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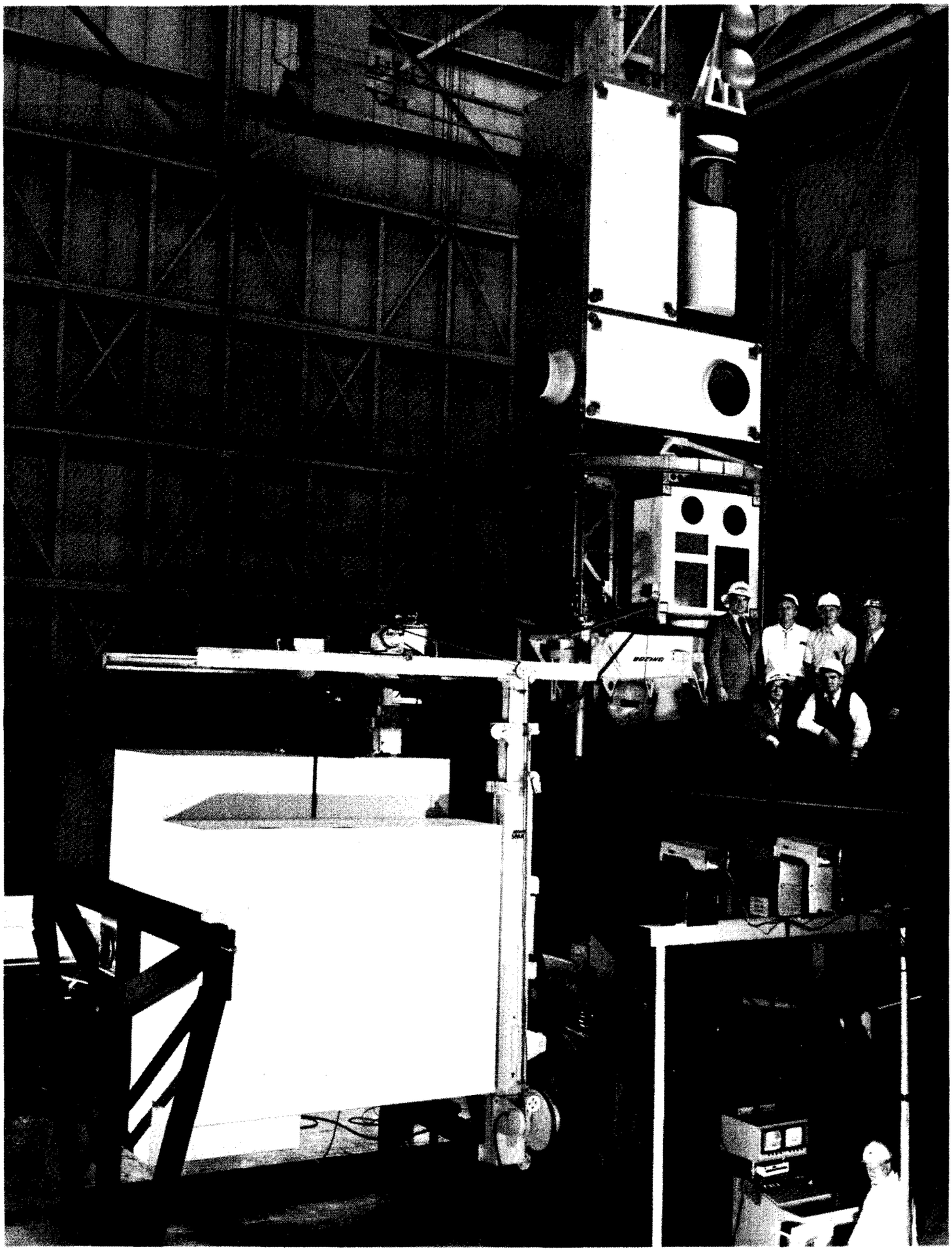

LOW COST MODULAR SPACECRAFT. See caption and story on Page 2.

PAGE ONE CAPTION. The engineering model of the Low Cost Modular Spacecraft (LCMS) at right with a mock-up of the Space Shuttle Module Magazine. Some Goddard employees who played key roles in the development of the LCMS are (from left) standing before the spacecraft: William H. Browne, Jr., Aerospace Engineering, Spacecraft Engineering Section; Burton N. Kelbaugh, Head of the Sheet Metal and Welding Section; Edmund Smigocki, Mechanical Engineering Technician; and Maurice Levinsohn, Chief of the Engineering Services Division. Kneeling are John W. Vanderhoof, Production Controller; and Richard Blumenthal, Electronic Technician. At the console at lower right is Leslie Perry, Mechanical Engineering Technician.

Low Cost Modular Spacecraft

New, yet simple hardware developed largely by a team of NASA engineers and small manufacturers from the Washington, D.C. area promises to be a very important and economical addition to the spacecraft fleet which will use the nation's Space Shuttle when it begins operational flights in the early 1980's.

Called a Low Cost Modular Spacecraft (LCMS) with support equipment, the NASA men believe their low-cost achievement, (costing about $250,000 to complete an initial working, mechanical model) will also make future space flight a lot cheaper too. If this concept is ultimately accepted, Project officials at the Goddard Space Flight Center say projected savings could run into the hundreds of millions of dollars over a period of 10 years in comparison with present methods of orbiting spacecraft that once launched, cannot be recovered.

It is expected that some 14 separate satellite missions running up to 1984 could readily use this approach to extend their useful life times, reduce costs and substantially increase the amount of data which are returned to Earth, per invested dollar.

Of course, this is what the Space Shuttle is all about . . . being able to fly into space, put spacecraft in orbit, service or retrieve them then return and land like an airplane. What Goddard engineers have done is to come up with a modular spacecraft that can be carried aloft by rocket or Shuttle to be placed in orbit.

While in orbit the modular spacecraft can be recovered by the Shuttle and held in position on a special platform that fits into the cargo bay of the Shuttle Orbiter. While the spacecraft is held in this position a special mechanism is used to remove malfunctioning subsystems or experiments and replace them with new units brought up from the Earth.

