GODDARD NEWS

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

VOL. XII, NO. 6 NOVEMBER 14, 1966

TANANARIVE, MADAGASCAR (STADAN). Natives and ox cart pass two range and range rate antennas. The Station Director is Goddard's Chester Cunningham. See "Goddard Around the World" on Page 6.

Goddard's Nimbus II Sets New Record

The Nimbus II weather satellite will complete six months in orbit, November 15, and the meteorological data it has collected would fill a library.

Launched last May 15, the butterfly-shaped weather eye has operated as planned longer than any other large earth orbiting observatory type spacecraft.

"It has been working better than a finely tuned engine," said Harry Press, Nimbus Project Manager. "Its performance has exceeded everyone's expectation."

The mechanical meteorologist, most versatile ever built by the United States, looks at the world's weather with many different camera eyes. It takes daytime and nighttime (infrared) pictures, measures cloud top and ocean temperatures, and the atmosphere's water vapor and carbon dioxide content. NASA physicists hope that Nimbus data will unlock the mystery of storm development.

Nimbus' control system, which keeps the cameras pointed at earth 24 hours a day, has operated without a hitch and is considered a major engineering accomplishment.

This system, which consists of some 8,000 electronic parts, must keep Nimbus pointed at the earth to within one degree.

If it swings away from the earth's center, flywheels, for minor corrections and freon gas, for large corrections, push the spacecraft back into the proper attitude.

The flywheels have worked so well that only six percent of the gas supply has been used.

Nimbus' accomplishments have been impressive:

- Photographed 17 typhoons and 9 hurricanes;
- Photographed the entire world twice daily (day and night);
- Photographed the meandering course of the Gulf Stream;
- Operated 24-hours a day for six months;
- Traveled 72,000,600 miles, and
- Orbited the world 2,449 times.

In addition to the experimental meteorological data that Nimbus has collected, oceanographers are extremely interested in its infrared photos of the Gulf Stream in the Atlantic Ocean.

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NIMBUS II . . . *from page 1*

The course of the stream changes, or meanders, several miles every few days. Because it covers such a great area it would take several ships and airplanes about 10 days to cover the entire area. Nimbus can do the same job in just a few minutes.

Because the Gulf Stream is about 10 degrees warmer than surrounding water, it can be seen in the infrared spectrum. NASA scientists and U. S. Navy oceanographers were able to see the northern wall of the stream near Cape Hatteras very clearly.

A better understanding of the Gulf Stream's shape and its changing course could be of tremendous value to weather forecasters and the commercial fishing industry.

Fishing experts say that the whereabouts of several fish species would be known if the precise location of the Gulf Stream was known.

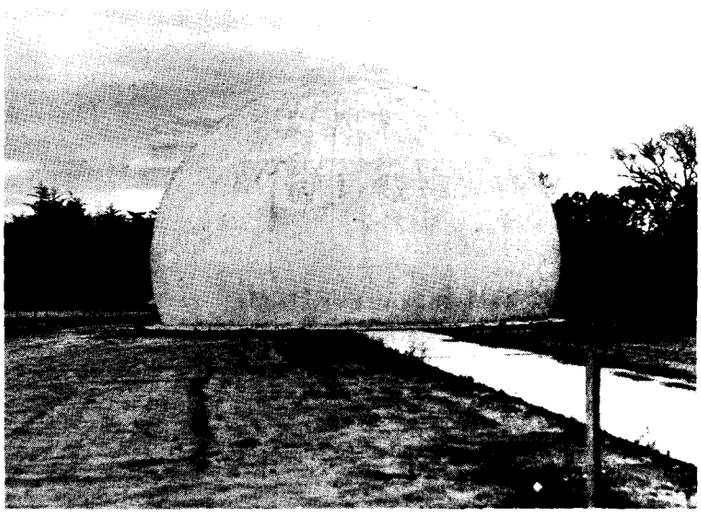
Another area of particular interest are the infrared pictures of the water vapor portion of the infrared spectrum. New light is being shed on the directions that storms take and why they dissipate. These same photos are being studied to determine the locations of jet stream. If they can be accurately pinpointed, the airlines could save considerable flying time.

Nimbus II is currently providing global meteorological coverage with one nighttime camera and one daytime camera. The satellite's other daytime and nighttime sensors are no longer collecting data because of tape-recorder failures.

The satellite is in an orbit ranging from 687 miles above the earth to 726 miles. It travels around the world every 108 minutes.

The next Nimbus, which will be third in the series, is scheduled for launching in late 1967.

WHAT IS IT?



GUESS where it's located at Goddard. Get the answer on Page 7.

Engineering Lecture Series

Nov. 16, 1966

Bldg. 8 Aud. 3 p.m.

