plastic on capsules and re-entry vehicles.

The view of the Cape then might appear a little crude to television audiences used to seeing the elaborate equipment now available at the launch site. The Cape had been selected as a launching site only a few months before that July, 1950 firing. Not all families had been moved off the strip yet. The only approach to the site was on sandy paths which were later converted into gravel roads, a forerunner of today's well-paved accesses.

Painters' scaffolding, about $6000 worth, was used for the gantry. The working platforms were made of plywood. The blockhouse was made out of one-inch pine and tarpaper and was erected 300 feet away from the launching site. Today the blockhouses are built with concrete walls that are 12 to 16 inches thick.



Nimbus weather satellite engineering test vehicle being lowered into huge space simulator chamber at Valley Forge Space Technology Center.

Other phases of the Hermes Program followed. There was Hermes A-1, Hermes A-2, Hermes B, Hermes C, Hermes A-3—all contributing to the fund of knowledge that would later put General Electric into the big time missile and space business.

In the early 50's the development of an intercontinental ballistic missile began to get emphasis in the nation, but primary concern was with the development of a large reliable booster. Some materials testing for re-entry vehicle environments was undertaken, but it wasn't until May of 1955 that the first Atlas/Thor Re-entry Vehicle Contract was awarded to General Electric.

From Campbell Avenue To The Cape

It's a long ways from Campbell Avenue to Cape Kennedy.

A key man on Campbell Avenue in Schenectady was

Division General Manager Hilliard W. Paige presents Mrs. Esther C. Goddard with model of monument erected near Space Technology Center to commemorate contributions to American rocketry by her late husband, Robert Goddard.

George F. Metcalf, a veteran of more than 20 years of General Electric experience with credentials that included managing radar and electronics research and development teams.

His first task: to bring together the best men available in General Electric to develop a formal proposal on the re-entry problem for the Air Force—and to do this in less than six weeks.

Temporarily headquartered in the Campbell Avenue plant in Schenectady, the new Special Defense Projects Study rapidly assembled its team—drawing from the General Engineering Laboratory, the Research Laboratory, as well as the Company's pioneer group in the missile field—the Guided Missiles Department.

First man hired by Mr. Metcalf was C. D. (Duff) Greentree, whose experience with the Engineering Lab had covered a variety of technical and resources assignments.

Other key members of the group included men like Logan Cowles, Art Robinson, Bob Haviland, Russ McFall, Bill Eaton, Charlie Botkin, and others.

"Preparing that study was simply the first in a series of round-the-clock efforts to meet schedules on the program," says Duff Greentree, now MSD Manager of Business Practices and Effectiveness.

Once the study was submitted to the Air Force and with it the Company's formal commitment of resources, three major problems faced the new General Electric team: one, the solution of the technical re-entry problem; two, the recruitment of large numbers of new people to carry out the work; and three, the acquisition of adequate facilities to house the people.

On May 31, 1955, with the winning of the re-entry vehicle contract the Special Defense Projects Department with Mr. Metcalf as General Manager was established by the Company. All the personnel of the Guided Missiles Department (except manufacturing) were transferred to the new organization.

These people plus the original study team gave the new SDPD a nucleus of 293 employees — some of them with a background of nine years of missile work.

The Search For A Home

Almost immediately, plans were made to relocate the Department to a site suitable for the growth and realization of the extensive, highly specialized research and development effort necessary to meet the contract requirements. A relocation study team headed by Duff Greentree was set up to determine the best spot for a permanent facility.

The team faced a difficult task — to find the best location within the continental United States for the new and rapidly expanding Special Defense Projects Department. Headed by Greentree, and with the aid of the Company's Real Estate Services and other Services components, the team developed a set of location criteria as a guide in selecting a site for a permanent facility.

Because of rapid growth in numbers of employees, the team decided to cover the move and Department growth in two steps:

(1) to lease suitable temporary quarters for the next few years until space and facility requirements could be determined on which to plan and design a permanent building;

(2) to purchase land on which to build the projected permanent Department headquarters.

In the words of Hilliard W. Paige, General Manager of MSD, "General Electric made a nationwide search of locations and chose the metropolitan Philadelphia area for our business for a variety of meaningful reasons."

Primary advantages of locating in this area were: (1) a heavy concentration of technical manpower — half of the engineers in the United States were located within a 200 mile radius of Philadelphia; (2) good communication with customers and other General Electric components; (3) excellent residential neighborhoods, schools, and educational institutions — making the area attractive to professional personnel; (4) the availability of a variety of competent subcontractors and vendors in the area; (5) the availability of land for the construction of a permanent facility as well as available space for shorter term leasing and (6) a pool of skilled people that could be hired for supporting and administrative positions.

"Once we had selected Philadelphia, we had to find immediate space to lease," says Duff Greentree. "For several weeks we scoured the city with various local real estate agents. When I saw the former A&P warehouse at 32nd and Chestnut Streets, I knew this was it. Although it was a musty, dirty, dark building then — it had the space and the flexibility we needed."

"We signed a lease for 230,000 square feet (parts of three floors) there and shortly after with an eye to the future we purchased about 100 acres of ground in King of Prussia," Greentree said.

With the selection of Philadelphia and the leasing of space at the 3198 Chestnut Street building, plans for relocating the Schenectady employees went ahead.

Early in 1956 about 500 employees and their families moved to Philadelphia.

Rapid Build-Up

As contract requirements increased and new tasks were undertaken by the Department, the work force rapidly increased. By the end of 1956, Philadelphia employment of the Department had reached 2170 people — and the Department was now leasing over half a million square feet in the 3198 Chestnut Street building.

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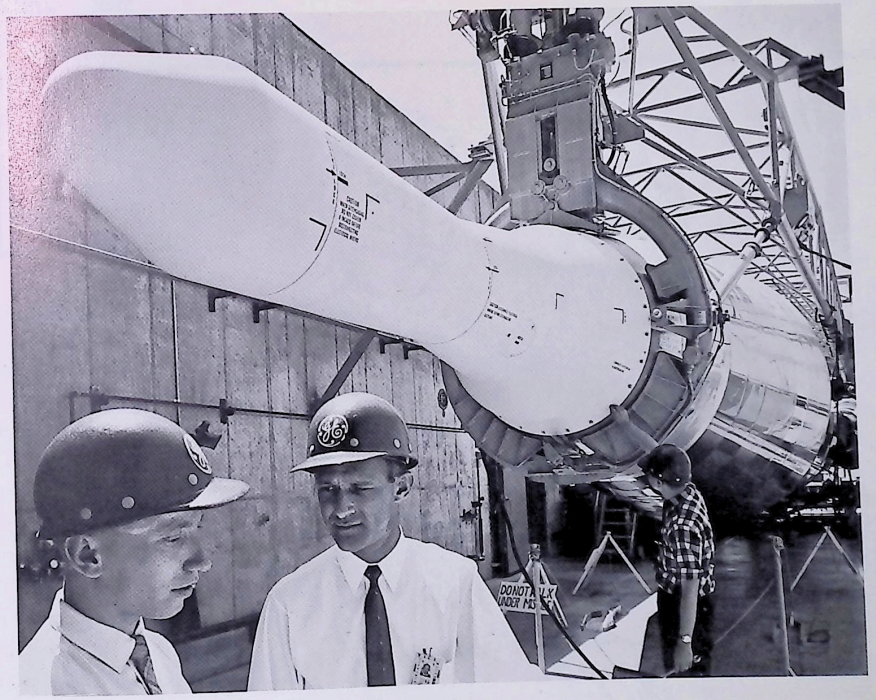
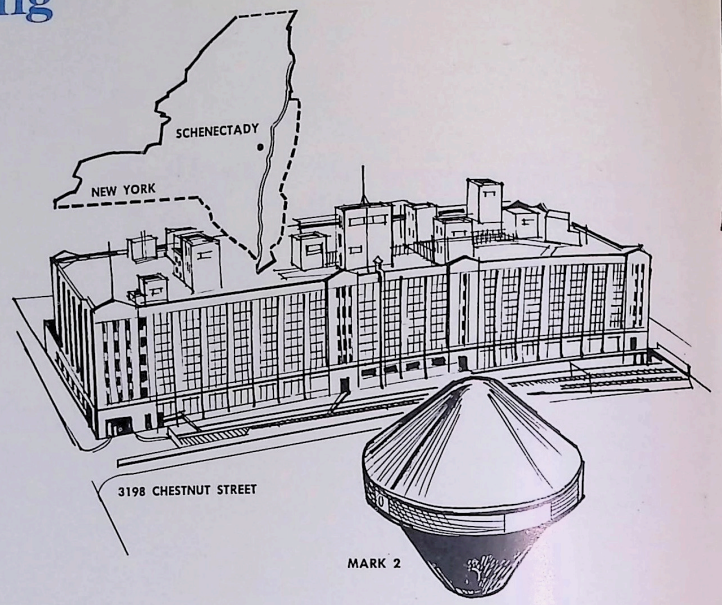


Mark 3 re-entry vehicle for Atlas intercontinental ballistic missile stands ready at operational base in mid-West.

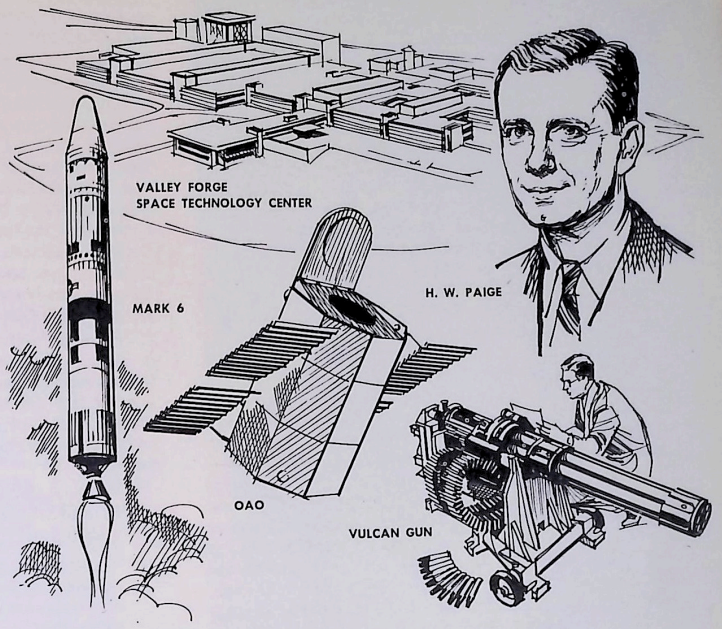
The Beginning

Schenectady, 1955 . . . a national need: development of a ballistic re-entry vehicle . . . the Air Force turns to General Electric . . . Company stakes its reputation and its resources to solve re-entry problem . . . Special Defense Projects Department organized under George F. Metcalf . . . the nation surveyed for a permanent home for the new Department . . . Philadelphia selected . . . heat sink approach under development to solve re-entry problem . . . nation's first ballistic re-entry vehicle, the Mark 2, declared operational by mid-1958.

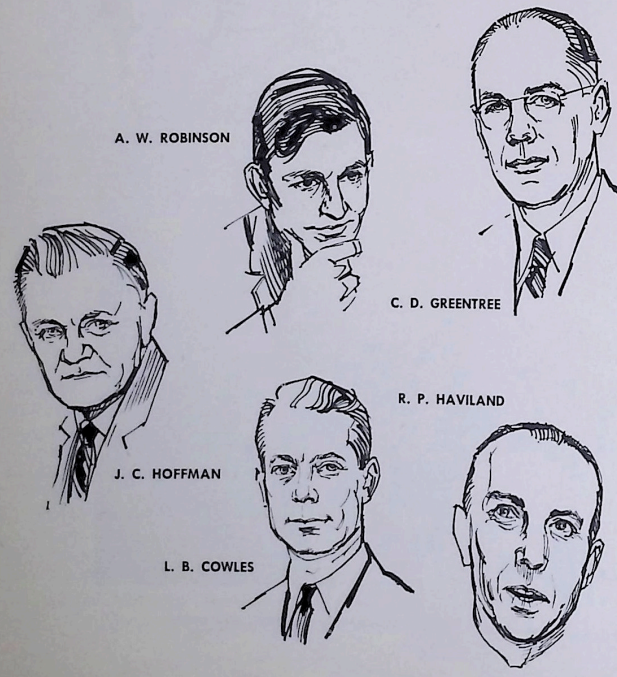


Today

A multi-product Missile and Space Division . . .under the leadership of General Manager Hilliard W. Paige . . . with headquarters at the $30 million Valley Forge Space Technology Center, the nation's largest privately financed space facility . . . four separate product Departments . . . the Spacecraft Department . . . the Advanced Space Projects Department . . . the Missile and Armament Department in Burlington, Vermont . . . the Re-Entry Systems Department . . . the Space Sciences Laboratory — the research arm of the Division . . . doing work on programs such as Orbiting Astronomical Observatory, Mark 12 re-entry vehicle, Nimbus, Vulcan, Bio-Satellite, and others.

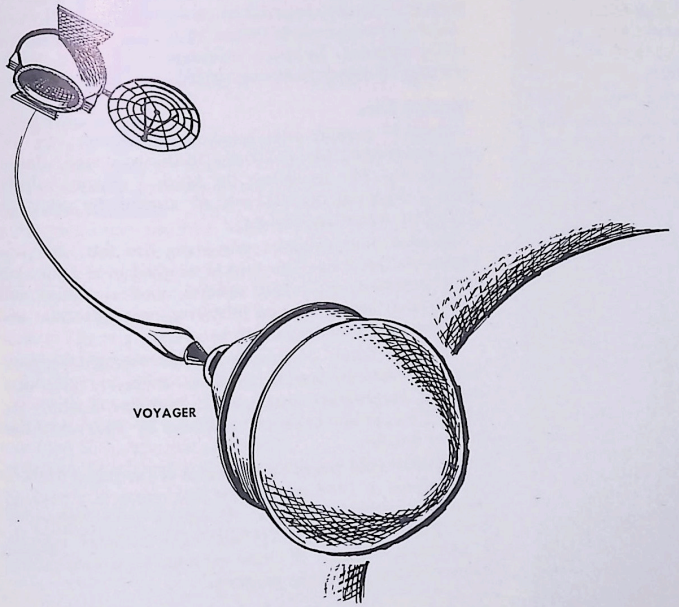


The People



A nucleus of 290 people in 1955 . . . technical talent drawn from the research laboratories of General Electric, the then-existing Guided Missiles Department, and advanced engineering groups . . . drawings at left show some, not all, of the original team still with the Missile and Space Division . . . rapid expansion the keynote . . . hundreds of engineers and support people recruited from within General Electric and elsewhere . . . by the end of 1956, a work force of more than 200 people . . . by 1960, a business with more than 6000 people.