The LCMS consists of an instrument assembly and spacecraft assembly. These assemblies are joined together with a transition ring in such a manner that the scientific experiments or Earth Resources instruments are carried above the ring and the spacecraft subsystems below the ring. The spacecraft subsystems consist of attitude control, power, communications and data handling, and propulsion modules.

Goddard engineers developed the idea originally in attempting to find a way to keep drastically rising costs of expendable spacecraft from continuing to mount. The concept was to develop instrumentation in modules or separate compartments that would perform their necessary functions, but would not cause the whole spacecraft to die when one or two experiments or subsystem components malfunctioned.

The spacecraft subsystems were designed to be compatible with the Delta and Titan rockets as well as the Shuttle. In this configuration the spacecraft can support a multitude of scientific and Earth applications missions without the necessity for costly redesign and development. Also, because the design can be fitted, in different configurations, to the Delta, Titan and Shuttle, the payloads can be placed in orbit in the late 70's and serviced or retrieved by the Shuttle in the early 1980's.

In its operational mode on a Shuttle service or refurbishment mission, the Remote Manipulator System (RMS) of the Shuttle would first capture the LCMS by using its long arms (15 meters or 50 feet) to reach out and pick the spacecraft from orbit. It would then move it into the shuttle bay and place it on the docking platform, hold it securely or rotate it 360° as needed.

Next the onboard Module Exchange Mechanism starts servicing the spacecraft. The MEM consists of electronically-controlled mechanism that can be raised and lowered from the onboard Module Magazine area. This mechanism can take a new module out of the storage magazine, pull a malfunctioning one out of the spacecraft, and replace it with the new one. The malfunctioning subsystem is then stored in the magazine which can then be taken back to Earth for repairs.

Shuttle astronauts observe and control the whole operation from the foreward cabin directly and by closed circuit television. They operate the mechanisms via a simple control console which has two television screens for close observation of the work area. The TV cameras are located in the cargo bay of the Shuttle and on the manipulator arm.

Contractors for the LCMS, under the overall supervision of Goddard, are:

The Middlestadt Machine Co., Baltimore, Maryland, built the experiment modules, spacecraft structure, and transition ring. The H. P. Slack Co., Baltimore, Maryland, built the subsystem module structures and Mega Analytical Research Services, Silver Spring, Maryland, did the major stress and dynamic analysis work.

Spar Ltd. of Toronto, Canada, built the module exchange mechanism. Arthur D. Little, Cambridge, Massachusetts, performed thermal studies. Boeing Company, Seattle, Washington, built the propulsion module.

General Electric Co., of Valley Forge, Pennsylvania, TRW Systems of Redondo Beach, California, and Grumman Corp., of Bethpage, New York, did separate feasibility studies for the spacecraft.

Rockwell International, Los Angeles, which has responsibility for the Shuttle Orbiter did the necessary Shuttle interface studies.

The next step for the LCMS engineering model will be to move it from Goddard to Rockwell's facility at Seal Beach, California, for testing and later it will be integrated with the full scale Shuttle model at Downey, California, for verification tests.

Second Westar in Orbit

The United States' second commercial domestic communications satellite was launched by NASA on October 10, 1974 for Western Union aboard a Delta rocket from Cape Canaveral, Florida.

Like Westar-1 which was launched April 13, Westar-2 traveled first in an elliptical transfer orbit and was then sent into a circular path by the firing of an onboard rocket motor a few days later. Its final position will be 22,300 miles above the equator at an assigned location of 90 degrees W. longitude with a scheduled move at a later date to 91 degrees.

Once in place and checked out Westar-2 will join Westar-1 to complete an operational fully backed-up system linking the country coast to coast. America's first domestic satellite communication system can reduce cost for some communication services as much as 50% below current rates.

The Westar system is capable of giving technically superior services for large and small users, and will provide the services at rate levels that are among the lowest ever offered by any domestic or international communications satellite facility.

Westar-2's successful launch was confirmed at 7:53 P.M. October 10, when the Guam tracking station picked it up after liftoff.

New British Satellite Studies X-Rays

A United Kingdom X-ray satellite, carried aboard an American rocket, was launched by a team of Italian engineers October 15 from a launch platform off the coast of Kenya.

The spacecraft is the UK-5, fifth in a cooperative program between the Science Research Council of the United Kingdom and NASA. It was renamed Ariel 5 in orbit.

The 131-kilogram (288-pound) X-ray observatory was launched by members of the University of Rome's Aerospace Research Center from Italy's San Marco platform. This launch facility is located in Formosa Bay, approximately 4.8 kilometers (three statute miles) off the coast of Kenya, some two and a half degrees south of the equator.

NASA project management of the UK satellite series is vested in the Goddard Space Flight Center. Project management of the UK-5 by the British Science Research Council is lodged in SRC's Appleton Laboratory at Slough, England.

The spacecraft carries six X-ray experiments—five from the United Kingdom and one from Goddard. These will be used to conduct a systematic survey of X-ray sources both within and beyond our galaxy, the Milky Way, from above the Earth's atmosphere which filters out X-rays from space.

Two of the experiments, located on the side of the spin-stabilized spacecraft, will continuously monitor the entire celestial sphere to provide long-term "looks" at known X-ray sources and detect new ones.

The remaining four experiments, located on top of the UK-5, can be pointed quickly at specific X-ray sources for detailed measurements by maneuvering the spacecraft with an onboard gas jet system by radio command.

The UK-5 experiments will measure the intensity, spectral energy distribution, and time variation of both old and new X-ray sources, especially those undergoing change.

X-ray astronomy became a science in its own right in 1962 with the discovery of the first non-solar X-ray source in space. Since then, about 200 X-ray sources have been catalogued. Many of these sources exhibit totally unexpected properties.

Some of the X-ray emissions greatly exceed all other radiative energy losses.

X-ray astronomers also have found evidence for the existence of a "black hole" companion to a faintly luminous star, Cygnus X-1. Theorists had predicted earlier that certain stars could collapse to an extremely dense state with an extra ordinarily powerful gravitational field—a so-called "black hole." This field is so strong that no object, not even light can escape from the star. The presence of the "black hole" is indirectly revealed when it is part of a binary star system (two stars revolving around each other) and when matter, continuously leaving the other star, falls on the "black hole", is accelerated and emits X-rays.

