GODDARD NEWS

GODDARD SPACE FLIGHT CENTER / GREENBELT, MARYLAND

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Goddard Ceremonies Honor 3 Years of Tiros Successes

A three-year milestone in the Tiros success story was officially recognized April 18 when the Tiros team received NASA's group achievement award in special ceremonies in building 3.

The occasion marked the third anniversary of the launch of Tiros 1 from Cape Canaveral, on April 1, 1960.

Presented by Dr. Harry Goett, Goddard director, to W. G. Stroud, chief of the aeronomy and meteorology division, the award noted the "outstanding competence demonstrated in developing and successfully operating the first meteorological satellite system, project Tiros." The award was signed by James Webb, NASA administrator.

On hand were many of the 47 members of the project Tiros group from the aeronomy and meteorology division and a good share of the 26 project support personnel representing administration, testing, tracking and data systems, procurement, finance, and launching.

Dr. Goett took the occasion to note that this indeed was a significant milestone in the growth of Goddard.

"I think the first generation of Goddard has now come of age," Dr. Goett declared. "We have gained the reputation that in 1960 we had just begun to make."

Mr. Stroud, in accepting the award for the group, stressed the role of the individual in group achievement. He said he did not consider that "we are rewarding an amorphous and anonymous mass," that in some way manages to accomplish things. "Creative men and women work for an ideal . . . not for another man or an organization."

Mr. Stroud noted the individual contributions of many team members as they came to the platform to receive miniature replicas of the group achievement award.

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Dr. Harry Goett presents the Tiros group achievement award to W. G. Stroud. Additional pictures on page 8.

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Fair Features Space Age Photography

A picture of the east coast of the U. S. taken by a camera in the Tiros VI meteorological satellite from more than 400 miles in space and relayed from Wallops Island, Va., directly to the New York Coliseum opened the 1963 International Photography Fair.

Keynote speaker for the opening ceremony was Bob Rados, Goddard's Tiros project manager. The east coast picture—taken less than an hour before — was presented by Rados to Anita Gillette, Broadway star of Irving Berlin's "Mr. President."

Cutting the ribbon to open the Fair were Bob Rados, Anita Gillette, and Col. A. L. Lucas, U. S. Marine Corps.

Purpose of the dramatic opening was to demonstrate the progress of photography from the world of Louis Daguerre to the age of space.

Sheldon Ritter, key Fair official, said that "the demonstration of Tiros' unique capabilities in relaying pictures from space symbolizes the advance of photography in this scientific age."

More than 75,000 persons attended the 1963 Photo Fair. A feature of the event was an exhibit prepared by the public information office which described the Tiros program and how earth cloud cover pictures are received from space.

Ernie Powers, Tiros coordinator, arranged for transmission of the Tiros pictures directly to the Coliseum. Assisting at Wallops Island were Charles Lundstedt and Joe Robbins.

Tiros Has Been a Real 'Camera Bug'

Tiros, NASA's first meteorological satellite, has recorded an unmatched series of successes in its three-year infancy.

In six launches out of six tries—a record unsurpassed by any other spacecraft—more than 220,000 cloud cover pictures have been transmitted back to earth. Tiros V and VI are still in operation after more than a half year in orbit.

Tiros V, nearing its first anniversary on June 19, gave valuable information on some of the world's 10 most serious storms last August and transmitted more than 53,000 pictures. Previous record was held by Tiros II, with 35,000 pictures.

From the estimated 220,000 cloud pictures transmitted by the six Tiros, more than

- 5,000 cloud cover analyses were prepared,
- 700 special storm advisories were issued and
- 300 specific instances of improved weather analyses were perfected.

Future plans call for seven more Tiros, which will bring to 13 the total number of spacecraft watching the earth's weather patterns (Goddard News, April 1).

Some experimental variations are scheduled or being considered for the new Tiros, consisting of the

- development of the horizon scanner (a part of the spacecraft altitude control) for the future Nimbus,
- testing of the automatic picture transmission to allow immediate "read-out" of pictures, and
- transmission of television and infrared data in polar latitudes and views of the earth from an eccentric 300 to 3,000-mile orbit.

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Contracts Study Synchronous Tiros

The possibility of taking earth cloud pictures from synchronous-orbiting Tiros and Syncom satellites at an altitude of 22,300 miles will be explored under two new contracts valued at $177,000.

The contracts will explore necessary changes in the Syncom I and Tiros spacecraft to provide in-flight camera check-out on the new synchronous satellite.

Radio Corporation of America's contract of $117,000 will study Tiros modifications, while the $60,000 contract with Hughes Aircraft company calls for investigating ways in which the Syncom I communications satellite can be adapted to use weather cameras. A modified Syncom could transmit cloud pictures of the entire disc of the earth from its 22,300 synchronous orbit.

The contracts will cover a four-month period.

Seven Goddard Scientists Confer With Russians in Rome

Seven Goddard scientists participated in the recent and historic discussions in Rome during which the United States and the Soviet Union signed an accord for a joint weather and communications satellite program. The negotiators envision possible cooperation on future planetary probes, and have started to forge a rapid communications link for transfer of meteorological data between the two nations.

Members of the American group, headed by Dr. Hugh Dryden, NASA's deputy administrator, conferred with a team of Russian space experts led by Prof. Anatoli Blagonravov of the Soviet Academy of Sciences.