The Future



The science of change . . . more sophisticated space and missile systems for the coming years . . . Missile and Space Division engineers and scientists helping to shape the future . . . with work on such advanced study programs as Voyager—a spacecraft which would be capable of orbiting Mars or Venus and landing a sizeable instrument payload . . . and a Solar Probe study for a spacecraft that would perform scientific missions close to the sun—to unlock solar mysteries that could help man improve weather prediction and control and communications on earth.

The Department's basic and applied research operation, then known as the Aerosciences Laboratory (now the Space Sciences Laboratory under Dr. Leo Steg) was transferred to another leased facility at "D" and Luzerne Streets in north Philadelphia. This 75,000 square foot facility was renovated to include office space and to house special test equipment, including the world's largest advance hypersonic shock tube and tunnel.

Pending the acquisition of additional space at 3198 Chestnut Street, 60,000 square feet of office space was rented at the downtown Suburban Station building. As space became available at 3198 Chestnut Street, personnel were moved back to that facility.

In October 1956, the Special Defense Projects Department was joined with Naval Ordnance Department in Pittsfield, Mass., to form the Missile and Ordnance Systems Department under General Manager Metcalf.

By early 1957, a Department facility study indicated the need for a capability for the production of nose cones. And on May 3 of the same year, the resources of the General Electric plant Burlington, Vermont were made a part of the Missile and Ordnance Systems Department. This plant was designated the Missile Production Section.

Facilities planning in 1956, 1957 and 1958 was based on the premise that a permanent facility would be constructed by 1960 or 1961. Therefore, Department facilities growth was marked by the piecemeal acquisition of short term rental space as dictated by personnel growth and contract modification. We began to fan out all over town.

By the end of 1957, the Department Philadelphia operations employed 3063 people and occupied 657,000 square feet of facilities.

By the end of 1958, Department manpower had grown to 3705 and 715,000 square feet were occupied in Philadelphia.

Because of the reorganization of the Defense Electronics Division, the Missile and Ordnance Department was renamed the Missile and Space Vehicle Department on September 1, 1958 — and the Ordnance Section was split off and became the Ordnance Department.

There was little expansion in employment or facilities in 1959. However, in 1960, manpower and facilities began a major upswing. Investment in plant and equipment at Philadelphia almost doubled the amount acquired through the end of the previous year. Manpower gained by 2400 or 65% while the owned and leased space gained by 217,000 square feet.

Valley Forge Investment

In 1960, also, the Company committed itself to construction of the 30 million dollar plus Valley Forge Space Technology Center — the largest and most complex of its kind and requiring investment of General Electric funds unmatched by any other private investment in a defense or space facility.

By the time the new Space Technology Center was ready for occupancy, a variety of locations in Philadelphia and suburbs were being used to house the ever-increasing number of employees. At one time, five floors of the Sheraton Motor Inn at 39th and Chestnut Streets were leased. Space in the Girard and Mall buildings in downtown Philadelphia as well as one of the Penn Center buildings was rented.

What was the product progress that was making this expansion necessary? In what way was the business growing? Many people who were here from the beginning look back and say it was a pretty logical, orderly growth, though at the time it may not have seemed so.

When that first re-entry vehicle contract was awarded, the problems were staggering. Ballistic re-entry presented material problems, fuzing problems, instrumentation problems, structural problems, weight problems, aerodynamic and thermodynamic problems, stabilization problems, cost problems, stress and vibration problems, manufacturing problems — the list goes on.

General Electric was well equipped to search for some solutions. We had 10 years of the Hermes Program, recognized technical competence, and the financial stability and capacity to support an effort of such magnitude.

The major technical problem to be overcome was to design and develop a nose cone that would shield the ICBM warhead and instrumentation through the heat of re-entry into the earth's atmosphere. Our scientists and engineers received many suggestions for coping with the problem and decided that two had the best chance for success:

- The heat-sink method, in which the nose cone would be clad with a material, such as copper, that could absorb a great amount of heat.
- The ablation method, a phenomenon in which the surface of the material melts or vaporizes, an extremely thin layer at a time, and the vapor carries off the heat.

Exhaustive Air Force/Industry studies indicated that the surest solution in the required time was to employ the heat-sink principle as a "first-generation" approach. With the proper heat-sink design, the heat input could be conducted from the heat shield surface into its mass sink of high-heat-capacity material to an extent sufficient to keep the shield temperatures below the melting point of the shield material. Intensive investigations resulted in the selection of copper as the heat shield material.

Mark 2 Flies

Only 30 months after receiving the contract, the job was completed. About 70 test fights were made during this period. The result was the Mark 2 re-entry vehicle. It was deployed operationally all around the world on both Thor and Atlas missiles.

Its maximum diameter was about five feet, and was about five feet long. The vehicle weighed over a ton and incorporated several major systems, such as arming and fuzing, instrumentation and telemetry, heat protection and structure, and trajectory control.

The total Mark 2 research and development program was concluded in March, 1960, an eminently successful on-schedule program that included 36 flights in which the Mark 2 was placed in proper trajectory by Thor and Atlas booster missiles.

The successful return and retrieval of the initial Mark 2 data capsule in 1958 marked the first return of a payload from outer space — and the Country's initial milestone leading to recovery of large and more complex vehicles from space. Thirteen of these capsules were successfully recovered throughout the program.

During the Mark 2 program, research had already started on higher-performance, advanced vehicles. Tests continued on the ablation method as offering greater long range promise. Hundreds of potential materials were tested in arcs, rocket engine exhausts and gas torches.

The primary objective of the test program was to demonstrate successful re-entry at ICBM range and to obtain materials and environmental information under ICBM conditions. Recovery of the ABLE vehicle in 1957 was needed in order to examine physically the burn-off rate and characteristics of the ablation material. Accordingly, a complete recovery system, consisting of a strobe light, radio beacon, dye marker, parachute, flotation balloon and shark repellant, was designed and incorporated into the vehicle. Two of three vehicles tested were placed in successful trajectory. Although recovery was not achieved, telemetry was received throughout the entire mission on both flights and the ablation concept could be considered to have been demonstrated.

The ABLE program was followed by the RVX-1 program and the RVX-2 programs. The RVX-1 was an ablation vehicle with a new shape — sphere-cone-cylinder-flare. The program was very successful. Four vehicles were placed in trajectory, all provided excellent telemetry and two were recovered successfully — the first recoveries of vehicles from space at ICBM range. The design information on materials and shape permitted the design of the Mark 3 vehicle, a second generation re-entry vehicle for the Atlas. The RVX-2 program was begun in 1958. The vehicle was of the conventional sphere-cone configuration. It was five feet in diameter, twelve feet long and weighed more than a ton. In July, 1959, this vehicle was recovered — the largest vehicle and largest payload ever to have been recovered from space. Data obtained from this program led to the development of the Mark 6 R/V — the re-entry vehicle for the Titan II missile.

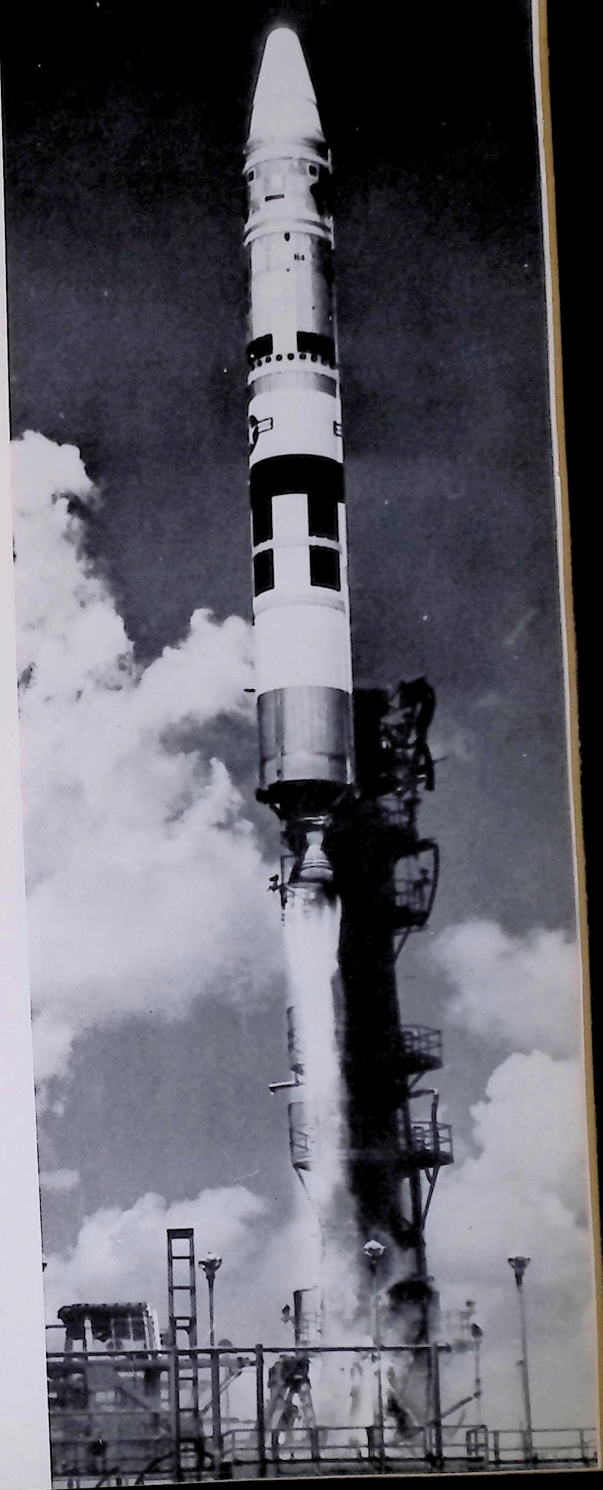
So the development of the business progressed "logically." The Mark 3 followed more recently by the Mark 6 have proven not only to be a valuable part of the nation's defense arsenal, but served to enhance our own technological abilities and lead to the awarding this Fall of the Mark 12 contract to MSD.

Flying Laboratories

As early as the Mark 2 and RVX programs, it became apparent that efficient use could be made of vehicle flight tests for scientific purposes in conjunction with the weapon's system flight tests. The vehicles became flying space laboratories using the free ballistic flight through space during the time between booster separation and re-entry into the earth's atmosphere. For example, on a full range Atlas flight, the re-entry vehicle reaches an altitude of 700 miles and experiments could be made for nearly 25 minutes. The real purpose of the mission could be accomplished and experiments could go along for the ride.

The Space Laboratory Program participated in more than 44 flights as part of the regular IRBM and ICBM programs. More than 140 missions were flown of which more than 60% returned useful data.

Without interfering with the primary flight objectives,



Nation's most advanced operational re-entry vehicle, the Mark 6, is launched on a test flight on the Titan II ICBM at Cape Kennedy.

space hardware and experiments containing meteorological, space environment, hypersonic re-entry materials and structures were flight tested in the actual space environment.

The success of these experiments is generally regarded as being highly significant in the obtaining of a number of new contracts along the way — some of which worked out well, some of which didn't — contracts like the Orbiting Astronomical Observatory, NERV (Nuclear Emulsion Recovery Vehicle), Nimbus Weather satellite, Advent communications program, and Skybolt. We had moved naturally from the missile business into the space business and employment figures moved right up with the expansion, exceeding 10,000 in the Philadelphia area alone in 1962.

In each of the eight years of MSD history there are a number of key highlights. It would be difficult to pick a pivotal year. You might point to 1955 and the first contract.

Or you might look at 1956 and the establishment of a promising business in Philadelphia and the development of the Mark 2.

There was 1957 and the addition of Burlington and the Space Sciences Laboratory.

And 1958 with the Mark 3, and the naming of Hilly Paige as Department General Manager, and the renaming of the Department to Missile and Space Vehicle Department.

Or 1959 and the real beginnings of expansion into space projects followed by the 1960 groundbreaking for the Valley Forge Space Technology Center.

Since then the Department has become a Division, has witnessed rapid growth, disappointing cancellations, aggressive marketing, severe competition. A great wealth of people talent has migrated into the Division. Most are still here seeking to help MSD establish a solid business base. Some have left — including some highly capable people. You gain some. You lose some. It's the nature of the business.

It's a business where the customers are few in number, and their needs frequently changing. Because of the nature of the business they seldom can specify their exact requirements. Rather they expect ingenuity from the contractor. The dollar volume of a contract can be very high, but can fluctuate dramatically during the life of the contract. There can be outright cancellation or stretch-out, or substantial expansion and speed-up. It's a difficult business to predict.

It's a business requiring a large concentration of scientific and engineering personnel who are constantly on or beyond the frontiers of the state of their particular art. Skill, imagination, willingness to experiment, to take technological risks — these have been standard equipment for eight years.

Bob Haviland, that project engineer in 1950 who stood on the sands of an unknown place called Cape Canaveral commented:

"Until 1958 no one expected to see the space race bloom forth the way it has with the jumping on the bandwagon by science and industry."

MSD's historical role is a proud one. Unfortunately, it's not the kind of business where you can dwell long on yesterday's successes, because a whole lot of tomorrows lie ahead, the competition is keen, the technical challenges are increasingly difficult.

From a few people who gathered in the Campbell Avenue building in Schenectady in 1955, an ambitious General Electric Division has grown into one of the nation's most prominent contributors — a Division that has posted "firsts" like:

—Recovery of space vehicle from outer space and from orbit

—Successful ablation re-entry over ICBM range

—Infrared measurement of Earth-space interface

—Measurement of Earth's magnetic flux from outer space

—Recovery of complete re-entry vehicle over ICBM range

—Color and black-and-white motion pictures of Earth from space vehicles

—3-axis (individually) stabilized space platform

—Re-entry vehicle to travel 9,000 miles

—Successful technique for telemetry transmission through re-entry blackout

—Largest weapon system re-entry vehicle to be successfully flown

—Control and stabilization system to demonstrate accuracy of one second of arc

Make-up of the Division now looks like this:

The Re-Entry Systems Department, located in Philadelphia, headed by Mark Morton, develops ballistic missile re-entry systems for the Air Force and orbital re-entry/recovery vehicles for the National Aeronautics and Space Administration. In addition, the Department conducts a continuing program of advanced research and experimentation leading to future generations of aerospace systems.