Most X-ray sources are variable to some degree, and emit some of their energy in sporadic bursts. The few that do exhibit periodicity (bursts at regular intervals) are in binary star systems or are rotating neutron stars. The periodicity of these sources result from binary eclipse or stellar rotation.

Because of its constant viewing capability, the UK-5 will permit scientists to record X-ray source variability as well as new transient X-ray sources which appear, turn bright, and disappear within relatively short periods of months.

When correlated with radio and optical astronomy findings, data from the UK-5 will give astronomers new insight into the mysteries of the high energy phenomena of our galaxy and those which govern the principal physical processes of the universe.

The agreement between the Science Research Council and NASA for the fifth satellite in the UK-series cooperative program was signed in November, 1970. It extended the fruitful cooperation developed in the Ariel 1, 2, 3, and 4 satellite projects, and confirmed the "mutual interest in carrying out a fifth joint satellite project for peaceful scientific purposes."

Goddard participants in the UK-5 project include Herbert L. Eaker, Project Manager; Dr. Stephen S. Holt, Project Scientist; Wilbur C. Nyberg, Project Coordinator; and William F. Mack, Mission Operations Systems Manager. The Goddard experiment was designed and fabricated under the direction of Dr. Holt in the Laboratory for High Energy Astrophysics.

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Successful S^3 Turned Off

After almost three years of operation, a small but scientifically prolific satellite, the Small Scientific Satellite (Explorer 45), was turned off on September 30, 1974.

Also called S^3, the spacecraft has been investigating the causes of world-wide magnetic disturbances associated with large solar flares since shortly after launch on November 16, 1971, from the Italian-operated San Marco Equatorial Range in the Indian Ocean off the coast of Kenya.

Dr. Robert A. Hoffman, S^3 Project Scientist, says the satellite has been working with the sixth Applications Technology Satellite (ATS-6) for the past few months to take advantage of the ATS's synchronous orbit to correlate a local time survey of small magnetic storms.

So far, 17 scientific papers have been published based on S^3 experiments and another 12 have been submitted to publishers. Sixty-eight papers have been presented at major scientific meetings. Dr. Hoffman says that most papers contain data from several experiments on the satellite.

Major accomplishments of the S^3 have been:

- Detailed measurements of the earth's ring current which produces the magnetic storm main phase.
- The first measurement by satellite of man-made stimulated electromagnetic emissions in the magnetosphere.
- The first measurements of alpha particles in the equatorial region of the magnetosphere where they were 100 times more numerous than expected.
- The first detailed analysis of the interaction of electromagnetic waves with charged particles.
- Measurement of the closest approach to Earth of the boundary of the magnetosphere at about 25,000 kilometers altitude.

Several new spacecraft systems were developed by Goddard engineers for the satellite. Project Manager Jerry Longanecker points to an on-board programmable data handling system; a unique ground computer software system to identify and extract data from telemetry; a light-weight, low power automated air-coil attitude and spin rate control system; a power system which has become a standard for Goddard spacecraft; and an especially light-weight structure which again has been adopted by other projects. The data handling system has been so successful that as of September 15 it had been reprogrammed 789 times. Before launch it was thought this would occur about once a month.

GODDARD AROUND THE WORLD

ASCENSION ISLAND. General K. R. Chapman, Commander of the Air Force Eastern Test Range, and his wife Mary were recent guests at the Devil's Ashpit station. General Chapman was visiting Ascension Island on an inspection tour and to conduct change of command ceremonies for the new Base Commander. At right, in front of the station's new dining facility, Station Director Jeff Speck presents Mrs. Chapman with a photo of the island taken from Skylab. Below, members of the party are (from left) Fred Helm, Area Officer, Property Services Agency; Ted McCarthey, Property Services Agency; Barbara Koval, Base Commander's wife; General Chapman; Jefferson Speck; and Lt. Col. Frank Koval, Ascension Island Base Commander.

Contract Awarded for Two Operational Weather Satellites

NASA has awarded to Philco-Ford Corp., Palo Alto, California, a contract to build two weather satellites, identical to its successful Synchronous Meteorological Satellite-1 (SMS-1), for operational use by the National Oceanic and Atmospheric Administration. The contract is valued at $17 million.

The award, made by Goddard, is a follow-on to a previous contract with Philco-Ford for two NASA SMS spacecraft and the first identical NOAA satellite, Geostationary Operational Environmental Satellite-A (GOES-A). The spacecraft to be built under the follow-on contract will be GOES-B and -C.

SMS-1 was launched from the Kennedy Space Center, Florida, May 17 and is presently in synchronous orbit, about 35,680 kilometers (22,300 miles) altitude over the equator just north of the mouth of the Amazon River. Later it will be moved westward to 75 degrees west longitude to provide a view of the entire United States and adjacent Atlantic Ocean areas. SMS-B (SMS-2 in orbit) is scheduled for launch early in 1975 to a position over the equator at 135 degrees east, where it can view the U. S. and adjacent Pacific areas.

Both will be turned over to NOAA for operational use. GOES-B and -C are expected to be launched in the fall of 1976 and the spring of 1977, respectively.

The SMS/GOES spacecraft, in fixed position relative to Earth, can transmit images of the same area day and night every half hour, keeping continuous watch on fast-changing weather systems. These new satellites also can relay information from thousands of sensors located on land and sea and even on airborne platforms, such as balloons.

As part of the Global Atmospheric Research Program (GARP), sponsored by the United Nations and International Council of Scientific Unions, the SMS/GOES spacecraft are expected to be joined, beginning in 1977, by similar spacecraft placed in orbit by the European Space Research Organization, Japan and Russia to form a global network of synchronous orbit satellites.

Goddard Mourns . . .

Richard L. Greene, Head of the Support Planning Section of the Network Planning Branch, died September 13 after a brief illness.