Participating scientists from Goddard included: Dr. John W. Townsend, Jr., assistant director for space science and satellite applications; Dr. James P. Heppner, head of the magnetic fields section; Dr. Joseph C. Cain, fields and particles branch; Dr. Joseph W. Siry, head, theory and analysis office; Daniel G. Mazur, head, spacecraft systems and projects division; Herbert I. Butler, aeronomy and meteorology division; and Laverne R. Stelter, operations and support division.

Dr. Cain, one of the Goddard participants, considered the fact that personal communications is being established with Russian scientists "one of the most important facts" of the contact. He noted that the tone of the discussions was generally friendly and as informal as the subject matter permitted.

Surprising Fluency

He noticed that the Russian participants all spoke English with surprising fluency, but noted a "communications barrier that transcended the language barrier" related to wide differences in the cultures of the two nations.

An example of this problem was noted by Dr. Townsend; "They have a different concept of the meaning of various words. The word 'coordinator' translates well in both languages, but their notion and ours of what a coordinator does are completely different.

"Our notion of a coordinator is, in effect, a liaison man. In their minds, a coordinator is one who exercises control. You can see where this could cause trouble in negotiations."

The meetings opened in the United States embassy in Rome, and alternated between that building and the Soviet embassy. Some of the meetings were held in what Dr. Cain described as a "large, ornate villa outside Rome," the summer home of the Soviet ambassador.

Earth-Bound U.K.-1 Encoder Outperforms Offspring

Last Friday, as the U. K.-1 satellite celebrated a lofty first anniversary in orbit, three Goddard engineers watched an earth-bound pre-prototype of its telemetry encoder which has registered more than 12,700 hours of continuous operation, equivalent to nearly a year and a half.

This pre-prototype of the heart of the world's first international satellite—a cooperative venture of the United States and Great Britain—was designed and constructed at Goddard under the leadership of a three-man team headed by Hosea D. White, flight data systems branch. Working with White were Ralph Cosme and John O. Thomason.

According to White, it contains approximately 600 transistors, and is actually two separate encoders, one real-time and one which feeds the tape recorder in the satellite for playback at a later time.

Examining a welded module from the U.K.-1 telemetry encoder are (from left to right): designer of the encoder, Hosea White, John O. Thomason, and Ralph Cosme.

The job of the orbiting encoder, which has been functioning for a little more than a year, is "to take the data from the experiments on board from 100 separate lines, and code the information so it can be transmitted back in a pulse frequency modulation format from the satellite and decoded on the ground."

There are three major reasons for the unusually long life of this Ariel equipment, according to the project engineers. First, it uses high-quality welded modular construction. This is the first PFM encoder so constructed at Goddard. The layout and fabrication were accomplished here by the modular techniques section, headed by John Lyons.

Secondly, fairly low power requirements are designed into the system. Only 1/10 watt is needed. At this rate, more than 500,000 transistors could operate on the power needed for one 100-watt light bulb.

Thirdly, credit for the longevity of the system is given in part to the extra care in selection of parts and extremely thorough dynamic testing. This testing was given to individual components, to the welded modules, and to the completed system *before* it was placed in the satellite body for pressure and vibration tests in building 7.

Electro-Mechanical Research corporation of Sarasota, Fla., built the flight model of the encoder to the same specifications as the pre-prototype.

Recognition for a joint invention is presented by Goddard's Associate Director Eugene Wasielewski (right) to Dr. James E. Kupperian, Jr. (center) and Pleasant T. Cole. Kupperian, head of the astrophysics branch, and Cole, recording techniques section head, divided equally a cash award of $100, and each received a written commendation for the invention—a magnetic recording tape having a low friction characteristic especially suitable as an endless tape for use with single reel recorders.

2nd Open House Scheduled May 4

The second annual open house for the families of Goddard employees and numerous other invited groups is scheduled for Saturday, May 4, from 10 a.m. to 4 p.m.

This year, as in the first event, there will be movies, displays, explanations and demonstrations in various buildings around the center. Further information on open house is being circulated individually to all employees.

Self-Help Medical Course To Begin

A medical self-help training course to teach self-sufficiency during prolonged periods following a nuclear war when professional medical services will not be available is scheduled to be taught in a new series beginning in May.

The series, conducted by the civil defense planning office, is designed to cope with the critical periods when large portions of the population will be without doctors, hospitals, or other professional care.

Present plans call for instructing an estimated 550 persons by mid-1964, which will include 10 per cent of the normal Goddard roster, 50 per cent of the evacuation wardens and emergency cadre and all of the first aid, light rescue and fire fighting wardens.

Open to all Goddard employees and dependents, the series will be taught to groups of about 25 at specific times to be determined between 4:30 and 8 Monday through Friday. Weekends also will be included if there is sufficient interest. The series will be taught until everyone at Goddard who so desires has had a chance to enroll.

The series will consist of eight 2-hour sessions. Subjects will include radioactive fallout and shelter; hygiene, sanitation; vermin control; water and food; first aid; infant and child care; and emergency childbirth.

Instruction will be given under direction of Robert von-Roeder, civil defense planning officer, with subsequent courses taught by graduates of Goddard's advanced first aid instructor's course, doctors, nurses, dentists, pharmacists or other representatives of the medical profession.

Phil Studer, second from left, accepts bond and plaque for new commutator design from Gary Leffer, representative for Burroughs. Hal Evans, left, and Bob Shuck of the L. G. White and Co., Inc., area representatives for Burroughs, look on.