The Spacecraft Department, located at the Valley Forge Space Technology Center, headed by Dr. Roy H. Beaton, is responsible for the development and manufacture of long-life satellites, satellite subsystems, and space probes. The Space Center's test facilities include all those necessary for the development and demonstration of long-life reliability requirements which will enable space vehicles to operate reliably for years in the hostile environment of outer space. The Center's manufacturing facilities were also designed and equipped for the building of space components and systems to meet these long-life reliability requirements.

The Missile and Armament Department, headed by C. Herbert Ridgley, located in Burlington, Vermont, has responsibility for the design, development and production of missile warhead safing, arming and fuzing systems, helicopter armament, tactical aircraft armament, and thin-film water distillation equipment. Production support is also provided to the Re-entry Systems Department for nose cones and for aerospace ground equipment for the Atlas, Thor and Titan ballistic missiles.

The Advanced Space Projects Department, located at King of Prussia, Pennsylvania, headed by Logan B. Cowles, is responsible for the design, development, production, and operational systems support of advanced space vehicle systems.

The Space Sciences Laboratory, a component of the Missile and Space Division, headed by Dr. Leo Steg, is the Company's center for basic research and exploratory development in space-related sciences and technology. It works in the national interest in: Plasma physics, Environmental phenomena and interactions, Celestial mechanics, High-temperature and solid state materials, Shock wave and superpressure phenomena, Biotechnology.

It is the mission and objective of The Laboratory to advance the frontiers of knowledge on research problems central to the space technology of the future.

The Advanced Requirements Planning Operation, located at the Valley Forge Space Technology Center, headed by Arthur W. Robinson, Jr., is composed of advanced systems engineering, marketing and manufacturing sections, and is responsible for planning and preliminary studies of products to achieve growth beyond present MSD products.

The Finance and Contract Management Operation, located at Division headquarters, headed by Edward L. Hulse, is composed of accounting, computer, financial planning, information systems, management practices, and contract practices sections.

The Operation performs accounting work on a pooled basis for the Division and operates the Division computer facilities in the Philadelphia area.

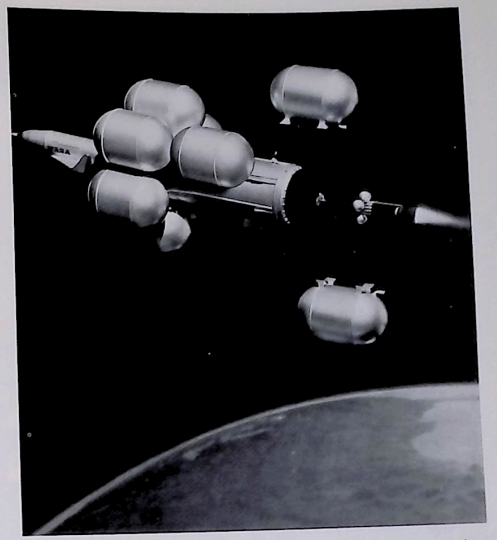
The Legal Operation, located at Division headquarters, headed by Bernard H. White, provides legal advice and service to the Division at all management, professional and supervisory levels with respect to all phases of the Division's activities.

MSD has posted quite an enviable impact on the Philadelphia area through its substantial payroll, through its dealings with thousands of small businesses, and through the contribution individual employees have made to their various communities.

Directing the Division is Hilly Paige who has said:

"The resources of MSD are directed exclusively to programs essential to national defense and to the nation's international posture in space. Current principal programs within MSD include: re-entry vehicles for Thor, Atlas and Titan II ballistic missiles; re-entry target vehicles for the Nike-Zeus program; recoverable satellites; Biosatellite vehicles; Nimbus weather satellite; control and stabilization system for the Astronomical satellite; arming and fuzing systems for tactical missiles; vulcan gun for the F-104, F-105, B-58 and B-52H aircraft; helicopter armament; and other study, design, and experimental projects related to missile and space programs."

"Performance, always a key in this business, is more important than ever before. Performance is measured in terms of performing within costs, staying on schedule and meeting specifications. Any company in this business is going to have its ups and downs, but the ones that are going to grow steadily over the years are those that establish, and maintain a reputation better than their competitors for dependable performance in the three critical areas of costs, schedules and specifications."



Model of a vehicle for a manned mission to Mars using nuclear propulsion.

Nike-Zeus anti-ICBM missile is test fired from White Sands Missile Range. MSD builds target vehicles for the Nike-Zeus program.

THE 30 DAY SPACE CABIN TEST

WHAT IT MEANS

When the Missile and Space Division's four terranauts finished a month-long space environment and mission management test a few weeks ago, it marked the successful completion of an experiment conducted under conditions closer to actual long-duration space flight than any other such test ever tried in the United States. The four men had continuously operated a full-scale ground based space station while isolated from the outside world in a giant space simulation chamber at the Valley Forge Space Technology Center.

The four men — Mike Daniele and Stu Sherk of the Re-Entry Systems Department's Engineering Section, Ed Hoelker of the Advanced Space Projects Department's Facilities Section, and Harry Lucas of Advanced Requirements Planning — demonstrated that a crew could operate without adverse physical or mental effects in an artificial atmosphere while conducting the highly complex and demanding tasks necessary to maintain and control an orbiting space station.

To get a first-hand explanation of the significance of the test, Challenge *interviewed Richard Passman, Manager of MSD's Advanced Systems Engineering Section, which conducted the test. Here's what he said . . .*

"The emphasis in our test was decidedly on man and how he can perform over a thirty-day period within the accurately simulated confines of a space station. The problems involved in this have been somewhat open questions. We did not know man's performance limits and capabilities under these conditions. We could make some educated guesses, but we needed actual experimental data so that we could plan to use man within his capabilities.

"Beyond this, we also wanted to know just how far man's limits could be extended in an emergency situation. How much stress can he take and still be able to perform?

"Another purpose of our test was to evaluate our own selection of atmosphere for the space cabin — to answer such questions as how man's well being and performance vary with his gaseous environment. We maintained the same oxygen content as we have in our sea level air and reduced the nitrogen to get about a 50-50 mix. This '7 pound' atmosphere is the pressure equivalent of being at 18,000 feet above sea level. We proved man performs well in this atmosphere and has no significant adverse effects either biologically or psychologically.

Simulated Missions . . .

"A variety of tasks were carried out by the terranauts. Using the controls and instruments on the upper level of the cabin, the men performed typical space station activities such as rendezvous, docking, maintenance and mission tasks. One of the questions we wanted to answer here was how much can man do and still have a sufficient safety margin. We got our answer. The men performed all tasks well. In some cases they would have liked more time but they still performed them in the time allowed.

"In analyzing the test, we have already come up with two improvements. One, mission and station management tasks should be separated. Two, the sleeping quarters of the terranauts should be isolated from sounds elsewhere in the cabin. These are measures that would make it easier for the terranauts to maintain a high level of efficiency.

"Also, there was limited opportunity to observe group relationships in our test. Our four men were on a 24-hour schedule with one asleep at all times and the others either carrying out mainly individual tasks or on rest periods. Future tests might well program two-man team tasks to provide opportunities to observe more group interaction.

"We are pleased with the performance of the terranauts. I think the careful selection process we went through, evaluating more than 60 volunteers, paid off. We picked men of astronaut caliber — high I.Q., engineering skill, emotionally stable, aviation experience, etc.

"And the men responded as astronauts. For example, when they came out of the cabin after thirty days, they didn't shout "Whee . . . we're out" — they were anxious to tell us how they were affected, to give us suggestions for the kinds of things that would be useful in future tests, and to offer a variety of other constructive comments.

Test Could Have Continued . . .

"Overall, the test was extremely successful — so successful in fact that I believe it could have been substantially extended. Nothing occurred to the men or equipment that prevented the test from continuing.

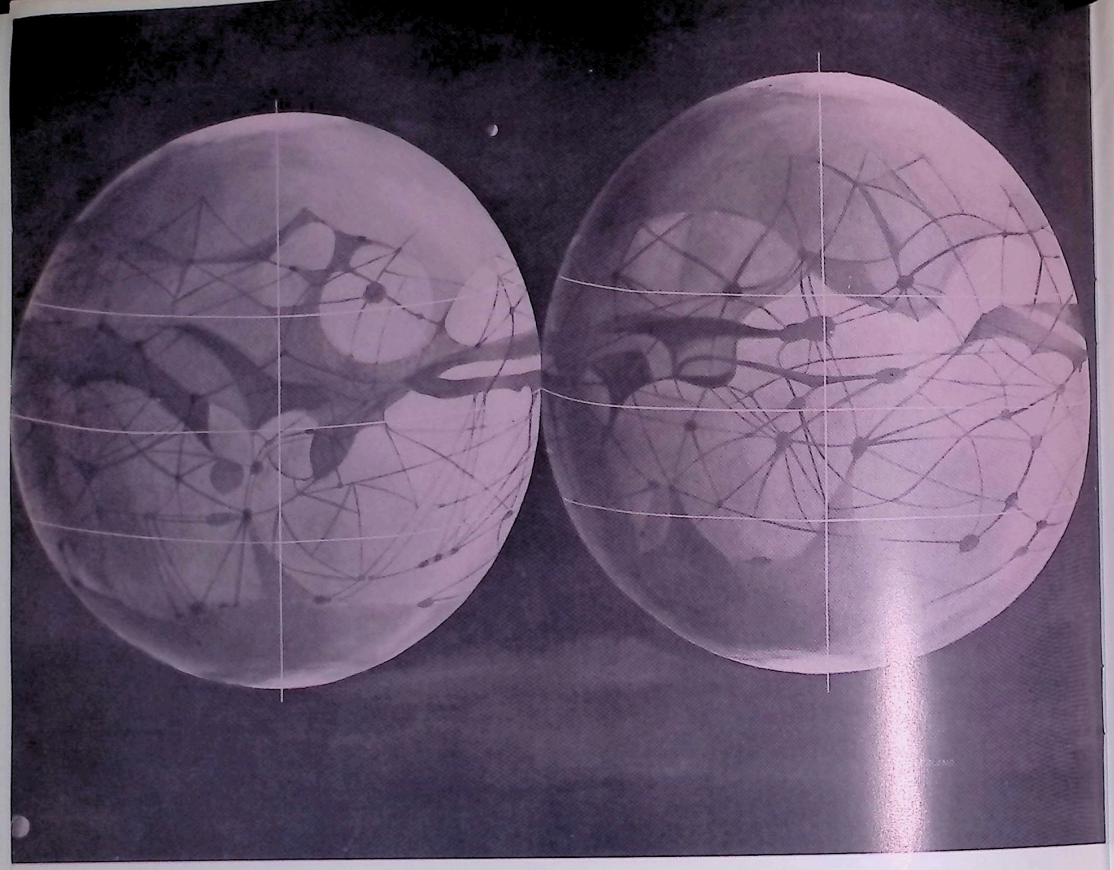
RICHARD PASSMAN

"The second major goal of the experiment — to establish and shake down this engineering test tool — has been accomplished. Our space cabin has proven to be the capability we sought with uses ranging from engineering concept evaluation and design validation through to operational crew training.

"Both public and customer interest in the test has also been gratifying. In fact, discussions of results of the test with Defense Dept., Air Force and NASA officials have been taking place.

"There are many possible future uses for the space cabin. Right now we are evaluating a number of these possibilities with different crew complement, different durations, different work/rest cycles, different equipment and so forth.

"The vital point is that this type of testing is mandatory NOW if we are to proceed on a timely basis to develop a space station. We must reduce to an absolute minimum the unknowns of this complex manned system before we orbit it — and this type of high fidelity system level simulation is the best available approach we have found."



MARS

Now with Mariner probes set for 1964 and 1966, and a proposed manned landing on Mars in the mid-80's, man is about ready to cross that threshold from speculation to actual observation.

Several centuries of speculation may be settled next year if Mariner probes of space can bring us some answers to the many mysteries that have fascinated man since he first began studying the skies.

Two nineteenth century discoveries stirred man's interest. The first discovery — that the planet was being orbited by two small moons, now called Phobos and Deimos — excited interest among scientists. But the second discovery — the controversial Martian canals — is the one that has captured widespread fancy and provided fodder for science fiction writers for nearly a century.

"It might be a little bit premature to eliminate the possibility that intelligent life exists on Mars."

The words are from Prof. Frank Salisbury, a professor of plant physiology at Colorado State University. Scientists have said there are no certain experts on Mars, but if there was one, Prof. Salisbury would probably be him. He's a man who hasn't just relied on his own studies, but has compiled opinions from leading scientists all over the world.

He now feels so strongly about the possibility of life on Mars that he is vigorously encouraging thorough observation by telescopes and fly-by probes before we land a robot exploration vehicle. In examining the possibility of life on Mars, he and others recognize that conditions there are harsher than we know them on earth.

Mars is about 4200 miles in diameter inclined on its axis. Its period of rotation is about 25 hours.

—The Mars year is 687 days, about twice the Earth's.

—It's much cooler than earth, being 42 million miles further from the sun.

—The air is thin, mostly carbon dioxide.

—There are white caps, figured to be snow because they expand during the cold season and shrink during the warmer times.

The temperature ranges from 90 below to only 50 above zero Fahrenheit. Atmospheric pressure at the Martian surface is estimated to be only about one-fiftieth that of earth and the gravitational pull only about three-eighths of the earth's. There is virtually no water or oxygen in the atmosphere.

"Despite these handicaps," Dr. Salisbury says, "Life could survive — in fact, it probably could thrive."

Fred Kochendorfer, chief of NASA's Mariner Program, is hopeful that we won't have to wait too long to find out. Television pictures flashed to earth from the upcoming Mariner probes should provide specific information on any vegetable or animal life on the planet. The probes will also test the atmosphere around the planet.

"Sure, we're confident man can land on Mars by the 1980's, but the key to manned flight to Mars is money. It'll take 12 times the power needed to put a man on the moon."

To get a man to Mars, NASA first must place a space vehicle in a "parking" orbit around the planet. Then the astronaut would be blasted off from the vehicle to Mars, along with a huge rocket to be used to later blast him back to Earth.