Mr. Greene was formerly a 1st Lt. in the U.S. Army and was a Capt. in Reserve Active Reserve Service.

After the Army, he joined the NASA Lewis Research Center where he spent over six years in the Aerodynamics Branch and in the Launch Vehicles Division of both the Agena and Centaur Projects.

He joined the Goddard staff in 1970 as an MSFN Mission Planner, a post which involved him in the provision of tracking and data acquisition support for the Mariner Mars '71 missions, Mariner Venus Mercury and Atmospheric Explorer programs. Mr. Greene was next promoted to the team responsible for the mission support required from the Spaceflight Tracking and Data Network.

He is survived by his wife, Linda; two sons, Steven and Jeffrey; his parents; and a sister and two brothers.

Charles P. "C.P." Smith, Jr., a member of the Telecommunications Systems Branch, died October 7, 1974.

One of Goddard's space pioneers, Mr. Smith's career dates back to the early days when the Naval Research Laboratory was testing V'2s and Viking rockets. He transferred to NASA with the original Vanguard team. Here his work has included Vanguard, Delta development and communications satellite projects. At one point he was Project Manager for Telstar.

Mr. Smith was born in Kenner, Louisiana. He received his B.S. degree in physics from Loyola University of the South in 1943, and then received a U.S. Navy commission after attending the Midshipman's School at Notre Dame for Navy officers training.

LAND USE TASK FORCE. A review of the capabilities of the Earth Resources Technology Satellite for use in solving urban and regional land use problems in the city of Baltimore and surrounding areas was the topic of a meeting held at Goddard on September 18. Meeting here for the first step in an on-going project were (from left) John Seyffert, Baltimore City Planning Department; Tom Buchanan, Maryland Department of Transportation; Dr. Jane Schubert, Goddard Mission Utilization Office; Jack Anderson and Larry Hennessy, both of the Baltimore Regional Planning Council; Carl Bostrom, Johns Hopkins Applied Physics Laboratory; Henry Foster, Baltimore Regional Planning Council; Warren Anderson and Mark Wasserman, both of the Baltimore City Planning Department; Dr. Stanley Freden, Chief of the Mission Utilization Office; and Tom Golden, Goddard Director of the Baltimore Applications Project.

Goddard Mourns. . .

Samuel Gubin, aerospace engineer and inventor, died of cancer October 15.

During the '30's Mr. Gubin invented a simplified airborne course deviation indicator; he is also co-inventor of an automatically tuned radio transmitter. Both are still in use today. During this period he developed many special transmitters for military applications. He is the holder of ten patents on communications and navigation equipment.

During World War II he directed a group which developed advanced electronics military techniques.

Employed at RCA from 1959 to 1969, he assembled and guided an engineering team which was responsible for spacecraft communications engineering. His leadership contributed to the successful performance of the communications equipment in such space projects as Lunar Orbiter, Nimbus, Navy navigational and TIROS-ESSA satellites. In 1967 he was an invited member of the National Academy of Sciences Study Group on Broadcast Satellites meeting in Woods Hole, Mass. He was a Fellow of the Institute of Electrical and Electronics Engineers.

He had been employed as an electronics engineer at GSFC for the past five years. During the first part of this period he served as Chairman of the Communications Working Group and as Chief, Communications and Navigation Division, which performed research on advanced communications satellite systems. Later he served as a staff consultant to the Spacecraft Systems and Technology Directorate and worked on Technical problems associated with national and international communications satellites.

Born in Russia in 1907, Gubin earned a BS degree at Yale in 1929 and an MS there in 1931.

Survivors include his wife, Betty (Cohen); a son, Jonathan; and a daughter, Deborah Meisels.

Contemporary Issues Special Exhibit

A committee concerned with communication at Goddard will have a special exhibit at the GSFC Library. The purpose of the exhibit will be to notify employees of the availability of non-technical materials of interest. On display will be publications including magazines, newsletters and books on psychology, management, business, federal civil rights legislation, the economy and manpower. The Communications Committee will provide a suggestion box and will review all ideas submitted on the exhibit and questions for further information.

The exhibit will be opened during the week of November 11, 1974.

ATS-6 Provides High Quality Ship Communication

NASA and the Maritime Administration have successfully demonstrated the feasibility of using a satellite for high quality ship-to-shore communications on the L-Band frequencies (1.5 to 1.7 gigahertz). Future operational systems of this type for both maritime and aeronautical application could save millions of dollars by speeding up day-to-day operations.

Certain frequencies in the L-Band range were allocated for operational maritime and aeronautical communications via satellite by the United Nation's World Administration Radio Conference in 1971.

Tests conducted recently with NASA's Applications Technology Satellite-6 (ATS-6), a communications research and development spacecraft, provided high quality duplex voice link data and experience.

The test transmissions originated at the National Maritime Research Center in Kings Point, New York, and were relayed by the ATS-6 to the "American Ace," a commercial container ship. The ship was enroute from Norfolk, Virginia, to Le Havre, France, at the time. All shore and shipboard equipment employed was designed for operational use. Control of the ATS-6 for the tests was maintained at NASA's Goddard Space Flight Center where the spacecraft project is managed for NASA.

Only one of 20 experiments on the versatile ATS-6, the L-Band experiment is designed to demonstrate and evaluate applications of a geosynchronous orbit spacecraft for maritime and aeronautical communications and position location. A spacecraft in a geosynchronous orbit remains over a specific point on the equator until moved by ground controllers.

Information from the current phase of the L-Band tests will be of particular value to the Maritime Administration, which is anxious to evaluate the economic benefits associated with spacecraft communications technology. Specific potential benefits include the transmittal of cargo manifests and documentation prior to ship arrival in port, transmittal of payroll data for shore processing, and the remote monitoring and transmittal of ship machinery performance.

Further tests will be conducted with the ATS-6 L-Band experiment to evaluate several communications and position location techniques, using the ATS-6 as well as NASA's ATS-5 spacecraft, with airborne planes and ships at sea.