Recent Technical Publications Authored by Goddard Staff

B. Donn, "The Characteristics of Distant Comets," NASA Technical Note D-1671, March 1963.

J. C. Cain, Syun-Ichi Akasofu, and S. Chapman, "The Magnetic Field of the Quiet-Time Proton Belt," D-1674, March, 1963.

K. J. Frost and E. D. Rothe, "Detector for Low Energy Gamma-Ray Astronomy Experiment," D-1693, March, 1963.

R. A. Hoffman, L. R. Davis, and J. M. Williamson, "Protons from 0.1 and 5 Mev and Electrons of 20 Kev at 12 Earth Radii During the Sudden Commencement on Sept. 30, 1961," D-1700, March 1963.

W. B. Fussell, J. J. Triolo, and J. H. Henninger, "A Dynamic Thermal Vacuum Technique for Measuring the Solar Absorptance and Thermal Emittance of Spacecraft Coatings," D-1716, March, 1963.

S. Chandra, "Electron Density Distribution in the Upper F-Region," D-1751, March, 1963.

M. M. Sokoloski and F. E. Geiger, "Apparatus for the Measurement of Transport Properties of Polar Semiconductors," D-1695, March, 1963.

H. W. LaGow and L. Secretan, "Results of Micrometeorite Penetration Experiment of the Explorer VII Satellite (1959 Iota)," D-1722, April, 1963.

W. B. Fussell, J. J. Triolo, and F. A. Jerozal, "Portable Integrating Sphere for Monitoring Reflectance of Spacecraft Coatings," D-1714, April, 1963.

R. T. Hollingsworth, "A Survey of Large Space Chambers," D-1673, April, 1963.

New Motor to Improve Satellite Efficiencies

From 20 to 40 per cent of the total weight of satellites is devoted to energy collection, storage conversion and regulation.

Small wonder, then, that Harold Evans is excited about a promising new motor for space flight use that may result in major savings in power conversion.

The brushless direct current motor is being developed under the direction of Mr. Evans' advanced technical development section, mechanical systems branch, in conjunction with Sperry Farragut company, division of Sperry Rand, of Bristol, Tenn. First prototype models of the motor arrived in mid-April, according to Phil Studer, technical director for the project, and a branch physicist.

The new motor—with an electronic commutator to replace the brushes—is expected to provide a significant improvement in the systems efficiencies of future spacecraft, Mr. Evans said.

"Any savings we can make in reducing power conversion losses represent sizable decreases in the overall payload weight booster requirements," said Mr. Evans. "The brushless motor promises to increase the efficiency of power conversion from battery power to mechanical output by 80 per cent."

Boon to D.C. Motors

The development of electronic commutators to replace conventional brushes in D.C. motors is expected to give a significant boost to the selection of D.C. over alternating current motors in present and future spacecraft application, according to Mr. Evans.

He listed several reasons for the trend from A.C. to D.C. motors for space use. For example, spacecraft power sources, such as solar cells, thermoelectric converters, etc, are almost universally D.C. In addition, electrical energy is readily storable in D.C. form and the motors have a generally higher efficiency than A.C. motors.

Principal disadvantage to the use of brushes in satellite application has been the abrasive effect created by the vacuum of space. Friction, arcing, and wear of switching commutation have been persistent characteristics of conventional D.C. motors.

"In the hard vacuum of outer space, the brush life of conventional carbon brush commutators is measured in minutes instead of years of life," said Mr. Evans. "In addition, they produced an electrical r.f. noise objectionable to other experiments, and created a drag on the motor."

The brushless motor has assets which tend to make it an attractive component for a wide variety of applications in tape recorders, guidance systems, inertia wheel stabilizing systems, etc.

When the Burroughs corporation of Plainfield, N. J., recently staged a nation-wide circuit design contest, Mr. Studer of the advanced technical development section thought that a brushless D.C. motor commutator would make a novel application for their beam switching tube. The results of his efforts won for him a special $100 savings bond in the competition.

Studer said the heart of the switching system is an electronic beam switching tube. It sends a beam of electrons to ten targets, each connected to a semi-conductor switch. These switches direct the electrical power to the proper motor coils.

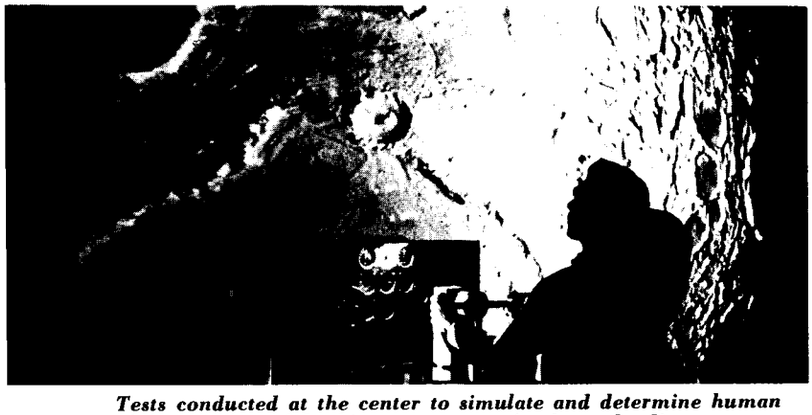
A variable frequency oscillator directs the beam successively from one target to the next at a rate determined by the motor speed. A photo-sensor provides the proper synchronization by starting each cycle at a precise position of the motor armature.

"This is an especially important aspect in achieving true D.C. motor characteristics of high starting torque and efficiency," said Mr. Studer.