Manned interplanetary flight has to take its place in the competition for the space dollar with such things as large launch vehicles, earth-orbital space stations, a lunar base, possibly military space programs and others. With budgetary considerations in mind as well as the technical hurdles involved, the mid-80's have been forecast as a logical man-to-Mars date.

Let's go back to the sparking of interest in Mars that occurred in 1877 when Phobos and Deimos were first noticed making their trips around the planet. The theories on these two are abundant.

Phobos and Deimos are very small, about 10 miles in diameter. Both satellites revolve around Mars in its equatorial plane, along orbits which are circular. The origin of these two is a considerable riddle. Here's some of the speculation.

They were separated from the mother planet.

(This one quickly gets debunked because of their dissimilar density and mass. In addition Phobos circles Mars faster than the planet rotates.)

These satellites were captured from outer space.

(This one is discouraged because it's figured the orbits would lie in different planes and would be strongly elliptical.)

Now for a theory that may go further out for some. It's followed by romanticists, science fiction writers and some scientists. These satellites were launched into orbit from Mars. This conveniently explains why these weren't visible when Mars was near in 1862, but was visible in 1877.

After an extensive world-wide search by astronomers for Martian satellites during the 19th century's most favorable opposition of 1862, it was universally considered that Mars had no moons. However, in 1877, when Mars was again in opposition, its satellites were suddenly detected — not by one astronomer at one observatory but by many. Furthermore, the two moons have been seen ever since, even in telescopes of a small resolving power, and certainly less powerful than the reflectors which Herschel and Lassell employed in 1862 (48-inch mirrors).

The conclusion naturally arises that Phobos and Deimos were not seen prior to 1877 simply because they didn't exist.

We get a simple explanation if we suppose that Phobos and Deimos are artificial satellites which the Martians made and launched into orbit. This idea was first voiced in 1951 by the American astronomer Gerd and elaborated in detail in 1958 by Prof. I. S. Shklovsky of Russia.

Mars' satellites have near-circular orbits close to the planet. From the point of view of thrust the alignment of artificial satellites in an orbit coinciding with the planet's equatorial plane presents the greatest advantage, using rotation as a "gift" launching velocity. Phobos and Deimos, as already remarked, travel along orbits that are set precisely in Mars' equatorial plane.

In its revolution around its primary, Phobos undergoes a queer acceleration which can be explained, Shklovsky claimed, only if this satellite is a hollow sphere — which would be out of the question were the celestial object of a natural origin.

And if Phobos and Deimos are metallic with a polished mirror-like surface, their diameters should be much less than indicated earlier, of no more than a mile or less.

Given a high technical standard in Martian space capability, artificial vehicles of such dimensions should not be thought impossible. Space scientists and engineers here on earth are already designing large permanent satellites, in the form of wheels, the diameters of which will be much longer.

The second discovery in 1877, this one by the Italian Schiaparelli concerned peculiar dark lines he called "canals." The discovery of the mysterious lines or "canals" on Mars sparked such interest in the planet that it lead to the building of new and improved observatories. In Flagstaff, Arizona the renowned astronomer Percival Lowell set up the now famous Lowell Observatory. The location was chosen for its unusually clear sky, and today the observatory is one of the best equipped in the world. In 1894, when Mars again orbited closer to the earth than its usual distance, Lowell made an intensive study of the planet and was able to sketch more than four hundred different canals. As far as he was concerned, they were irrigation canals, built by Martian inhabitants to carry water from the melting polar snowcaps to the desert region near the equator.

The famous French astronomer Camille Flammarion had another idea. He maintained the lines showed cultivation along the banks, not the canals themselves, but this also argued for the existence of life on Mars.

Many astronomers dismissed both ideas. Some said the lines were not lines at all, but stretches of land irregularities blending together. Others, while agreeing that the lines were solid, did not feel they necessarily meant the presence of intelligent life. Father Moreux, director of the Observatory of Bourges in France, declared: "Nature offers examples of nearly perfect geometric forms . . . the study of crystals, cells and tissues will enlighten you on that point."

The mathematician Alan Webb argued otherwise. To distinguish between a network traced at random, as in a cracked vase, and one deliberately laid out, Webb devised a mathematical criterion, and according to it the Martian canals appeared to be intentionally designed.

Science fiction writers were like a child with a new toy with the stimulating idea that life might exist on Mars, and for a while books and magazines by the hundreds speculated on the nature of the planet's inhabitants and the possibility of their invading the earth with strange ships and weapons. Most famous such story was "The War of the Worlds," written by H. G. Wells in 1898, in which Martians landed in space ships and began to conquer the world with huge robots. Mankind was saved only because the invaders proved vulnerable to the world's lowest form of life — the common germ.

In 1939 the story was made into a realistic radio program by Orson Welles causing near-panic among many listeners who became convinced they were hearing the sensational news of an actual Martian invasion. Although the program was clearly identified as a fictional radio play when it began, people who tuned in late heard only the voice of a terror-stricken newscaster giving an eyewitness account of Martian monsters destroying everything in their paths as they advanced on New York City. New York, in all its majestic strength, survived this threat and prohibition and the Mets.

It is fairly certain that plants can live on Mars, and since plants produce oxygen it is possible there may also be some forms of simple animal life. Some scientists believe that Mars once was able if not now, to support even human life. The reddish color of the planet is thought to be iron oxide — rust — which could have been produced in some remote past when oxygen and water were plentiful. And this possibility leads to the interesting speculation that Mars once may have had inhabitants who perished when the planet's supply of water and oxygen was exhausted.

Some writers have even suggested that the Martians foresaw this, and built subterranean cities engineered for comfortable atmosphere, humidity and temperature, where they live to this day manufacturing their air from the oxygen-rich soil. A Russian astrophysicist, Chklowski, is another who maintains that the planet's moons are actually artificial satellites launched long ago by highly intelligent beings.

His countryman Shklovsky thinks that Mars' satellites were orbited in ancient times — many millions of years ago — and today are merely mute monuments to a long extinct civilization.

But the story of the discovery makes it seem logical that if they were launched it was less than a century ago, in 1877.

There are other factors to support the recent origin of the Martian satellites. Phobos and Deimos would be subject to an incessant hail of micro-meteorites which in the course of millions of years would have completely destroyed the Martian "Sputniks."

Want to go further out? Mars adds bits of evidence that apparently lend comfort to those who believe in a current civilization on Mars. When the apparent oases fade in winter, a permanently observable dark "core" remains in the middle of each. Could this be a Martian city?

In 1952, astronomers suddenly detected an unfamiliar green patch on Mars. This odd formation darkens every year, preserving meanwhile its general shape. Is this an irrigated and planted Martian desert?

From time to time curious sparkling points flash out on Mars' surface, to be followed by tiny clouds which all closely resemble what happens during a large detonation. These phenomena were observed in 1937, 1951, 1954 and even quite recently. Moreover, they lasted a few minutes at times. Would atomic bomb tests look like that from space? Prof. Salisbury comments about the atmosphere of Mars. There are three important atmospheric features he says about Mars: the blue haze, white clouds, and yellow clouds.

The surface features of Mars are visible when the planet is photographed in red light but usually not when the planet is photographed in blue light. There seems to be a haze with high light-scattering properties in the blue region of the spectrum. It can best be accounted for on the assumption that it consists of minute water ice crystals, although carbon dioxide ice and carbon or hydrocarbon smoke have been suggested. Occasionally the haze disappears on a continental or even planetary scale. During this blue clearing, ultraviolet light would penetrate to the surface of the planet at intensities which would probably be lethal for the majority of our earthly organisms. An interesting feature of the blue clearing is that it seems to occur most frequently at opposition, when the sun, the earth, and Mars are nearly in a direct line. It would be extremely interesting, Prof. Salisbury speculates, to know if the position of the earth can thus influence the Martian climate; this apparent influence may be an illusion, as most observers are watching Mars only around the time of opposition.

The second important atmospheric feature concerns the "White clouds." Sometimes white clouds can be seen, especially over the polar cap. These may be similar to earth clouds, although they probably always consist of ice crystals. There is some evidence that they produce rain on rare occasions.

The third feature is the "Yellow clouds." Occasionally yellow clouds obscure certain portions of the planet, as in 1956, when nearly all of the markings were covered by an extensive yellow cloud formation during opposition. These clouds are usually thought to be a fine yellow dust. Markings on the planet may be temporarily tinged yellow after such a cloud has passed over, but within 1 to 2 weeks they are again visible.

None of this is direct evidence for life or intelligent life, Dr. Salisbury said, but it is enough evidence to justify further consideration of landings in our space program.

Man may not have to wait much longer to learn the answers to many of the planet's mysteries. Space probes launched from earth will soon be radioing back data, perhaps even pictures, that may tell us about the strange markings called canals. From what we know of the planet now and despite some adventuresome speculation to the contrary it seems too much to hope that any inhabitants will be found. But as Schiaparelli said when the same doubt was suggested in 1877, "I am very careful not to combat this supposition, which includes nothing impossible . . ."

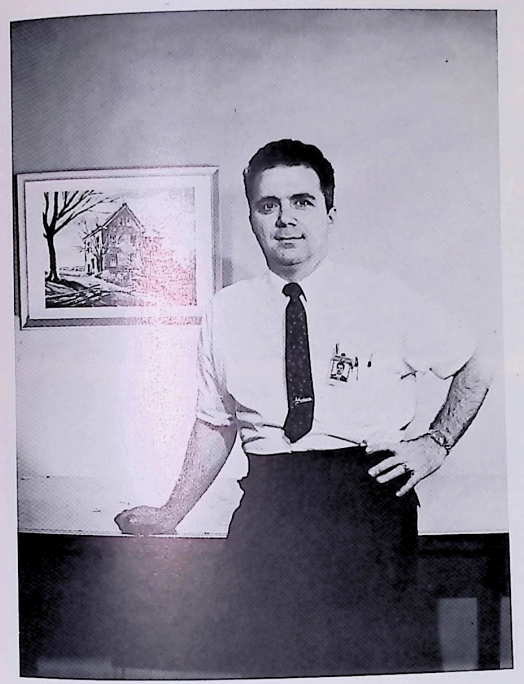
BIOGRAPHY OF A SPACE ARTIST

From a 6th grade desk in South Philadelphia's Andrew Jackson School to the outer reaches of spheric density, the paintbrush of Peter A. Bertolino of the Space Sciences Laboratory has touched a surface, there to leave an indelible mark.

Since winning the first prize in a city-wide competition in his grammar school days, Pete Bertolino has been steadily encouraged to develop his artistic ability. Encouragement came mostly from his teachers and it came in many ways — an oil set, classes at the Philadelphia Art Museum, et cetera.

Then, World War II . . . Bertolino served with the Headquarters Company, 41st Armored Infantry Regiment, 2nd Armored Division which, incidentally, participated in The Big Lift to Germany from Texas last fall. Twenty years ago, it brought the first American troops to Berlin and was the Honor Guard to the Postdam meeting of the Big Three (Stalin, Churchill, and Truman).

With this Division, Bertolino saw action in northern France, the Rhineland, the Ardennes and central Europe. At the front for nine months, he found his past training and ever-present ability being put to use — sketching the terrain of the front lines for staff meetings. Having been wounded in action in November of 1944, Bertolino was awarded the Purple Heart. The War soon ended and Bertolino returned to civilian life.



. . . from South Philadelphia to outer space

GI Bill Aids Training

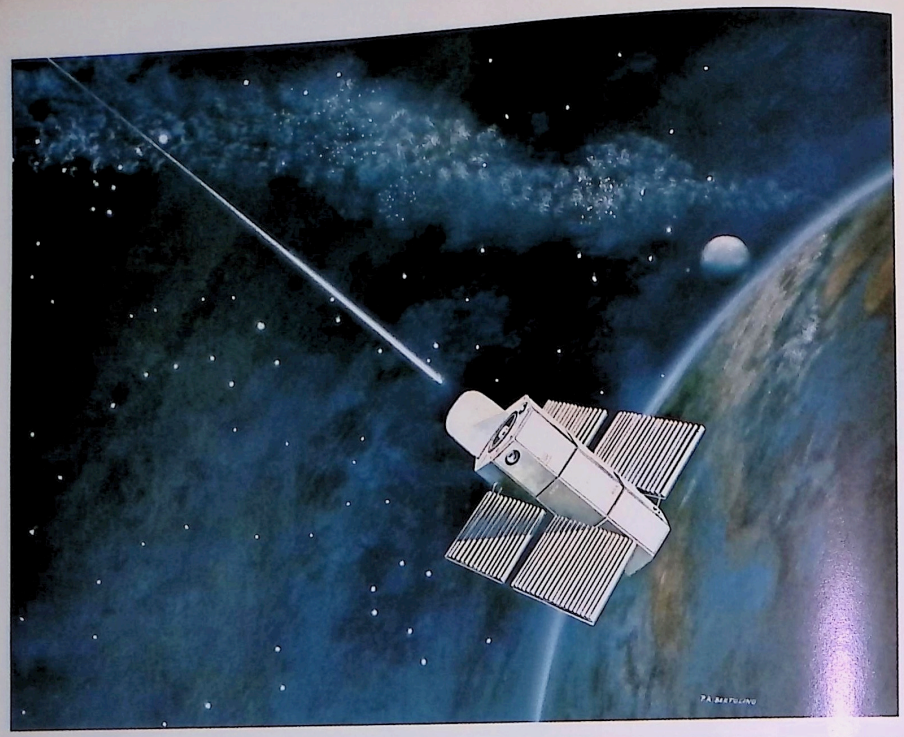
After serious consideration, he realized his artistic interest and the encouragement of the past left only one path to be followed — that of art. Bertolino then enrolled in the Hussian School of Art in Philadelphia. There he studied advertising design and fine arts under the GI Bill of Rights. While there, his practical experience included numerous murals — one of which he is especially proud and which is now displayed in a doctor's office. Of course his experience also included an introduction to the industrial arts of flip charts and posters which was to serve him in good stead a few years later.