In addition to NASA's Goddard Space Flight Center and the Department of Commerce's Maritime Administration, other active participants in the L-Band experiment include the U.S. Coast Guard and the Federal Aviation Agency of the Department of Transportation. The experiment also is international in scope, with participation by Canada's Department of Communications and Ministry of Transport, and the European Space Research Organization.

OPTICAL MICROSCOPIC EXAMINATION of samples is conducted at various magnifications up to 2000X by Carl Johnson (left), Carl Haehner, and Jane Jellison. A 150 Kv X-ray radiographic camera is located in the lead-lined room in the background, and a microhardness tester in the right foreground.

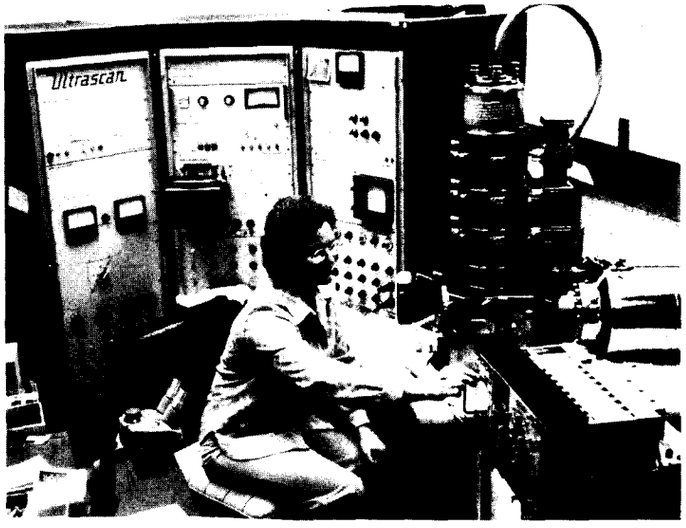
Materials Engineering Services

This article by Alfred J. Babecki, Head of the Engineering Metallurgy Section is the fourth in a series of articles about the services and people of the Materials Engineering Branch.

Metallurgical Failure Analysis

Proper analysis of failed metal components is necessary in order to determine the cause of the failure and to suggest courses of action to prevent their recurrence. In the fabrication and testing of spacecraft hardware, failures of a variety of metal components are commonplace. Such failures range from bulky hardware, such as separation clamp bands and propellant tanks, down to almost invisible components, such as solar-cell interconnects and integrated circuit leads.

The Engineering Metallurgy Section routinely performs metallurgical failure analyses. Its personnel include four professionals with degrees in the metallurgy discipline, and other technical graduates, all of whom have many years of industrial and government metallurgical laboratory experience. These technologists have at their disposal the services of chemical, electrical, and other technologists in the branch. By way of specialized equipment for the failure analysis, the section has a scanning electron microscope with non-dispersive X-ray analyzer; three research metallographs, one with vacuum hot stage and microhardness tester; X-ray radiographic camera; heat treat furnaces; corrosion test equipment; fatigue, tension/compression, and high strain rate testers.



JANE E. JELLISON adjusts the energy-dispersive X-ray analyzer attachment to the scanning electron microscope in preparation for identification of microconstituents on a sample. Elements above the atomic weight of sodium can be detected, and useable magnifications up to 20,000X can be achieved.

METALLURGY TECHNOLOGISTS (from left) Al Babecki, Carl Haehner and Carl Johnson, prepare metallographic samples for microscopic examination by polishing and chemical etching techniques. Mirror-smooth surface finishes are achieved in order to delineate grain boundaries, microcracks, and other microstructural features. Hardnesses of microscopic areas can be determined.

In pursuing the failure analysis, the section metallurgists first examine the failed component visually at various magnifications in order to ascertain the extent, origin, and mode of failure. This examination may involve various microscopes, including the SEM, with magnifications up to 20,000X. If corrosion is involved, any associated corrosion product is removed for chemical analysis. Then, one or more specimens from the failure are examined metallographically to learn if there were deficiencies in the metal. If sufficient sample exists, mechanical tests are performed on the failed material in order to determine its properties and ascertain if they conform to specification or requirements for the application.

Sometimes, in order to determine the cause, the failure must be duplicated in the laboratory with similar material. Recently, Jane Jellison conducted fatigue tests on BeCu wire in order to compare the fatigue-failed surfaces of those specimens with the surfaces of RF connectors that were failing on the SMS spacecraft, or were found cracked in the new condition. The comparison suggested that the connectors had pre-existing cracks probably produced by fatigue.

Too often, failures of metal components at contractor's shops are not analyzed but, rather, the part is simply replaced, only to recur a second time. This is so, in many cases, because the contractor, or vendor, does not have a materials or metallurgical laboratory. In the recent past, the Engineering Metallurgy Section performed numerous metallographic analyses of heat pipe samples for the ATS program because the vendor did not have the capability. Because of these examinations, Carl Johnson and Jane Jellison were greatly instrumental in improving the quality of the pipes.

Besides the analysis of failed spacecraft components, the Engineering Metallurgy Section cooperates with other centers, tracking stations, and other government agencies by analyzing their failures. Recently, Chuck Vest analyzed a number of cracked wheels from Quito Tracking Station vehicles, and determined that it was a stress corrosion problem that could be prevented by maintaining a coat of paint in the susceptible areas. Al Babecki analyzed a number of shipboard missile launcher failures for the Navy and a gear failure problem on armored vehicles for the Army.

In addition to failure analyses, the section can perform examinations to verify the service suitability of a component. In that regard, John Grimsley and Carl Johnson routinely radiograph sounding rocket sections that are recovered from flight in order to ascertain if they are reuseable. Carl Haehner and Charles Vest frequently disassemble and perform high magnification examination of ball bearings to look for subtle defects and to evaluate the ball and race surface finishes and, thus, determine their suitability for long life in spacecraft.

The capabilities of the Engineering Metallurgy Section to perform metallurgical failure analyses or to determine metallurgical quality of spacecraft hardware are broad. It behooves program managers and system technical officers to make frequent use of these capabilities. The cost is minimal, but the savings can be maximal. For more information, contact A. J. Babecki, X4833.

500,000 Green Dots?