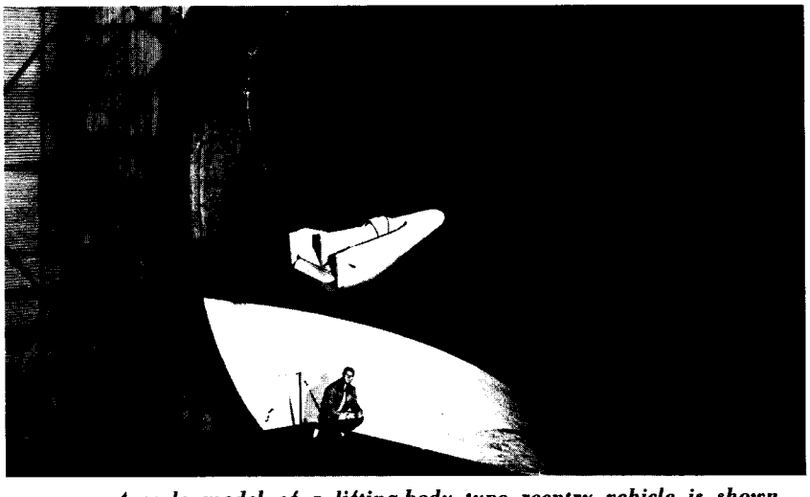
The circuit does not have immediate application in small instrument-size motors, such as the miniature motor being built by Sperry for Goddard. This is attributed to the fact that the beam switching tube uses almost half the power required to run the motor. However, the circuit is expected to prove useful in forthcoming higher power motors.

FAMOUS FOR FIRSTS:

Langley—NASA'S Largest Research Center



Tests conducted at the center to simulate and determine human ability to control braking maneuvers for lunar landing are part of an extensive NASA program. The "pilot" operates a hydraulic analog simulator as though it were a vertical-landing spaceship. A stand at the pilot's right holds a slide projector which shows the lunar surface upon a curved background.



A scale model of a lifting-body type reentry vehicle is shown here being tested in Langley's full scale wind tunnel to determine its characteristics while being towed. The full-scale version will have wheels and will initially land at about 55 miles per hour. Later versions will land at 200 miles per hour, the landing speed of the X-15.

As well as being the first NASA laboratory and the largest NASA center specializing in basic aeronautical and space research, Langley Research Center has many other firsts to recall and to build upon.

Just a few of these contributions are: The world's first transonic wind tunnels; the Area Rule—a design principle regarded as the key to practical supersonic flight; the invention of automatically erectable spacecraft, leading to the development of Echo, the world's first in its field; and the development of Scout, first all-solid-fueled launch vehicle to place a United States satellite into orbit.

Langley, at Langley Station, Hampton, Va., was the major research establishment of the former National Advisory Committee for Aeronautics from 1917 until the creation of NASA in 1958. Although located on an air force base, the center is an independent member of the civilian space administration.

Floyd LaVerne Thompson has been Langley's director since May, 1960. The mission of the center is defined in three major areas—objective research, new concepts, and advice and support.

Objective research at Langley is aimed at providing the technical background necessary for the accomplishment of such NASA missions as the manned and unmanned exploration and use of space and improvement in the performance, safety and utility of airborne flight.

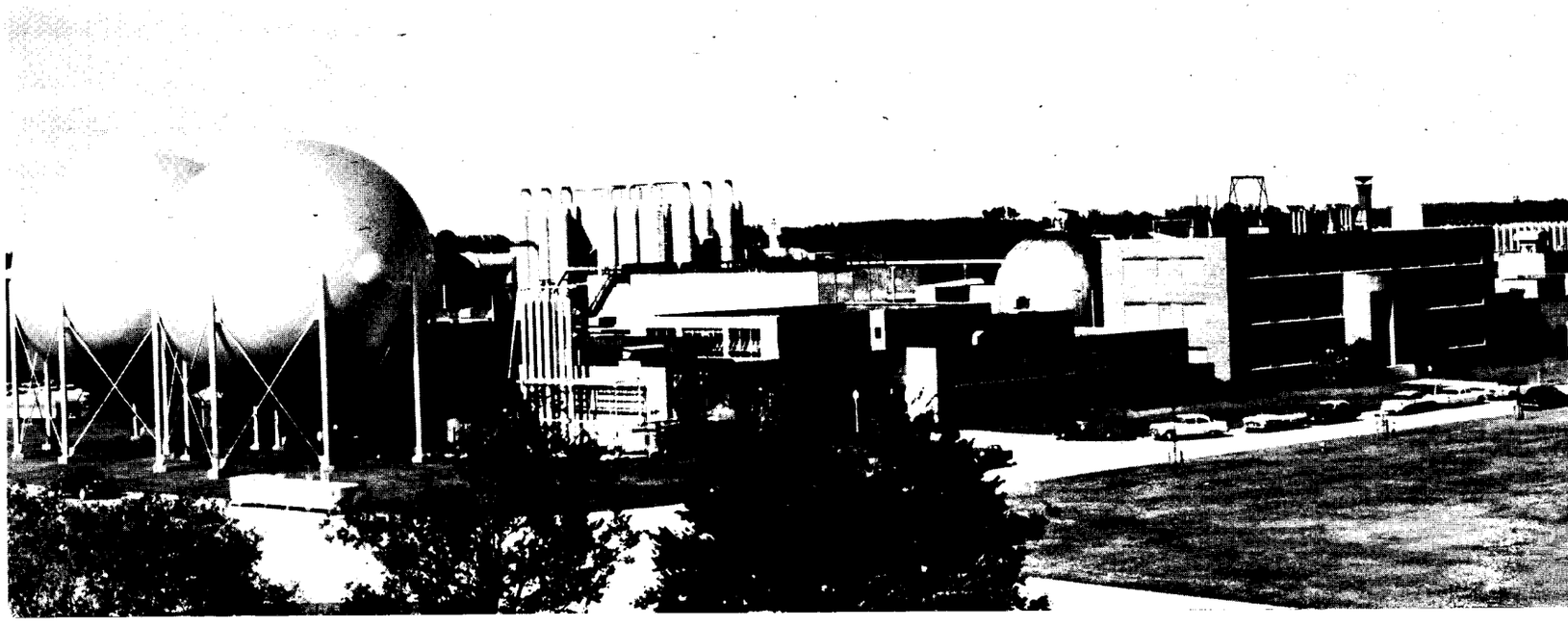
Scientists at Langley are constantly working to generate new and advanced concepts for future NASA missions on the basis of research findings. Their advice and support are directed to other branches of the government, including assistance to the Department of Defense in the development of new weapons systems.