Having joined General Electric in July of 1956, Bertolino has had several positions, the most current of which is that of technical illustrator in the Space Sciences Laboratory. He modestly says his job consists of "putting scientific thoughts into pictures." He categorizes these into two main classes:

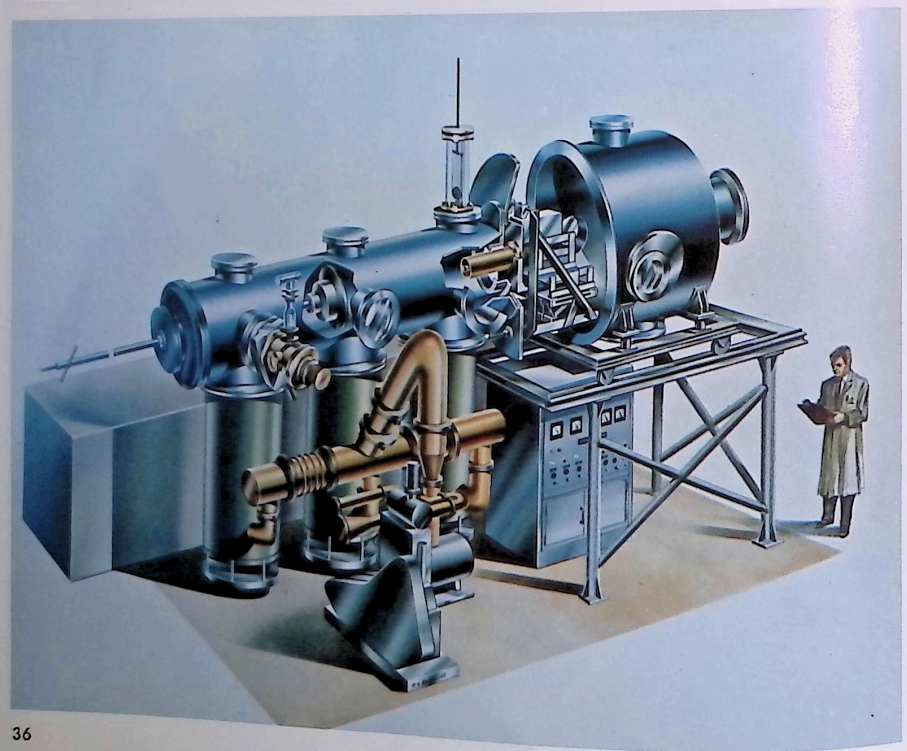
"Projects currently being developed by General Electric, and concepts which may develop into future space projects." In both of these, the vivid imagination of this artist, coupled with his knowledge of descriptive scientific data plays an important role.

Commenting on the main satisfaction he derives from his work, Bertolino said: "the most important thing is that I am communicating. There is something about any artist which makes him want to comment on what he sees."

It is evident then, that Bertolino reflects an open eye and an active paintbrush as shown by his penetrating and searching look at space age concepts. From these have emerged some imaginative and highly-exciting work.



Orbiting Astronomical Observatory



Plasma Engineering Test Facility

Variety of Exposure

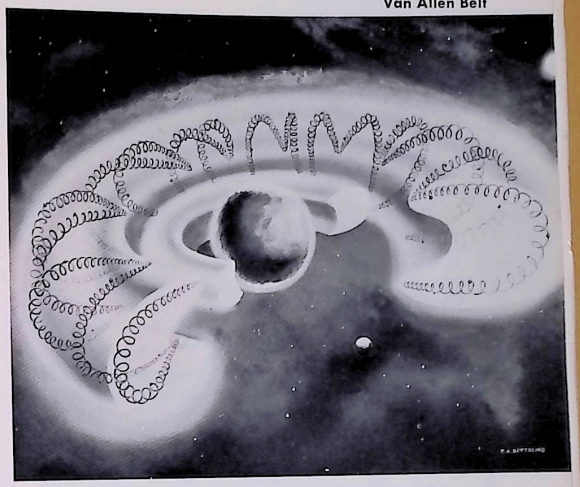
Bertolino has appeared and been exhibited both nationally and internationally. Nationally, his space art and fine art has been exhibited often in the Delaware Valley area. He has been featured in numerous magazines and newspapers including the Philadelphia Inquirer on two occasions. Also, last June his work appeared in the Boston Sunday Advertiser in full color. This art accompanied an article which pointed out the role of the Missile and Space Division in space research.

Internationally, Bertolino's work has been featured in HABLEMOS, the Sunday magazine supplement of 10 leading Latin American newspapers. It recently featured an article on space travel and was highlighted by a two-page spread of space illustrations depicting space vehicles, complex lab experiments and abstruse scientific concepts.

Again, nationally, the 16th and final volume of the American Heritage series, an illustrated history of the United States published by New York's Dell Publishing Company, Inc., includes a pictorial portfolio of The World of Outer Space. Bertolino art, in full color, illustrates the new ventures and new techniques and suggests how busy the realms of space may one day become.

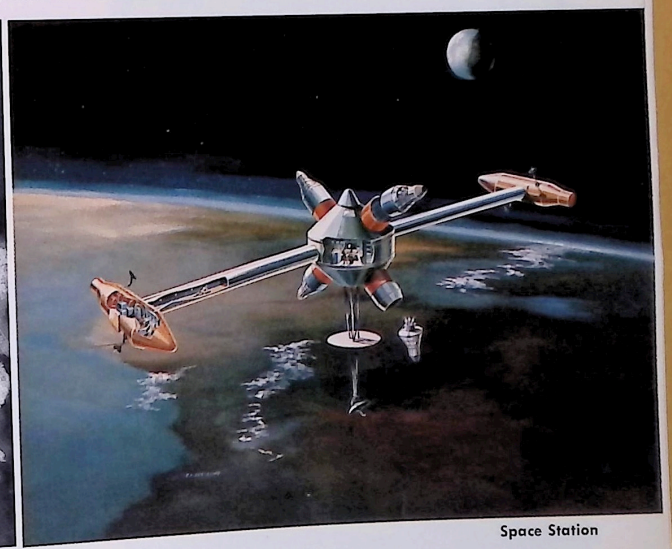
The sound training Bertolino has acquired has given him the best that the past has to offer, thus enabling him to make his mark through seeking a new means of artistic expression. This expression lies in his forte with water colors—one embodies the richness of oils with the fine arts technique of the classical water color. The resulting technique creates a forcefulness and three-dimensional strength that has caught the eye of numerous space age enthusiasts, largely due to his having a great feel of distance. With special lighting the illusion of depth is heightened even further. This optical phenomenon has astonished casual observers who think they are oils because of the fine art quality.

On these pages are shown samples of Bertolino's work.



Van Allen Belt

Saturn rocket with Apollo

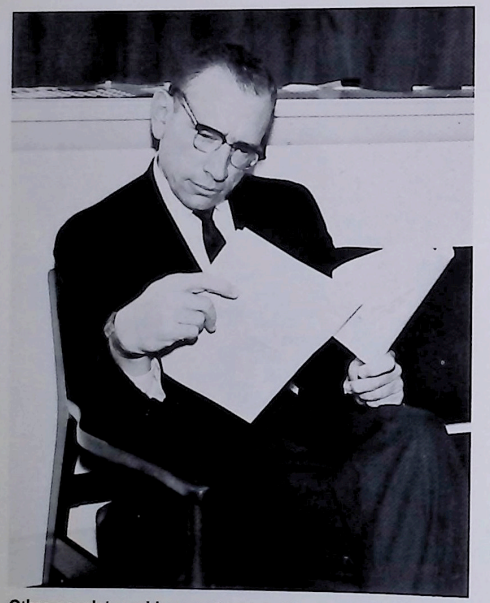


Space Station

OFF THE SHELF TECHNOLOGY

"The ingenious man, the ingenious organization and the ingenious nation — other things being equal — have the best prospect for survival and success in the world today."

—Luis De Florez, NATION'S BUSINESS



Other people's problems and accomplishments make good evening reading. Weekly status reports are circulated throughout our technology community to aid in technical communications. Otto Klima and his managers read the progress reports from all thirty-four of the system and technology management groups.

Otto Klima was doing the talking:

"Two Defense Department policies are now in effect that have a pronounced influence on our business:

- No major operational weapons systems development will be committed where a major uncertainty in the state of the art exists;
- A large percentage of research and development shall be accomplished under fixed price contracts."

"Our challenge is to do business in this climate — we are meeting it head on and it looks to us as if it's good for both the customer and ourselves. To compete in this business we first meet our contracted commitments 'by the numbers' with each detailed task treated as a fixed price contract. Secondly, we put the critical new technologies 'on the shelf' to minimize future risks. When we bid we have solutions to the critical problem areas already in hand and our customers know we will meet the performance requirements for the dollars quoted."

Otto Klima manages the Systems and Technologies Section at the Re-Entry Systems Department and he guides his team by this effective two-way approach. Klima has been with the General Electric Company since 1946. With the Hermes Program he did the Aerodynamic Design of various missiles. He became Manager of Aerodynamics in 1955 when what was to be the Missile and Space Division got its start. It was Atlas and Thor then, and it has been many programs since. He speaks his mind, knows the aerospace business, is impatient with mediocrity, and is convinced his two-way approach to the job of managing the Systems and Technology Section is the best. "It's working out just fine. We're meeting the customer's requirements on current programs and are ready and able to handle his future needs."

As Manager of the Systems and Technologies Section, Klima is responsible for the System Specification, the Technical Direction of the system, the analysis of the design in the technology areas, and a continuing evaluation of the capability of the system through test and flight evaluation. To insure that this responsibility is met he delegates the direct program responsibility to one of his five System Managers, who worked directly with his five technology laboratory managers.

It is the responsibility of the System Manager to implement current programs and to determine the technical direction of improved performance and new business for his product area. This growth direction is combined with overall Department planning through the Advanced Technology Operation working with Marketing's Advanced Planning functions. The direction is then related to the necessary technological developments required by the laboratory functions of the Systems and Technologies Section. The five Laboratory Managers and the Manager of Advanced Technology are then responsible for establishing the technological base to insure that the required improvements in performance can be attained. This can be visualized as a chemical reaction between the System Manager and the Laboratory Managers with Klima as the catalyst. The catalyst's responsibility in normal reactions is delegated to the Manager, Advanced Technology. For explosive reactions, Klima himself is the stimulant.

"Advanced planning is concentrated on those elements of the business that we can do something about. There are several echelons of influence in regard to this business, and on some you can have an impact and on others you can't. There's no point in investing energy in those things you can't do anything about. Whether or not there will be a certain type of weapons system may be determined by world problems. If cold war tension increases, the development of certain systems may be required. If the tensions ease it might mean a re-routing of our defense efforts. The point is that we here can't affect this decision."

"When the decisions reach the level of defining generic or specific weapon systems and identifying their mission requirements, then this is our business, and it's at this point that we want to apply our manpower, our facilities and our experience. One of the many things we must do is anticipate the technologies advances that will be required by these systems."

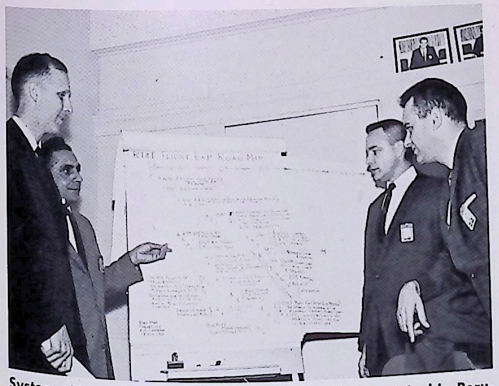
To accomplish the job of putting a competitive technology base in place, the Laboratory Managers are responsible for accomplishing work in each of the future system critical problem areas. Budgets for this work are established by competing for study contracts, by working in the contractor's independent research program, and by instituting feasibility flight test programs.

"Advanced technology management — or placing the dollars on the right critical item — consists of getting the right mix of skills, the facilities needed, and applying this effort to the key critical problem prior to preparing a systems hardware proposal. To establish the priority of the many candidate problems for technology development, the elements that force changes in the future systems are evaluated. Working with our Market planning operation, each generic system has been examined to determine the capabilities that might be required in the future. These capabilities place requirements on the technologies and elements of the system that are being met by planned advanced work going on within each section. This can be illustrated by projecting the effective life of a strategic re-entry system. Since this effective life is largely dependent on the development of anti-missile defense systems, the timing of these defense developments identifies when and to what degree critical problems must be solved to permit orderly development of advanced weapon systems. These driving functions have been established and are constantly examined. Relating these developments to skills is accomplished by establishing a roadmap of the technical direction in each product area."

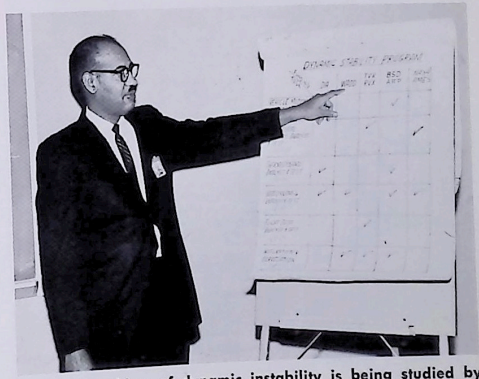
Five Phases

In the dual role of applying RSD's re-entry technology capability and of developing future capability, Klima's organization is in a unique position to make maximum use of manpower and facilities. In each major program in RSD these are five phases of effort: Analysis, Design, Manufacture, Test, and Operations. For each of these phases an effective set of operating tools has been developed.

The analysis phase deals with defining the mission, determining the operating environments and establishing design and performance requirements. System tradeoffs must be conducted to establish the best configuration and design approaches to accomplish the total required mission. The tools available for this analysis effort are many, and include such items as computerized simulation models, a configuration selection program, systems specifications,



Systems Managers, Ed Ulmann, Frank Nistico, and Archie Perugi conduct a critique of the road maps for Target and Test Vehicle Development generated by Ewen Cameron (second from right). The road maps for all generic systems are reviewed to evaluate our capability to meet the critical problem areas.



A critical problem of dynamic instability is being studied by Lonnie Marshall, on contract with Aeronautical Systems Division of the Air Force. Performance on these study contracts is insured by periodic reviews by RSD management. Consulting services from the entire General Electric Company are often invited to the reviews.

risk analysis techniques, energy management control, reliability and operational analysis tools, and the technology programs used for material performance predictions, stress analysis and trajectory and dynamic analysis calculations. These tools (including some 180 general purpose computer programs) are in working order, ready to be used — they don't have to be re-invented for each new program.