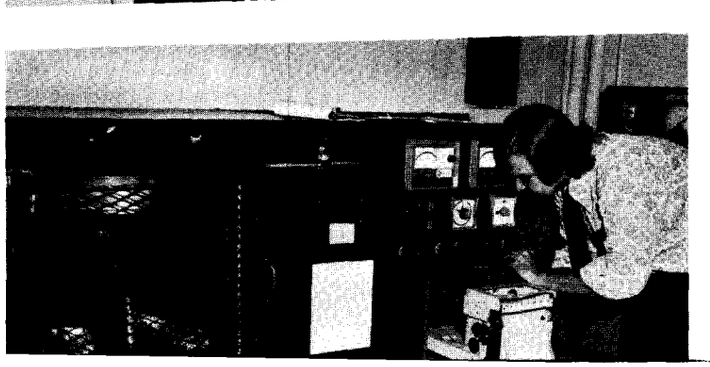
By Winslow Womack
Head of the Inspection Section

Yes, over 500,000 green dots have been used to identify electronic parts that have been tested by the Inspection Section of the Quality Assurance Division for the IUE, ISEE and AEM projects. The tests performed have involved both screening and acceptance tests which consist of a variety of functional and environmental tests.

For over three years now the Inspection Section has been conducting screening and acceptance tests for many of the Center projects but the peak workload came when it was decided late last year to have all parts for IUE - ISEE - AEM, being purchased on a commonality buy, tested in-house. The over 500,000 parts that have been tested to date have ranged from the ordinary passive devices such as resistors and capacitors to very complex linear and digital microelectronic circuits.

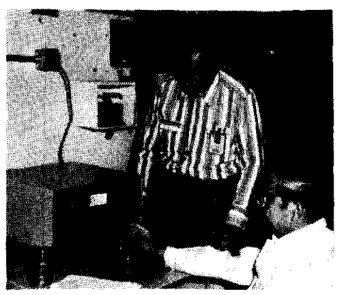
The Parts Branch of the Quality Assurance Division recognized the need for an in-house acceptance and screening test capability for electronic parts over three years ago and has made a concerted effort to accomplish this goal through the procurement of new test equipment.

An Optimized Devices Model 6000 Linear Integrated Circuit Tester has recently been installed. This test system uses a DEC PDP 8 computer in an interactive mode to generate test programs and control the testing sequence. This system is capable of testing operational amplifiers, voltage regulators and comparators. Recently a Tektronix Model 3260 Digital Integrated Circuit Tester was delivered and is undergoing acceptance testing. This system is also computer controlled and will perform DC and AC parametric tests as well as functional tests on devices having up to 40 leads. In the area of DC parametric testing, leakage currents as low as 10 pica amps can be measured. This measurement requirement was brought on by the many C/MOS devices now being used on the Center. A Teradyne T241 transistor and diode tester has been in operation for the last two years. This system is also computer controlled and has a scanner attached that allows parametric measurements to be made on up to 50 devices in a thermal chamber at either high or low temperature. A 10' x 14' shielded room has been constructed and equipment obtained to perform parametric or high power burn-in tests on RF power transistors at room or elevated temperature at frequencies as high as 8 GHz.



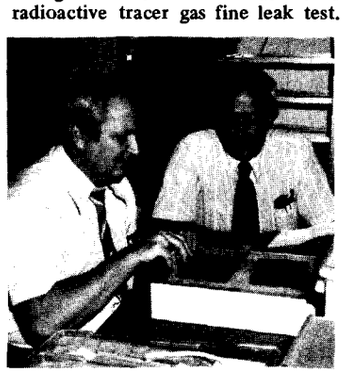
TEST ENGINEER Lenny Rosenberg (left) and Winslow Womack, Head of the Inspection Section, discuss a test program being generated on the new Linear IC tester.

SHARON BRISCOE applies tiny green dots to a group of inductors.



GEORGE CLAWSON (left), Mission Technical Monitor, observes with George Traversone the results of a radioactive tracer gas fine leak test.

BOB FRASER (right) reviews with Joe Johnson, Test and Inspection Mission Supervisor, an acceptance test being performed on the new digital IC tester.



IUE PARTS ENGINEER Perry Hason (right) reviews final data with test engineer John Yakupkovic.

A radioactive tracer gas leak detection system manufactured by Trio-Tech has just been delivered and when installed will greatly increase the fine leak test capability. Within the last two years an automatic temperature cycling chamber has been installed. This equipment can be programmed as to the number of cycles and temperatures required. A considerable amount of test fixturing has been designed and fabricated to conduct burn-in tests on a variety of electronic part types. Ovens have been purchased so that many of these part types can be burned-in at elevated temperatures.

The addition of more sophisticated test equipment to the lab as well as requests to test more complicated part types brought about the need to increase the technical expertise of the lab personnel. This has been accomplished and today the lab is extremely well equipped and is capable of testing most any electronic part type to any test procedure or specification. The operation of the lab is performed by the Sperry Rand Corporation under a mission type contract to the Quality Assurance Division.

Anyone interested in having work performed by the lab should contact George Clawson (x2339) or Winslow Womack (x5625).

CARL MIELNIK (left), Lab Operations Supervisor, checks the status of IC's undergoing a burn-in test with IUE parts Engineer Bob Wilkinson.

MIKE FISHER sets temperature fail safe mechanism on temperature cycling chamber prior to a test.

Space Pictures May Help Measure Rainfall

CECILIA GRIFFITH of the NOAA Experimental Meteorology Laboratory in Miami explains how she measures rainfall accurately by comparing satellite imagery from ATS-3 with radar scans of the identical area at the same time.

A young weather researcher using an aging NASA satellite is fast approaching a breakthrough in accurate measurements of Earth's rainfall from space.

The researcher is 25-year-old Cecilia Griffith of the National Oceanic and Atmospheric Administration's Experimental Meteorology Laboratory (EML) in Miami, and the satellite is Goddard's Applications Technology Satellite-3 (ATS-3) launched into synchronous orbit (22,300 miles in altitude) in 1967.