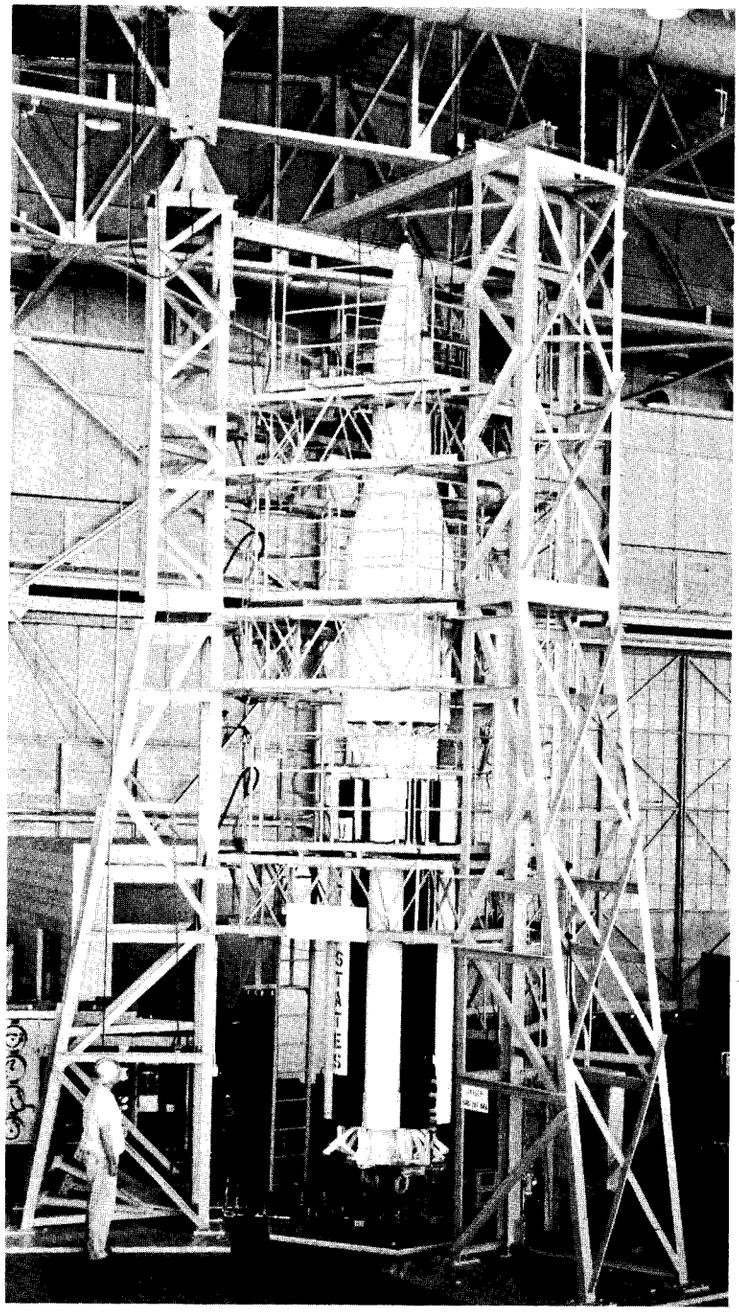
One of the most distinguished "graduates" of the Langley Research Center is Goddard's director, Dr. Harry Goett.

Editor's Note: This is the fourth in a series of special articles on the activities and responsibilities of NASA's far-flung installations and operations.

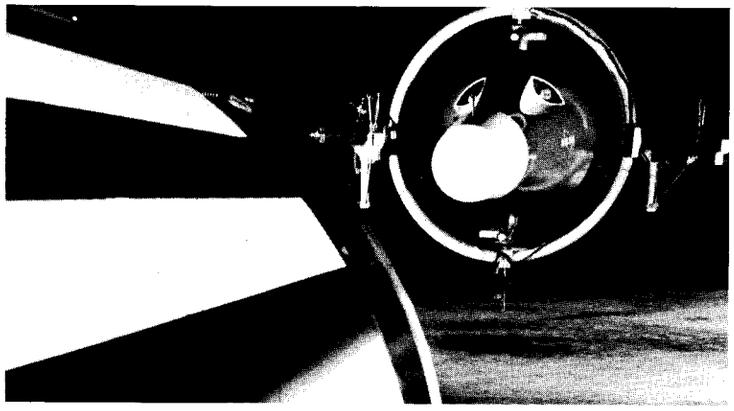
Floyd LaVerne Thompson, director of Langley Research Center, is in charge of all research activities and other operations.