The same depth and scope of operating tools is available for the other phases. In design, the tools include a four-stage drawing release system, configuration control, design change control, design reviews, parts standardization, design evaluation, development labs, mockups — and the list goes on. Built-in to RSD's method of operating is a continuing series of measurements to make sure that all of these units of operation are functioning properly. Through all five phases of the program, the checks and balances are elaborate, so that the finished product has the benefit of combined analysis and test.

A key asset in the design area is the stage release system where the particular design progresses through four stages, each stage becoming more defined, more precise. The stage release system provides a formal, understandable method for communicating design interface information in a timely fashion.

The third phase is manufacturing. Here, again, some tools are required to insure adequate communications and control. The Department can quickly call upon production planning, producibility methods, the "make or buy" structure, sound vendor surveillance, purchasing and subcontracting, stock control, material disposition, final assembly. Again, all of these have a well-worked-out set of measurements to guarantee maximum results.

The fourth phase — testing — utilizes an integrated test plan encompassing ground, flight, and qualification tests, failure reporting, reliability data reporting, system calibration, flight evaluation. Taking just one of these — the integrated test plan — you find that this outlines the Department plan for obtaining basic development data, reliability information, logistic data and a demonstration of design capability.

Fred Schultz, Jack Stewart, and Otto Klima discuss some material samples under development. Fred has a contract with NASA to apply our reaction kinetics computer program to predict the behavior of ablative material for application in rocket nozzle design. Dr. Stewart, responsible for material development in the Department, is Chairman of the Division Material Panel, and is the Technical Area Monitor for materials for the entire defense business of the General Electric Company.

Operations is the fifth phase and it involves flight operations planning, logistics and facilities planning, communications planning, launch and recovery requirements, command and control plans, training plans, and retrofit instructions.

These five phases and the mechanics for carrying them off successfully are all backed up by a proven set of management tools. *Effective application of all these inter-related operational tools results in a continuous and thorough evaluation of technical risk versus cost and effort applied.*

"The complicated nature of this work requires that you have, on a ready-to-go basis, the capability for constant implementation and then measurement of what you've done," Klima said. "It's the only logical approach to getting success in this business."

Varied Talent

The Systems and Technologies Section can offer outstanding talent right now in such things as aerodynamics, trajectory mechanics, energy management, aero-thermodynamics, structural dynamics, materials, electro-magnetics, man-machine integration, systems engineering, reliability engineering, guidance, environmental control, command and control, instrumentation, computer programming, energy conversion, weight and balance control, processes and fabrication. And that, of course, is only a partial list.

With these critical skills available, plus sufficient experience and tools to make the proper tradeoff decisions, RSD is in a position to offer the customer a great deal for his money. This capability is imperative, for the competitive nature of our business continues to grow tighter and tighter.

"We're in excellent shape with people and facilities to offer the customer a great deal for his money and we work constantly with him to see that future technologies are available when needed."

"Our organization allows an individual to concentrate his specialty on a wide variety of tasks. It provides both a built-in motivator and a continual training device."

The Systems and Technologies staff has a wealth of people with high credentials in the field. The staff organization is simplified, reflecting again the logical approach to this complex business.

The five Systems Managers include Ewen Cameron, Target and Test Systems; Frank Nistico, Orbital Systems; Chuck Jamison, Strategic Weapon Systems; Ed Ulmann, Scientific Experiments; and Archie Perugi, Maneuvering Re-Entry Vehicle Systems. These men set the direction for systems engineering and the requirements for future growth. They provide technical direction to both the operational and R&D phases of a program. They're responsible for the evaluation of the capability of the systems and for the balanced utilization of technical resources including financial and schedule considerations. They must identify long range product trends and indicate the need and timing of new technical skills.

There are five laboratory managers.

Heading up the Radiation and Space Physics Laboratory is Dr. Pat Friel. His people must solve the fundamental physics and environmental problems related to present and future re-entry systems. They deal with electro-magnetics, plasma physics, radar, nuclear weapons technology, thermo-chemistry, chemical kinetics, bio-physics and other special areas.

The Systems Synthesis and Analysis Laboratory is managed by Rowe Chapman. Using systems models and simulation, this laboratory provides subsystem environments and total system analysis. These people are responsible for performing system tradeoffs and establishing total system requirements for the program. They must determine the system configuration that will best meet the required customer performance, and determine the complete performance capability of the system evolved.

The Aeromechanics and Materials Laboratory under Dr. Jack Stewart defines the detailed vehicle requirements necessary to meet the system performance in the areas of thermodynamics, environmental control, aerodynamics, flight dynamics, materials and structural mechanics. A continuing program of advanced analysis and technique development insures the placing of new technologies "on the shelf." An extensive laboratory capability insures the validation of the analytical.

The Flight Operations Laboratory is managed by Art Flathers. They provide definition of operations systems and mission and operational analysis for all systems from launch to recovery. Their responsibility includes such things as man-machine relations, flight test, data systems, range measurement, and real time command and control capability.

The Systems Simulation and Energy Management Laboratory is managed by Jack Carpenter. They provide systems analysis and requirements for guidance and attitude control, system design for feasibility studies, computer programming, mathematical analysis; and he also must enhance Department growth in specific technology areas such as energy management, reaction systems and command control techniques.

The man looking to the future is Wes Anderson who is manager of Advanced Technology. He sets priorities and works closely with Marketing in evaluating the total technical market to determine areas where the Section may make its greatest technological contributions. Anderson also manages the Section's investment funds and study contracts.

The section has two consulting engineers. One of them is Dr. Fausto Gravalos, who is a consultant on applied mechanics and has the responsibility for advising and reviewing technical activities in the fields of fluid mechanics and dynamics.

The other consulting engineer is Jim Carroll who specializes in planetary entry problems, providing guidance and consultation on engineering techniques and methods. He carries out early investigations related to new product opportunities, and serves as chairman of the Department DA (Development Authorization) Council.

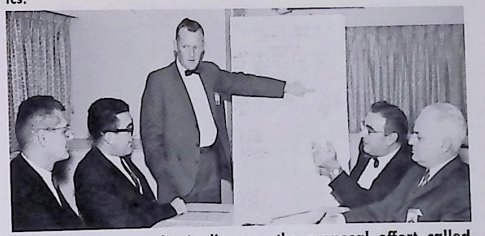
The manager of Administration for the Section is Bob Sheets who handles budget and other administrative functions including manpower planning, personnel records, security, procedures, and facilities and equipment control.

"As far as I'm concerned we have a capability unmatched anywhere," Klima said. "The men, skills, facilities, and measurement tools make us better equipped to give the customer what he wants."

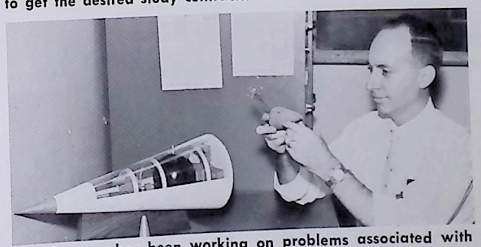
"These skills applied in our systematic procedure for running a program and establishing off-the-shelf technologies minimizes risk in cost and performance on a program. This makes the fixed price contract an acceptable business risk with an attractive profit potential for the Re-Entry Systems Department."

Klima discusses Mark 12 decision points with Dr. Jack Gilstein (right), and Dr. Cos Botje (left), the Mark 12 Systems Engineers. The Mark 12 contract is a challenge to the professional technical man. It is a fixed price contract with the attendant fee commensurate with the risk. Each task must be done to contribute to the end product and is treated as a small fixed price contract.

Jack Carpenter and Rowe Chapman (right), discuss the mission profile for an advanced flight feasibility test which should validate the analytical solution obtained from a study contract performed by Dr. Fausto Gravalos, Consultant-Applied Mechanics.

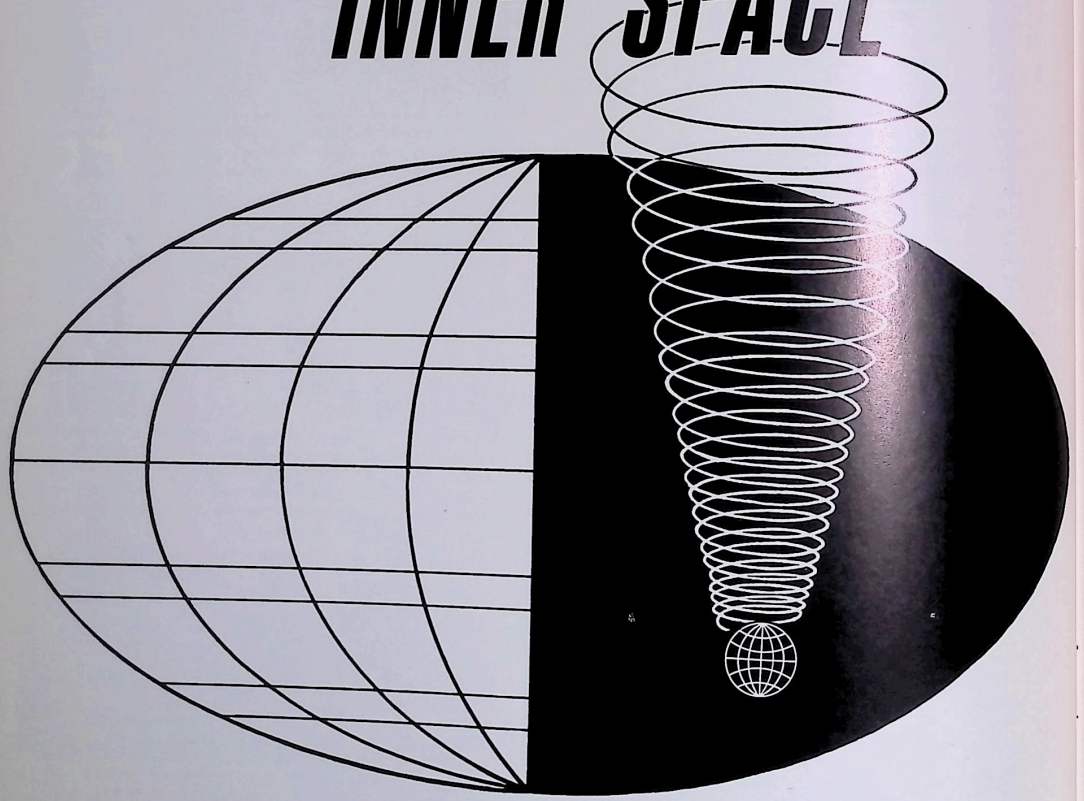


Wes Anderson (standing), discusses the proposal effort called for in our Systems Road Maps, with (left to right) Chuck Jamison, Art Flathers, Jim Carroll, and Ed Hilbert from Marketing. Jim Carroll, Chairman of the Department's DA Council, insures that the company investment dollars put us in a sound position to get the desired study contracts.



Matt Brunner has been working on problems associated with transpiration cooling of re-entry vehicles for some five years. The models shown have been successfully tested in the rocket exhaust at the Malta Test Station. Company investment has put this technique in the "ready for flight testing phase." Dr. Pat Friel, Manager-Radiation and Space Physics Laboratory, and Matt are currently working up the direction of this flight test program.

Conquering INNER SPACE



The earth he's been walking on for thousands of years is more of a mystery to man than outer space.

For thousands of years man has pointed his biggest questions upward into the skies, achieving in the past few years the ability to hurtle a man upward many miles into space to learn its secrets.

The best he has been able to achieve in the other direction is to sink an oil drill bit five miles and a mining shaft two miles. Now some scientists are preparing to look not to *outer* but to *inner* space. They hope that their findings will tell them how the planets were formed, when this took place, and what the future holds for them. There are scores of mysteries to be unraveled from inner earth. For example:

- What creates the earth's strange magnetic field?
- How old are the oceans? Life itself?
- Why are we jarred by a million earthquakes each year? Why do they occur at such great depths as 500 miles? How can we detect quakes like the convulsion in 1556 that killed 830,000 people in China?
- What caused the Krakatoa explosion in 1883, in which a Pacific island actually disintegrated with a blast that hurled rocks 34 miles into the air and used a hundred times more power than the largest H-bomb detonations?
- Why did a 400-mile-long section of the earth's crust sink 1,300 feet in the area of the Dead Sea? Could it ever happen again?
- Do continents wander? Sir Francis Bacon suggested land masses may move about, after he noticed that the coastlines of South Africa and South America roughly "fit" like separated pieces of a puzzle.

Hopefully, in a few years a team of top U. S. earth scientists will begin to get answers to these questions. But first they will have to complete "Project Mohole." They will have to push present engineering knowledge to the limit — and beyond, to drill for the first time through the earth's crust and into its mantle. The precious sample they will then obtain will be studied for years and will yield hundreds of secrets about the earth. Long-held theories about this and other planets, many of them the results of entire lifetimes of work, will be destroyed — or supported — by the small core of rock (no larger than 2 inches) brought to the surface by Project Mohole drillers.

Early Speculation

Speculation, if not much action, concerning the earth's interior, has always been popular. In 1678, a Dutchman named Athanasius Kircher published two weighty volumes devoted entirely to the inner earth. Much of his writing was on "dragons and other darkdwelling beasts," but he also suggested theories of which at least 50 have been since proven by geologists.

The 19th century saw British and German mathematicians Leslie and Euler both writing that the earth was a hollow ball with a separate fiery core at the ball's center. That century also brought Dr. Edmund Halley (discoverer of Halley's Comet), who avowed earth consisted of "three concentric hollow spheres without any openings and with a hot spherical core in the center," and Darwin, who wished "someone would bore a hole so we might see."

The earth, science has since learned, is a solid, but not rigid, ball which weighs 5,887,613,230,000,000,000,000 tons. We also know it get hotter the deeper we descend into it. In the world's deepest gold mine at Robinson, South Africa, the walls are so hot a $500,000 air-conditioning plant had to be installed to keep the miners from being roasted alive. Yet the total heat coming up from below the surface is so slight it is 30 million times smaller than the amount the earth receives from the sun.