Rain gauges, which catch rain and are regularly monitored by human effort, presently are the most accurate and commonly used means by which to measure the extent of a rainfall. The large number of people required to tend and service the gauges, however, limits the usefulness of the device in remote, unpopulated regions. A method of rainfall measurement other than the maintenance and reading of rain gauges is needed in inaccessible parts of developing countries to provide the flood warnings often vital to the low-lying, populated regions in the path of floodwaters.

Ms. Griffith's rainfall research, for the past 18 months under the direction of Dr. William Lee Woodley, who is acting director of EML, has been concentrated on comparisons of ATS-3 imagery with radar scans of the identical area at the same time, to obtain measurements of cloud size and brightness. Clouds visible in the satellite pictures are color coded according to degree of brightness and corresponding radar echos are matched. The study has shown that when a cloud reaches a specific level of brightness, the chance of precipitation within that cloud is 50 per cent. As brightness increases, so does the precipitation probability.

Earlier studies by Dr. Woodley showed a distinct relation between the amount of rainfall associated with an echo and the area of that echo as measured by radar. Experimenters subsequently sought to link the relation of rain volume in the radar echo area to cloud brightness and cloud area as measured by the ATS-3.

The cloud echo relationship is still under study, but a preliminary test of the rainfall measurement method recently made in EML's experimental (4,800-square-mile) seeding area located in central Florida showed favorable early results. The area is well instrumented with rain gauges.

Volume of rainfall was computed by two methods, the first using satellite images, the second by a combination of radar and the rain gauge readings. The satellite computations proved to be within a factor of two of the radar-gauge volumes.

After the derivation is computed the method will be tested in other areas of the tropics and sub-tropics. If successful, accurate rainfall measurements in remote mountainous areas, for example, would give urban and farm populations ample time to prepare for high or flooding rivers fed by mountain streams.

Developing countries, now unable to afford extensive rain gauge networks, could improve their predictions of national agricultural output on the basis of the amount of rainfall. They also could plan hydrology projects, such as dams or other flood-control projects, and achieve a better understanding of the economic impact of the country's water resources.

INTERESTING PEOPLE

Dan Pendleton: Pedal Steel Guitarist

DAN PENDLETON plays his pedal steel guitar.

Dan Pendleton's "hobby" is also his second profession—he is a widely respected pedal steel guitarist with local singer Emmy Lou Harris, who recently signed a four-year recording contract with Warner Brothers. Dan has also worked with many nationally known artists, including Linda Ronstadt, Leo Kottke, Roy Clark, Steve Goodman, Souther, Hillman & Furay, Little Feat, Bonnie Raitt and Bill & Taffy Danoff, writers and singers of "Take Me Home Country Roads" with John Denver. He recently has also done some recording in New York with Linda Ronstadt.

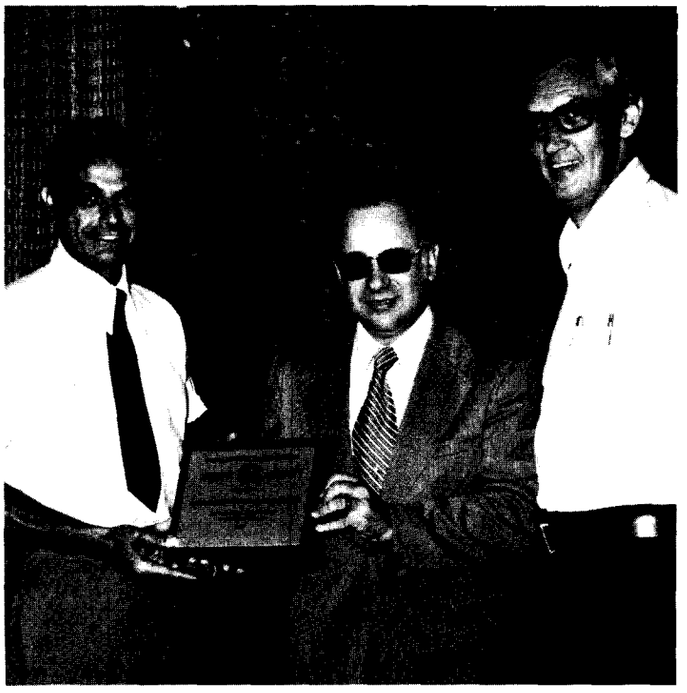
Dan says he began playing pedal steel guitar in 1955. He played professionally until 1967, including a weekly one-hour TV show during 1957-1959, and then quit for seven years before taking it up again recently "just for fun". "We usually play various clubs around town several nights a week," he says, "and shortly we will begin recording Emmy's first solo album."

At Goddard, Daniel M. Pendleton is best known as Head of the Transportation Branch, a post in which he manages Goddard's motor vehicle, freight traffic and mailroom functions. He came here in 1960 from the Department of Agriculture, and has also served as Head of the Administrative Communications and Administrative Support Branches.

Besides music, his pastimes include photography, golf and the Redskins. He also has begun pursuing a B.A. degree in evening classes at the University of Maryland.

His wife Peg is employed at the National Security Agency and they presently reside in Crofton, Maryland.

Sciences Zero-In-On Safety Awards



DIVISION AWARD. Dr. Siegfried Bauer, Associate Chief of the Laboratory for Planetary Atmospheres, recently received a Zero-In-On Safety Award in behalf of all employees in his laboratory. The award was presented to the division that achieved the best safety record in the Sciences Directorate in 1973. Presenting the award are George E. Abid (left), Assistant to the Director of Sciences and Code 600 Health and Safety Protection Council Member; and Dr. George F. Pieper (right), Director of Sciences. The purpose of the Zero-In-On Safety Program is to reduce the number of injuries and other losses on Center through a concentrated attack on the causes of accidents. The awards recognize achievement contributing to the goal of accident reduction and the improvement of Goddard safety practices.

INDIVIDUAL AWARD. Dennis C. Evans received an individual Zero-In-On Safety Award for his part in establishing an alarm system at the Goddard 36-inch Observatory to protect astronomers who often work alone at night. Presenting the award are Mr. Abid (left); Dr. Anne B. Underhill, Chief of the Laboratory for Optical Astronomy; and Dr. George Pieper (right).