Shown below is a section of Langley's west area, where most of the major facilities are located. At the left are two 60-foot diameter vacuum spheres which receive helium from nearby steel storage bottles to produce speeds of Mach 24 in the 22-inch helium tunnel, where spacecraft reentry is tested.





This test stand was built and installed at Langley to conduct vibration tests on the pictured 1/5 scale model of the Saturn launch vehicle. It also will be used to determine the feasibility of building large-scale dynamic models of even larger booster vehicles such as Nova.



This rendezvous docking simulator will enable scientists to determine man's ability to complete a rendezvous in orbit. Two research pilots are maneuvering a full-scale model of the Gemini into final contact with a target vehicle.

News About Space & Aeronautics

● "NASA already has demonstrated on a limited scale that space research can be of use in solving industrial problems. . . . NASA technicians, in welding parts for the Saturn missile, employed a glass fiber tape that kept the inside seam smooth while the outside seam was being welded. At the urging of Midwest Research Institute, a furnace and air conditioning manufacturer adopted the tape and halved its welding bills.

"NASA specialists, in seeking a way to land space vehicles, discovered an especially efficient shock absorber, an aluminum tube that shattered on impact. MRI engineers say eight of these tubes could stop a two-ton elevator after a ten-floor drop, and the impact would be little more than that of a man falling out of bed.

"NASA, also in the Saturn project, made improvements in a metal-forming system in which metal is forced against dies by a powerful magnetic field. A maker of camping equipment found this method the most successful yet for fastening the metal clips that keep tent ropes from fraying."—*The Wall Street Journal*

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● Keeping the public informed of the progress of the MA-9 will be an easier news-coverage job than in the past, since a tracking exhibit is being provided to display mission developments as they unfold. The exhibit, which will be checked out and erected as a news facility at Cape Canaveral prior to the MA-9, will illustrate or demonstrate the following actions: orbital paths; spacecraft location along orbital paths; tracking station locations and indication of acquisition of spacecraft signals; time frame in which the spacecraft is traveling (daylight or darkness); elapsed time of flight and orbit count; and prime recovery forces and their deployment. The exhibit is a project of Goddard's public information office.

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● "A unique blend of space station construction and food supply has been developed by a Grumman scientist who bought all his supplies at a local supermarket.

"Called ESM (Edible Structure Material), and made solely from organic substances, it emerges after pressure-heating looking much like fibreboard.

"ESM is slightly harder than Fibreboard (compressive strength is 7230 psi and can be improved); it has about the same weight (0.049 lbs. per cu. in.); and it can be used for much the same uses. But there the resemblance stops.

"Unlike fibreboard, it has 300-400 calories per 100 grams and can be ground up or soaked for 24 hours to make a cereal to be eaten in emergency conditions.

"The material contains hominy grits, powdered milk, cornstarch, flour and powdered banana flakes. It is heated around 300° F at 3,000 lbs. psi for 5-10 minutes until the sugars and milk powder flow and form a matrix.

"When molded in sheets and covered with a removable film laminate of Mylar, aluminum foil and polyethelene, ESM can be used for such secondary structures in space stations as instrument panels, bunks, clipboards, internal sheathing and walls, packaging and compartment dividers.

"The material holds screws and nails, has no known low-temperature limit (although it will char at about 250° F) and—with its covering—would be waterproof and insect proof. Therefore, ESM should last indefinitely, says its originator, Dr. Sydney Schwarz.

"In its present makeup, ESM is said to taste like a banana-flavored cereal. Other flavoring and vitamins added to the formula would not change its properties. Schwarz, adding: 'With sugar and cream it's delicious—but then anything is!' "

"Schwarz, who is Grumman's chief physiologist for the Lunar Excursion Module, doesn't suggest that the material be used as a main food supply. But, he points out that it would reduce backup supplies 'by about 90 per cent.' "—*Missiles & Rockets*

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● A management advisory committee for manned space flight has been created within NASA, and will advise D. Brainerd Holmes, deputy associate administrator, in areas of organization and management of the manned program. Dr. Mervin J. Kelly, retired president and board chairman of Bell Telephone Laboratories will serve as chairman.

NASA—University of Maryland Experiment Comes to an End As Research Aide Leaves Capsule After Five Months Alone

America's man from inner space is out, and the nearby University of Maryland's psychology department considers the 5-month solitary confinement of research assistant Whilden P. Breen, Jr., a step in the right direction in an attempt to determine the ability of human beings to spend extensive periods of time confined in space vehicles, orbiting space laboratories or stations, and within extra-terrestrial bases.

The primary objective of the study was the gathering of basic information on how man performs under conditions of stress, and methods to deal with such problems so that astronauts of the future will be able to perform their duties at highest efficiency.

The experiment was financed by a grant from NASA and is part of an advanced program of research in the life sciences being conducted currently by the office of advanced research and technology.

The NASA program is headed by Dr. Eugene B. Konecci, director of biotechnology and human research. Dr. Stanley Deutsch, chief of systems research and human factors, is the program manager for this study. Dr. Jack D. Findley, of the University of Maryland's psychology staff, is principal project investigator.

Breen spent his six-month wedding anniversary in a 12-foot square "capsule" constructed for the experiment in one of the university's wooden temporary buildings. The compartment is painted a drab grey on its exterior, and various wires and equipment lend an unearthy appearance to the apparatus. Breen's living quarters were under constant surveillance via closed circuit TV (see location on accompanying diagram). The subject was free to leave at any time, and he did so on April 18. The decision was his own choice.