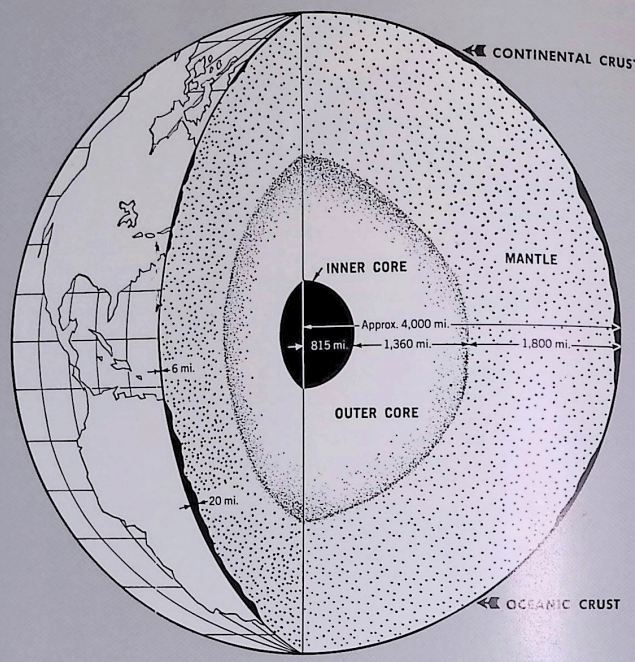
Not entirely unlike their forebears, most modern geologists believe the earth consists of a number of concentric shells of different materials, arranged in the order of increasing density. On the surface there is a thin *crust* of solidified granites and basalt, then the *mantle,* a thick layer of heavier rocks in a fairly plastic state. Next, comes a liquid *outer core.* Finally, there is a solid ball within the liquid, called the *inner core.* This supposed separation of materials probably took place in the earth's early youth. When it was still quite liquid, or even gaseous, the heavier materials easily sank to the center of the ball, where they remain still. The crust cooled off and solidified perhaps five billion years ago, but temperatures in the deep interior are believed to have been unchanged during all this time.

The crust, which varies in thickness from three to 40 miles, is thought of as a thin, comparatively soft veneer of lightweight rocks. Its most abundant metal is aluminum, estimated to make up 7.85 percent of the crust. Beneath the sea the crust's composition differs radically from that under the land masses. The continents are seen as thick blocks of relatively light granite rock, the ocean basins as floored with a much thinner, but heavier basaltic rock. But both crust types act as though they are floating on the much denser rock of the mantle.

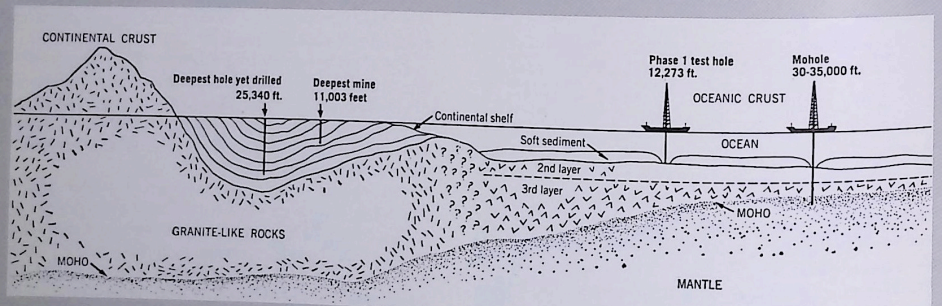
The mantle, comprising 85 percent of the earth's bulk, is, of course, the largest section. It is estimated to be 1,800 miles thick and made of basalt (dark volcanic rock) or something even heavier. We know less about the mantle and the part it plays in our events than we know of the sections beneath it.

The mantle's rocks probably exist under a pressure equivalent to that of 40,000 tons of weight put on a U. S. ten cent piece. This in turn causes mantle temperatures of at least 5000 degrees above zero Fahrenheit. Thus, the rock bends, twists, and possibly even flows like bread dough, and the mantle may well be the reservoir of molten matter that feeds volcanoes. Seismologists are convinced it is where the severest earthquakes originate.

Below the mantle is the earth's outer core. It is about 1,300 miles thick and may consist of liquid iron and nickel. Part of the enormous heat there is caused by the pressure of the above weight, and part is thought to be heat originated when the planet was born.



Scientists believe that the earth's interior consists of several concentric rings, each composed of a different material. They hope current experiments will confirm this theory and reveal even more of the earth's secrets.



Floating in this liquid is the inner core, a solid ball of 1,600 miles diameter which may be made of iron and a little nickel. The pressure (which keeps the ball compressed as a solid) is about 4,000,000 times the earth's atmospheric pressure at sea level. A professor in California is attempting to prove the inner core can be moved. He claims it moved toward Japan as a result of a "kick" supplied by the Chilean earthquake of 1960. He is waiting for another strong quake to produce a "kick" that his university can measure.

Earthquakes (the results of rocks fracturing under stresses) have seemingly proved this crust-mantle-core theory of the earth's composition. Seismologists have observed that when an earthquake wave enters the core, for example, it bends twice, once as it goes in and again as it comes out. From this they've concluded that there **is** a core and that its texture and weight differ enormously from the mantle. Some types of quake waves won't go through the core at all. Scientists studied them and found they won't go through liquid either. Therefore, it seems likely the core is liquid, perhaps as thick as hot asphalt.

Among other clues to the nature of the inner earth, there is the fact that the earth acts like a great magnet. Iron is the magnetic element, so the bulk of the earth should be iron. Meteorites, generally assumed to be pieces of some broken planet, also support the "iron earth" theory.

These come in two categories: meteorites containing up to 90 percent iron and stone meteorites which are similar in chemical composition to the rocks of the earth's surface. The conclusion seems inescapable to geologists that the difference between the two types of meteorites is due to their having originated at different depths of the disintegrated planet and that the earth contains a like composition.

Knowledge Lacking

Although much of the foregoing is not new, the surprising thing is that at this point in world history very little of it has been proven. Until man can journey deeper into earth than he has, or obtain temperature measurements and composition samples, he will simply have no factual knowledge concerning 99 percent of the planet he lives on.

That's why the 1957 announcement of Project Mohole created world-wide scientific interest. Mohole is sometimes described as "a plan to drill a hole in the bottom of the sea." Actually, it is a considerably complicated experiment which will cost the National Science Foundation up to $68 million and probably won't be completed for another several years — perhaps 1967 or 1968.

The plan calls for a hole which would reach through the crust, pass the Moho, and enter the mantle. The project takes its name from the Moho, the popular term for Mohorovcic Discontinuity. The latter is the narrow boundary between the crust and the mantle. It was named for the Yugoslav seismologist, Andrija Mohorovcic, who discovered the discontinuity in 1909 when, during a quake, he noticed the seismic-wave speeds abruptly increased there. Today some geologists believe the Moho was the primordial surface of the earth.

The NSF project directors have decided that the easiest route to the Moho, and thence the mantle, is through the ocean floor. There the crust averages just one third of the average thickness under the continents. While the aim is to sample the mantle, examination of the sediment layers on the sea floor as the drilling progresses should be an important by-product. The layers are believed to contain a continuous record of all life forms that have evolved.

From an ocean site where the crust is only three to five miles thick, the mantle can be reached by a drill-string 30,000 to 35,000 feet long. The string or pipe, would pass through 15,000 to 20,000 feet of water, then about 15,000 feet of crust. The only hole which comes even close to this — a Texas oil probe which came up dry — went down just under five miles — 25,000 feet.

Though there still remain many problems to be worked out, the project's study of American offshore petroleum technology and its own test drillings in the Pacific both have proven the feasibility of using the standard rotary drill common to the oil industry. But this record-depth drilling will entail many peculiar and unprecedented hazards.

For one thing, the floating drill platform will have to maintain its position — perhaps for years — within a 500 foot radius circle in an average of 18,000 feet of water. Even minor drifting could snap the 4½ inch pipe. Radar targets mounted on floats and an array of sea floor stationed sonar targets will help keep the drilling vessel positioned. And to re-enter the hole, an act comparable to threading a needle through 18,000 feet of water, the drillers may possibly use a funnel-type target at the entrance in conjunction with television and still more sonar equipment.

The bold scope of Mohole has sparked international enthusiasm. This was verified when last year the Soviet Union decided also to begin a subterranean study. Thus a race to conquer inner space appears in the making.

The Russians will attempt holes at five land sites — one of them up to nine miles deep — solely in the crust. Although they will be connected with oil and metal prospecting, the principal reason for the holes will be to make scientific discoveries. "Such penetration," asserts the head of Russia's Geology Institute, "is just as grandiose a task as penetrating into the cosmos."

A spokesman for the National Science Foundation in Washington, D.C. is equally confident of the project's success. "All we really know about earth," he has pointed out, "is by indirect methods of geophysics. Now man will receive actual samples . . . to confirm or deny some of his theories." Another possibility is that the first mantle core brought to the earth's surface may also answer questions no one has yet asked.

PEOPLE ON THE MOVE

Tom Shaw . . .

Tom Shaw is a man who believes success is never permanent and neither is failure — and he encourages his people to enjoy a little of each. As Manager of Thermodynamics for the Re-entry Systems Department he deals in heat, and in problems. And out of any particular advancement his crew may make in the "management of heat" may well develop a dozen new problems.

"The more problems we develop, the better it is," he comments, "Providing these are new problems and they lead us to new intelligence. We aren't just in the business of combatting the heat of re-entry into the atmosphere or overcoming other heat problems. What we really are seeking to do is to use heat to our advantage — put it to work for us."

Tom Shaw sometimes talks like a chronic optimist (which he is) and sometimes like a Maine farmer (which he wouldn't mind being), but always like an engineer who finds the difficult enjoyable and the complex irresistible. A versatile manager who has obligations to the Department's program managers, to the customer and to the development of his own people, Shaw would like to "uncomplicate" engineering. He urges colleges to present more about what engineering is all about. "We need to teach that it's a matter of common sense and logic mixed with fundamentals."

He got his common sense and logic and fundamentals at Bowdoin College in his home state of Maine, and at MIT. He feels most engineers should supplement technical courses with touches of economics and business management. Shaw encourages his people to develop their business skills, and their ability to get on their feet and give an acceptable exhibition of communications and poise.

If they follow the leader, they'll do okay. Somewhere in his crowded schedule Tom Shaw finds time to become one of the most requested public speakers in the Philadelphia area. ("I'm selfish — the appearances give me valuable experience in speaking before crowds.")

It's an interesting, exciting world for Tom Shaw.

Dick Katucki . . .

Preparation is the password for Dick Katucki.

"I think the engineering profession is very satisfying," he says, "And I'd certainly encourage my children to follow it. But to be ready to do something worthwhile in this business you have to prepare yourself both academically and through on-the-job learning."

Dick prepared himself well for his current assignment as manager of the PACE (Passive Attitude Control Engineering) Project for MSD's Spacecraft Department. His combination of scholastic achievement at Brooklyn Polytechnic Institute and a dozen years of diversified assignments in General Electric have gotten him ready. Dick puts a high premium on an engineer continuing his education on the job, and he has demonstrated what he means.

After a tour at Lynn, Mass., in the early 50's he participated in the Advanced Engineering Program in Schenectady and also completed the Company's unique System "C" Course. The following year he was asked to supervise the course. An MSD pioneer, he came to Philadelphia in 1956, watched and helped this business grow.

Dick Katucki calls himself an engineering physicist — and got there the hard way. He worked his way through school finishing his final year at night while working full-time days. He believes most any young man can get financially through college if he has the intelligence and ambition it takes. His wife June is no stranger to this business (a B.S. in Chemistry) — she was a mathematician for General Electric on the HERMES Program. She adds different figures these days — 3 (boys) + 1 (girl) = a full schedule. Add to that a husband who not only concentrates on his current job, but is continually getting himself ready for the next one, and you find you have a busy household. One of Dick Katucki's associates may have summed it up best: "He shows a real mental maturity in his approach to the job." It's all a matter of preparation.

Hugh Raymond . . .

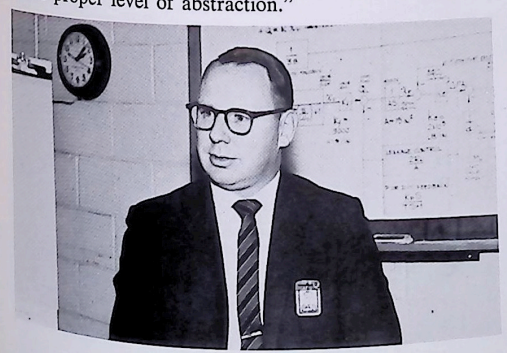
Maybe not, but chances are Hugh Raymond is the only former Royal Canadian Electrical and Mechanical Engineer in the Missile and Space Division. At least he's the only one who is Manager of Navigation and Controls Subsystems Engineering and when you look at his background you get the idea that he's been planning to be just that all along.

He and his people concern themselves with terms like navigation ("The art or science of figuring out where you are"), guidance ("The technique employed in determining where you want to go and how to get there"), and control ("The techniques employed in moving you where you want to go in the most effective and efficient way."). The tasks in this business are complicated, yes, but insurmountable, no. Raymond figures we're getting smarter all the time, and most of the credit goes to the "natural intellectual curiosity of engineers."

There's a certain "love of complexity" among these people, he says, and the challenge of dealing with things they can't see is stimulating enough to lead to the sophistication required. Raymond and his people don't spend their time on far-out futuristic guidance concepts. "Our most important task is to make sure that our current projects work and the demand for reliability is constantly on the increase as each mission gets a little more advanced."

You can run through the roster of Hugh Raymond's career and find milestones like the University of Toronto, a radar and communications stint with the Canadian Army during World War II, Willys Electronics, Minneapolis-Honeywell. These are some of the stops he made. Like his approach to the job, Hugh's approach to his career has been a logical, well-planned series of experiences.

How do we get the best use of engineers? Hugh Raymond's comments, as usual, are brief: "Get them to think at the proper level of abstraction."



John Brainard . . .

John Brainard has probably had to make more decisions about "coffee, tea, or milk" than most any man in America. John is Manager of Field Operations for The Advance Space Projects Department and in the past year has logged over a quarter million miles flying time shuttling between his job on the West Coast and ASPD headquarters in King of Prussia, Pa.

Responsible for the initiation and implementation of all ASPD field activities he must be in close touch with progress and plans back in the Philadelphia area in order to carry out his field assignment. It takes a comprehensive technical knowledge, an ability to organize men and facilities and, of course, an intricate knowledge of airline schedules.

"I was attracted to General Electric because of the obvious abundance of technical talent, and the opportunity to contribute directly at the systems level in the space business. Meeting the customer on his ground to discuss our goals and problems is a rewarding experience. As for the business picture in general, I find that all companies are going through rigid cost analyses — cost is a real key these days."