VALERIE THOMAS, a mathematician and data analyst in Goddard's Information Processing Division, was one of more than 300 black professionals gathered to participate in the National Technical Association's symposium on "Blacks in Science and Engineering" held at the Sheraton Hotel in Cleveland, Ohio, on October 10 and 11. The symposium, sponsored by the Cleveland chapter of the NTA, offered leading black professionals from 37 states an opportunity to communicate and to address themselves to the problems particularly unique to minorities entering the scientific field. On the second day of the symposium, 150 students from the Greater Cleveland area schools attended to listen to the formal presentations and later take part in an informal discussion with all the speakers.

Utilities Conservation Good News! Bad News!

By David G. Lewoc
Assistant Chief
Plant Operations and Maintenance Division

First the good news: Goddard was successful in reducing its FY 74 energy usage over that of FY 73 by the following amounts:

Usage Reduction:

Utility	FY 74 Over FY 73
Electricity	-12%
Oil	-59%
Gas	-3%

Now for the bad news: Despite the reduced usage indicated above, Goddard had to pay quite a bit more for its energy in FY 74 than in FY 73.

Cost Increase:

Utility	FY 74 Over FY 73
Electricity	+24%
Gas	+16%

The cost of oil in FY 74 decreased by only four percent over what was paid in FY 73, and considering that the usage decreased 59 percent, the four percent simply isn't that impressive. Costs are continuing to climb. For example, July and August 1974 electricity usage is down 14 percent but costs are up 69 percent from July and August 1973. July and August 1974 gas usage was constant with gas usage in July and August 1973, but the cost this year is up 46 percent. And, while the amount we spent on oil in July and August 1974 dropped a healthy 56 percent below that spent during the same period in 1973, the usage dropped to an even healthier 83 percent!

Well, one more piece of bad news: Goddard has been notified by the Washington Gas Light Company that as of December 16, 1974, (and continuing through the spring) all natural gas services will be suspended to the Center. Consequently, we will use fuel oil and will have to pay the $0.40 to $0.42 (and constantly climbing) rate per gallon.

Howard Galloway Named India SITE Representative

HOWARD L. GALLOWAY, his wife Dottie (right) and their "adopted" daughter Mumtaz Sunderji say good-by to their friends at a party held in their honor at the Fireside Inn on October 22. (Photo by Gilbert Bullock.)

Howard L. Galloway of Goddard's ATS Project has been named NASA Resident Representative for the United States/India Satellite Instructional Television Experiment (SITE). He left on October 25 for a stay of about one-and-half years in Ahmedabad, India, and was followed a few weeks later by his wife Dottie and their "adopted" daughter Mumtaz Sunderji.

The SITE program will begin around August 1, 1975, and will use the Applications Technology Satellite-6 (ATS-6) to relay instructional and educational programs to over 5,000 villages in remote parts of India. Villagers will receive instructions on such things as planning the size of their families, nutrition, hygiene and home economics; farmers will be instructed on modern methods of agriculture; students and teachers will receive educational programs; and other cultural, national integration and news programs will be transmitted.

These programs will be created by agencies of the Indian Government and transmitted to ATS-6 by Indian ground stations at Ahmedabad and Delhi for relay to the villages. Since ATS-6 belongs to NASA and the ground stations and receivers are owned by India, Howard Galloway will act as coordinator between Indian participants and NASA personnel to assure smooth operation of the experiment.

Mr. Galloway is well equipped for the job of SITE Project Resident Representative since he has already had extensive contact with the Indians. This came about several years ago when he went to India to participate in an international seminar as a guest speaker on sounding rockets at the Thumba rocket range. He lectured to a group of Indian scientists and engineers and his outgoing personality and thoughtfulness endeared him to all who met him, including the then Chairman of the Indian Atomic Energy Commission, Dr. Vikram Sarabhai. Dr. Sarabhai took Mr. Galloway into his home during his stay in India at that time.

As NASA Resident Representative, Mr. Galloway will coordinate all activities of the experiment between the Indian space agency and NASA. The task will range all the way from what is to be done in the villages to commitment of ATS-6. He will act as liaison between the SITE project at NASA Goddard and the Space Application Centre of the Indian Space Research Organization. He will keep NASA informed of the progress of the experiment and help the Indians solve problems as they occur. He will do everything possible to make the experiment a success and will be the sole NASA representative in India.

Professor Heath Riggs Spends Sabbatical Here

DR. HEATH K. RIGGS (center), Professor of Mathematics at the University of Vermont, meets with Dr. Carmelo Velez (left) and Robert T. Groves of the Mission Support Computer Analysis Division to discuss his sabbatical year at Goddard.

Dr. Heath K. Riggs, Professor of Mathematics at the University of Vermont, is spending his sabbatical year here at Goddard working on problems of space mathematics. His objective is to learn the types of mathematics encountered in orbiting of satellites and in their attitude determination and control. Upon return to Vermont in September 1975, he hopes to offer a course dealing with these subjects.

In 1960 Dr. Riggs organized the first computing center on the University of Vermont campus. He taught the first courses on computing to be offered at the University to both faculty and students. In recent years he has worked in the field of numerical analysis at the University. Numerical analysis takes higher mathematics and converts it into a form from which mathematical problems can be solved on a computer.

He was a Visiting Scholar in numerical analysis on his sabbatical at the University of California in Berkeley in 1965-66. His present sabbatical at Goddard uses numerical analysis to assist in solving space problems.

"Orbit determination of earth satellites and their proper pointing toward specific areas on earth are accomplished through complex mathematical procedures," Riggs stated. "When satellites point properly toward earth, they can be used in intercontinental TV and telephone communication, weather prediction, land use planning, pollution control, location of natural resources, and estimation of size of forests and crops throughout the world. Since space is one of the new frontiers, college students should have a knowledge of how mathematics enter into the space field."

He is working under the supervision of Dr. Carmelo Velez and Eugene Lefferts of the Mission Support Computer and Analysis Division headed by Robert T. Groves. This arrangement was worked out by Mr. Elva Bailey, Educational Programs Officer at Goddard.

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