After entering Nov. 17, the 35-year-old volunteer performed daily routine programs with a sequential choice leading to various rewards ranging from cigarettes to communications with the "outside".

He slept "a little more than 8 hours a day," and worked, exercised, read, worked on his science fiction novel, painted, or ate during other periods of what became for him a 26-hour day. He was allowed to communicate by teletype, as a "reward" for successful completion of required tasks.

Breen could elect to perform a simple repertoire (six tasks), consisting of toilet operations, flight duration exercise, weight and temperature measurements, light eating and sleep. This minimum repertoire consisted of activities which had to be completed one after the other. It was self-cycling if the subject selected sleep, the completion of which returned the program to toilet operations.

He could select to extend the sequence to more intrinsically rewarding activities—the full program—by selecting one of two work tasks rather than sleep. This sequence consisted of 14 activities, such as various work tasks, programmed instruction, hobbies, and selection among alternative activities such as major meals, dessert, music, cigarettes, and finally delayed rewards such as oral communication with the experimenters via an intercom system.

Completion of the more extended repertoire returned Breen to the conditions for reinitiation of functional sequence of tasks.

The character of the program, therefore, was designed to fall somewhere between the extremes of a highly regimented, temporally determined environment on the one hand, and a *laissez-faire* type existence on the other.

Breen made selections of various types of music as a reward for program completion, and chose various types, from slow, soothing melodies to "jazzy" musical selections. Sometimes he would dance around the room to the latter type of stimulus.

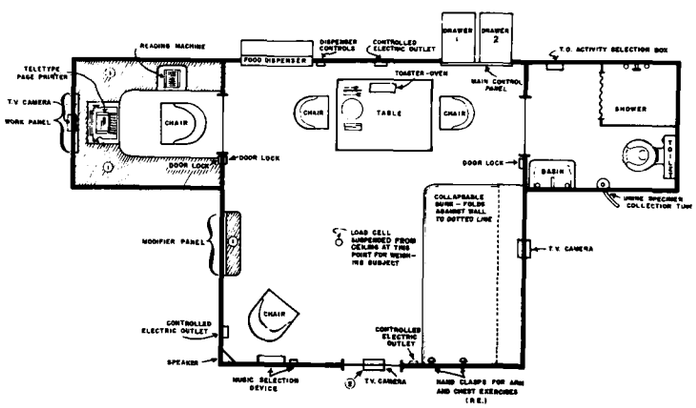
There were two broad alternatives. On the one hand, a man could be trained and motivated to the point of being highly cooperative in the hope that he would engage in the activities he had been asked to do.

The other alternative was to design the environment to support a man in carrying out those activities that are desired. In this situation the environment is actually laid out so that he is required to weigh himself, take his temperature and exercise before he can engage in activities which are more desirable, for example, eating, listening to music, or hobby activities.

Toward the end of the experiment, various performance indices suggested the beginning of stress conditions, and the emphasis was shifted to finding factors most effective in alleviating stress and boredom.

Now the compartment stands empty, but plans are underway to try a situation similar to Breen's past experience with two men—a more realistic venture from the standpoint of direct application to the manned space effort, since it will involve interaction between two individuals under simulated conditions of space travel.

Dr. Stanley Deutsch (left), chief of systems research analysis and human factors, NASA headquarters, and Dr. Jack D. Findley of the University of Maryland check data received from the control board (background) which recorded Breen's reactions and responses to his programed life.



Shown above is a line drawing of the 12-foot-square compartment with two five-foot-square alcoves in which Whilden Breen spent more than five months without seeing another person.

Whilden P. Breen, Jr. is shown here before a board which diagrams the various activity programs from which he could choose during his confinement.

Goddard News

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New Solar Cell Can Increase Space Craft Life

Bill Cherry, head of the space power technology branch, is an engineer, not a salesman. But for the past three years he's been doing almost as much "selling" as engineering. And his efforts—which could have far-reaching benefits to America's space program—are now paying off.

Mr. Cherry's "product" is an advance version of the now commonplace solar cell. And his selling efforts have been directed country-wide to industry and government alike.

Today, Goddard is close to implementing the new cell for the first time on a number of future spacecraft, and Mr. Cherry is on the NASA team to which he proposed the cell while it was being pioneered under his direction at the Army's Electronics Research and Development laboratory in the late 50s and early 60s.

The upcoming Goddard spacecraft which now plan to utilize the new cells include Nimbus and Relay, with several additional spacecraft, including OSO-2, EGO, and OAO, also scheduled to make the conversion to the "n/p cells."

Bill Cherry displays his collection of assorted solar cells. When subjected to full sunlight conditions, a conventional 1 by 2 centimeter cell 20 thousandths of an inch thick will create .05 milliamperes of current (50 thousandths of an amp), 23 milliwatts of electricity (23 thousandths of a watt), and .46 volts (a transistor radio requires 3 volts).

More Radiation Protection

The new cells, principal advantage of which comes in the increased protection provided against the deteriorating effects of space radiation, have proved in ground evaluation to last 20 times longer than conventional p/n cells, said Mr. Cherry.

Flight data to back up this evidence now has provided additional support for proponents of the cell. The data came from Bell Telephone laboratory's Telstar, which has deteriorated at a "slower rate than any other spacecraft," according to Mr. Cherry. Bell—original developer of the first p/n solar cell, in 1953-54—was the first to take advantage of the breakthrough announced by Mr. Cherry's group at Fort Monmouth, N. J., and first to put the new cells to use on the now well known Telstar.