John is nearing the end of three years with the Missile and Space Division. He advanced from an engineer in Systems Experimentation to Manager of Experimental Engineering and then to his current job. All of this followed better than 10 years with Thompson Ramo-Wooldridge of Roanoke, Virginia.

Being close to the customer, he emphasizes the "need for performance" in all phases of the job. He echoes ASPD General Manager Logan Cowles' plea for reliability, cost consciousness and meeting schedules.

John Brainard in three short years has exhibited the know-how, the talent, the managing skills that have won him admiration from customer and company officials alike — and airlines people.

challenge and response . . .

A Message on Space . . .

• We were enthralled by the fall issue of "Challenge," particularly President Johnson's statement. We have been assembling data for a long time indicating the reluctance of the public to accept the need for space and their feeling that every other dollar that was spent was thrown away on the space effort.

This is the first time that we have seen the space cost put in a perspective that made sense. We would like very much to carry this in all of our house organs and wonder if you can give us the approval.

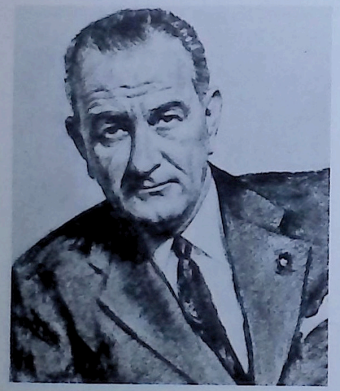
R. O. Day
Advertising Manager
Thiokol Chemical Corporation
Bristol, Pennsylvania

• I was recently elected as editor of "The Register", a publication of our national honor society in chemistry, Phi Lambda Upsilon. Our publication is issued twice yearly and includes information concerning our active chapters and non technical articles of general interest to our members.

Is it possible to obtain permission to reprint President Johnson's message?

Dr. Thomas J. Clark
National Editor — The Register
Detroit, Michigan

■ *These letters are typical of the many received praising Lyndon Johnson's message about the space program in the Fall issue of "Challenge." Permission was granted to all such requests.*



President Lyndon B. Johnson

Space Sciences: The Not So Silent Partner

• The article about the "conversation" with my son, Edgar M. Cortright, was most interesting. The library of his alma mater in Jenkintown is anxious to have a copy.

If possible will you mail a copy to the Librarian at Jenkintown High School.

I read the article while visiting my son in Bethesda.

(Mrs. E. M.) Janet P. Cortright,
Jenkintown, Pennsylvania

■ *Thank you for writing, it was a great pleasure to hear from you. As you requested, copies have been sent to the Librarian at Jenkintown High School.*

• We appreciate your kindness in sending us a copy of the fall issue of "Challenge". The lead article was of particular interest because the material was prepared by one of our graduates here at Jenkintown. The other articles were also of value to our science teachers and students.

We would be happy to receive copies of this publication in the future.

John E. Rice
Supervising Principal
Jenkintown School District
Jenkintown, Pennsylvania

Smithsonian Report . . .

• This will acknowledge, with thanks, the set of seven photographs of the young couple at the National Air Museum, looking at missile exhibits. They are all charming — it comes as a shock to me, even yet, that a generation is growing that takes space travel matter-of-factly, as my own generation embraced Radio!

(Mrs. Robert H.) Esther C. Goddard

■ *Mrs. Goddard is the widow of rocket pioneer Robert H. Goddard.*

• My sincere thanks for the copies of "Challenge". It was a source of pride to me to be associated with you in this endeavor. We consider your magazine to be one of the outstanding publications which are issued by the various industries. The content and format are always a source of pleasure and I look forward to each issue.

Kenneth E. Newland
Curator
Smithsonian Institution
National Air Museum

Career Guidance Panel . . .

• Many thanks for the copy of "Challenge" and for the material on GE's cooperation with Rev. Leon Sullivan's training and research project.

John A. Hurley,
Bureau of Labor Standards
Regional Youth Consultant
U.S. Department of Labor
New York, N.Y.

Generally . . .

• Today I was delighted to be given a copy of "Challenge". We are most appreciated of your usage of Strathmore Pastelle on the cover, and to say the least, we are elated with the results that you have achieved.

Aside from the fine printing and sharp die cutting which the piece displays, the thought that went into the layout and the planning must also be recognized as quality art.

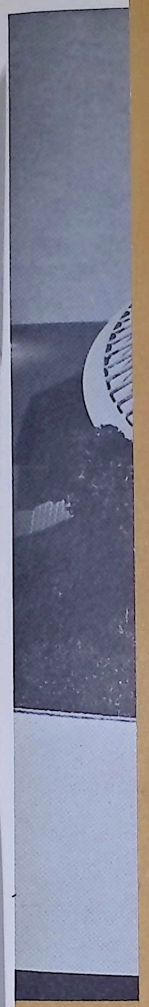
Finally, congratulations once again on an outstanding job and many, many thanks for utilizing Strathmore Pastelle for such a handsome presentation.

John M. Pierce,
Strathmore Paper Company
West Springfield, Massachusetts

• I have had an opportunity to read the Fall 1963 issue of *Challenge*. May I obtain a set of back copies of this publication?

This is a very interesting publication indeed. It contains some articles I would like to display on our bulletin board for the benefit of our engineering students.

Edward V. Krick
Associate Professor of Industrial Engineering,
Lafayette College,
Easton, Pennsylvania



FACT

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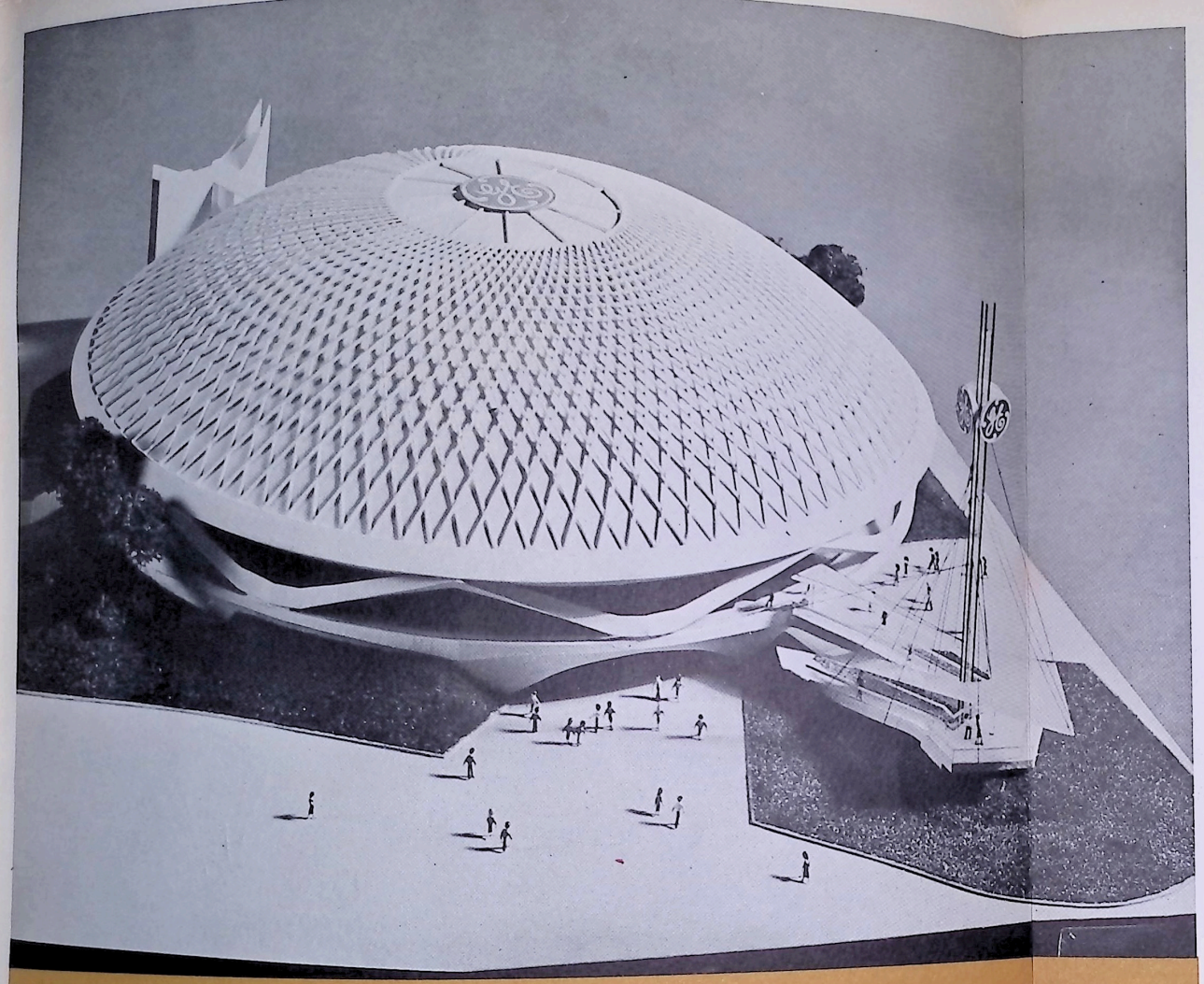


"Progressland" — How General Electric Company's Pavilion at the New York World's Fair will look when completed. The Pavilion was created by Walt Disney for General Electric. Its 200-foot-diameter dome will be crowned with more than 1,000 lights providing a special night-time effect in which the entire roof will seem to rotate. Rising 80 feet high, the three story building is the first of its kind in the world.

FACTS ABOUT PROGRESSLAND

WHAT ARE THE SIGNIFICANT HIGHLIGHTS OF PROGRESSLAND?

1. A demonstration of thermonuclear fusion, the first ever witnessed by a general public.
2. A programmed show that uses Disney-designed "audio-animatronic" figures — talking, moving humanlike replicas that are remarkably lifelike and entertaining.
3. A unique dramatization of nature's energy sources that uses the entire inside of the curved pavilion dome as a projection screen. Some 87 specially designed projectors, controlled by intricate tape programming, will be used in the "Skydome Spectacular".
4. A unique architectural design that marks the first time certain advanced structural and construction techniques have been used.

WHAT IS THE THEME OF THE PROGRESSLAND EXHIBIT?

Progressland ties in with the World's Fair by using the theme "Peace Through Understanding; Progress through Electric Power". It will interpret, in an educational and entertaining way, the role electricity has played in the betterment of man's living conditions. In a dramatic climax, it will show where man's work with electrical power may go from here.

WHO CREATED PROGRESSLAND?

Joint teams from the General Electric Company and Walt Disney's WED Enterprises, Glendale, Calif.

OTHER FEATURES OF THE WORLD'S FAIR

- LOCATION: Flushing Meadow Park, Queens, N.Y., (same site as for the World's Fair of 1939-1940, and less than one day's drive for 50,000,000 people). Mailing address is Flushing 52, N.Y. Telephone: area code 212, WF 4-1964.

- DATES AND HOURS OF OPERATION: from April 22, 1964—October 18, 1964; and from April 21, 1965—October 17, 1965. Open daily (including Sunday) from 10 a.m. to 10 p.m. (some night spots are open until 2 a.m.).

- OBJECTIVES:

A. an exhibition of the best work and products of all nations
B. a performing arts program jointly sponsored by the Fair and Lincoln Center for the Performing Arts, Inc.
C. celebration of the three hundredth anniversary of New York City
D. completion of the metropolitan arterial system
E. entertainment
F. restoration and improvement of Flushing Meadow Park.

- SPONSOR: N.Y. World's Fair 1964-65 Corp., a private, nonprofit organization headed by Robert Moses, President.

- THEME: "peace through understanding." The fair is dedicated to "Man's achievements on a shrinking globe in an expanding universe."

- PREDICTED ATTENDANCE: 70 million people; however, based on the success of the Seattle's Fair, predictions have ranged as high as 100 million.

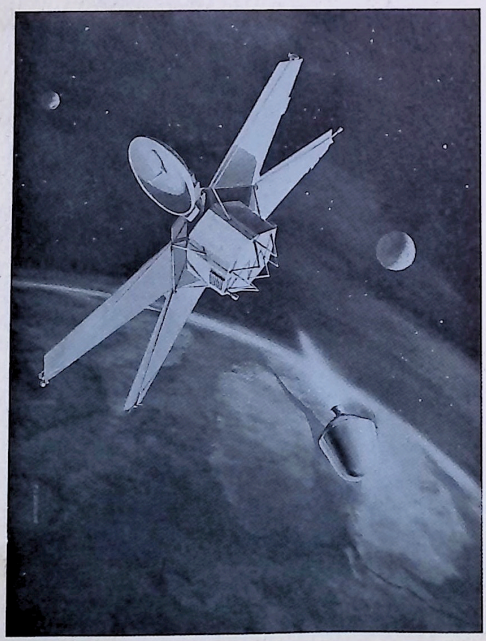
- ESTIMATED COST OF THE FAIR: $1,000,000,000 — over one-half of this is in structures and materials. The fair was financed by the sale of $35,000,000 worth of 6% promissory notes sold to private investors. Other financial facts: estimated costs to be borne by the fair — $131,600,000; estimated revenue — $184,710,000; reimbursement of New York City — $24,000,000; and estimated surplus — $29,110,000.

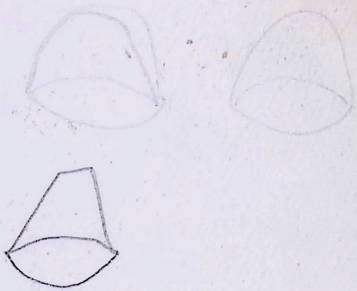
- EXHIBITORS: More than 45 foreign countries from 5 continents will have booths (more than any other exposition). There will be more than 32 states and 240 industrial companies — more than 30 of these companies will build pavilions of their own; (for example, General Electric's Progressland). The remainder are making use of multiple-exhibitor pavilions. In addition, for the first time there will be religious pavilions highlighting the "Peace through Understanding" theme.

- WORLD'S FAIR SYMBOL: the symbol is the UNISPHERE, a global representation of the world. Towering 14 stories high, this stainless steel symbol will live on for generations. It is being given the Fair Corp. and New York City by U.S. Steel and will stand as a permanent fixture.

I like to be space man landing in the water in a space ship, because it looks exciting.

exciting





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