"Use of the new cells on Goddard's Nimbus is expected to give the spacecraft a lifetime of from 200 days to a year as compared with 20 to 40 days it would have had with conventional cells," Mr. Cherry said.

The new cells were necessitated by the adverse effects oper of the first p/n solar cell, caused by the Van Allen and artificial radiation belts on the original p/n cells. It was first thought these cells would last upwards of 10,000 years—but that was before space radiation was known to be so intense.

The new n/p cells have similar electrical characteristics to the p/n cells but differ in that negative silicon forms the top layer or skin of the cell and positive silicon forms the underside or base layer.

The technique of making the cells is achieved by diffusing impurity atoms into the cell in a proper proportion to silicon atoms. (Silicon is the predominant material that goes into most solar cells. It is the second most abundant element in the world, after oxygen, and is found most often in common beach sand. "It's one item we don't have to stockpile," said Mr. Cherry.)

The impurity atoms—1 atom of boron for every million "pure" silcon atoms—provide the cells with the electrical properties necessary in a solar cell.

New Cell Superior

Superiority of the new cell is evident in the increased radiation resistance it provides compared to its predecessor. For example, under 8 Mev proton bombardment, the n/p cell is about 3 times more resistant to damage than the p/n cells. When subjected to 1 Mev electrons, the new cell is about 20 times more radiation resistant. As the electron energy increases beyond 2 Mev, the difference in radiation resistance between the two types is not so great.

In addition, the n/p cells can be made much more uniform in its electrical characteristics than the p/n. Manufacturers already are able to produce the new cells with performance characteristics as good as the best p/n devices.

Mr. Cherry said that the new process will give not only better cells but better yields, which will reflect in an eventual price reduction.

While this superiority is an important breakthrough for the present state of the art, major research is underway to further improve the cells.

One approach being investigated involves the reduction of impurity atoms diffused into the silicon base, perhaps to "1 particle per 10 million." This will increase the radiation resistance of the n/p cell even further.

A major problem is encountered in that while the current of a cell increases with a reduction of impurities the voltage and maximum power value decreases.

"At some point, however, the optimum will be found," Mr. Cherry said. "We can improve the radiation resistivity of the cell by at least 5 times or more by properly adjusting the impurity level in the base region." Just where this optimum is may soon be answered.

Another approach being followed involves a move away from the "life-time dependent" cells, which depend on a high crystal perfection in the base material but which eventually deteriorate under irradiation conditions. The move may be toward a "drift-field" solar cell which depends more on impurities being diffused into a cell in "just the right pattern or gradient" so that they act as built-in electric field which moves the carriers toward the junction.

There are indications "these are 10 times more radiation resistant than conventional n/p cells," said Mr. Cherry. "They would give us another order of magnitude over the n/p cell now becoming available in large quantities."

Long Range View

The long range view looks to "thin film" solar cells, in which polycrystalline materials are used. These may be constructed by inexpensive evaporation techniques over large areas.

Mr. Cherry said that "efficiencies may be only 3 or 4 per cent compared with 12 to 13 per cent in the single crystal cell of today," but due to a tremendous weight advantage, systems producing watt-to-pound ratios of 15 to 20 may be feasible, as compared with 6 watts-per-pound for present day oriented arrays.

Considerable research has yet to be done to develop suitable substrates, films, and junction characteristics before thin film systems will be adaptable to space flight.

"Film cells, not being dependent on collecting carriers deep within the bulk of the material, should be quite radiation resistant to high energy electrons and protrons," Mr. Cherry said.

New materials such as gallium arsenide and cadmium telluride also are being considered as possible replacements for silicon but either cost or their state of development has prevented their use on spacecraft.

A Deserved Tribute To The Tiros Group . . .

Left to right are Dr. Harry Goett, Herbert Butler, Lewis Allison, Thomas Ashton, Roderick Carter, William Burton, John Balla, Kay Church, William Bandeen, Sebastian Costa, Harold Oseroff, Ernest Neil, William Nordberg, W. G. Stroud.

Left to right are Charles Rhodes, Musa Halev, Kenneth Stark, Edward Rich, Markham Hanchette, Marjorie Townsend, Robert Rados, Ernest Powers, Robert Gibson, Laverne Stelter.

Left to right are Rudolf Stampfl, George Hogan, Richard Falwell, Marvin Maxwell, Nancy Miller, John Davis, William Kley, John Fedor, Bill Leavy, James McLean, John Maskasky, Robert Hite, Rudolf Hanel, Andrew McCulloch.

Some members of the Tiros group could not be present at the ceremonies, and thus are not pictured on this page. Included in this group are Frank Bartko, Clarence Catoe, Barney Conrath, Isidore Goldberg, Virgil Kunde, William Parker, Charles Thienel, Sydney Alterescu, Edward Alvord, Bob Gray, Wayne Gunter, Lawrence Hendershot, Ron McIntyre, John Neilon, Ed Rosette, Bill Schindler, Joe Schwartz, Orville Stanton.

Left to right are Anthony Brozena, Marius Weinreb, Arthur White, James Dupree, Donald Sheppard, Charles Smith, Dr. Joseph Siry, Leon Schwartz, Wayne Traylor, Joseph Natrella, Maxwell Strange, Eugene Tetirick, Charles Lundstedt (Tiros station manager at Wallops Station), Ingrid Strange, A. Gerald Johnson, Frederick Woolfall, W. G. Stroud, Charles Wood, John Palmer, Richard Wiack.