Dr. Charles S. Sheldon II

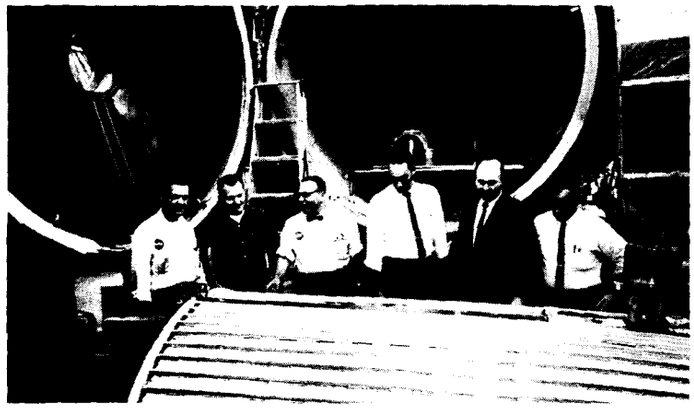
Library of Congress

U.S.-SOVIET COMPARISON IN SPACE ACTIVITIES

Dr. Charles S. Sheldon II

Harry Press, Nimbus Project Manager

POLYETHYLENE ROOM, that has been attracting so much attention in the laboratory of Building 7, is actually formed by a dust cover. The polyethylene room is used by the Thermodynamics Branch (T&E) to trap dust formed during equipment modifications.



SPACE ENVIRONMENT SIMULATOR inside the temporary polyethylene room is one of two vacuum chambers being modified for dual capabilities in thermal and solar vacuum tests. From left are Clayton W. Klotz, Donald I. Deibler, David Weiner, Frank G. Cuzzalina, Anthony R. Trotta, and Billy S. Peterson of the Thermodynamics Branch (T&E).

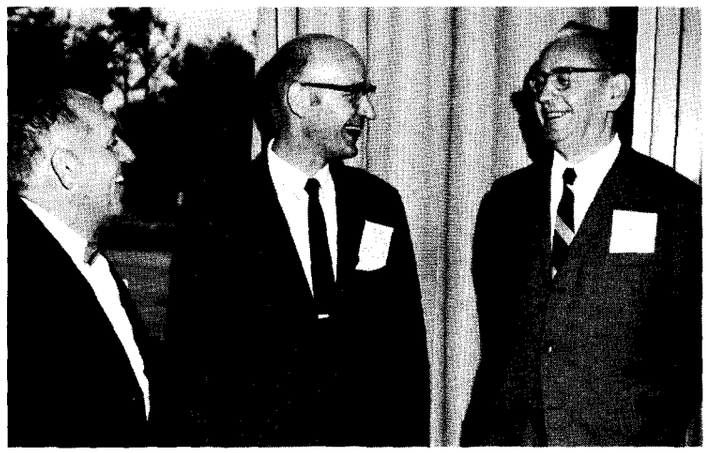
ASTRODYNAMICS CONFERENCE HELD HERE

The Special Projects Branch of the Laboratory for Theoretical Studies held its fourth biannual astrodynamics conference here at Goddard on October 25 and 26, 1966. Topics discussed included recent developments in celestial mechanics and applied statistics.

In attendance were about 120 conferees, comprising Goddard personnel, researchers from other U. S. Government Agencies, contractors and interested university people. Conference Chairman was R. Kenneth Squires, Head of the Special Projects Branch; while Robert C. Blanchard, of the same branch, was conference coordinator.

Goddard speakers at the conference were Carl A. Wagner, Ronald Kolenkiewicz and Stephen J. Paddack. Contractors presenting their biannual progress report on the research being performed for the Special Projects Branch were Sheldon Kass, of General Precision, Inc.; Dr. Henry Wolf and Samuel Pines, of Analytical Mechanics Associates, Inc.; and William J. Ferguson and Robert M. Fitzgerald, of Computer Sciences Corporation.

Three well-known researchers, who gave papers at the conference, were Professor Karl Stumpff of Göttingen University, Germany, Dr. Victor Szebehely, of Yale University Observatory; and Professor Harold J. Kushner, of Brown University.



PRE-CONFERENCE DISCUSSION. Sam Pines (left) president of Analytical Mechanics Associates, Inc.; R. Kenneth Squires, Head of the Special Projects Branch; and Professor Karl Stumpff, of Göttingen University; discuss the agenda prior to the conference. Professor Stumpff, an invited guest speaker, is a well-known scientist in the field of celestial mechanics. He has written many articles and books on the subject. Currently, he is at Goddard until April 1967, presenting a lecture series on topics in celestial mechanics.

CARL A. WAGNER, of the Special Projects Branch, presents a paper on determining the shape of the earth's gravitational field.

RONALD KOLENKIEWICZ, of the Special Projects Branch, presenting a paper on the "Restricted Four-Body Problem."

DR. VICTOR SZEBEHELY, an invited guest speaker, presents a paper entitled, "Power Series Solution of the Restricted Three-Body Problem."

CONFERENCE CHAIRMAN, R. Kenneth Squires, Head Special Projects Branch, gives opening remarks at the first session.

CONFEREES. Some of the interested conferees listening attentively to one of the 10 papers presented at the Special Projects Branch IV Astrodynamics Conference. The group consists mainly of government scientists, private industry contractors, and university professors, as well as some of their students.

San Marco Launch Slated For Early 1967

Beginning a new series of articles on international projects at Goddard.

Following two years of intensive preparations, the second San Marco satellite is being readied for launch in the first part of 1967 from the East Coast of Africa. The first launch, which took place December 1964 at Wallops Island, served primarily as a training exercise for the Italian launch crews, and secondarily to qualify the San Marco spacecraft for a later launch into an equatorial orbit from the sea platform in the Indian Ocean.

The upcoming launch should culminate in the attainment of the goals set up by an agreement signed by the representatives of Italy and the United States on September 5, 1962, to perform high altitude measurements of atmospheric and ionospheric characteristics in the equatorial region.

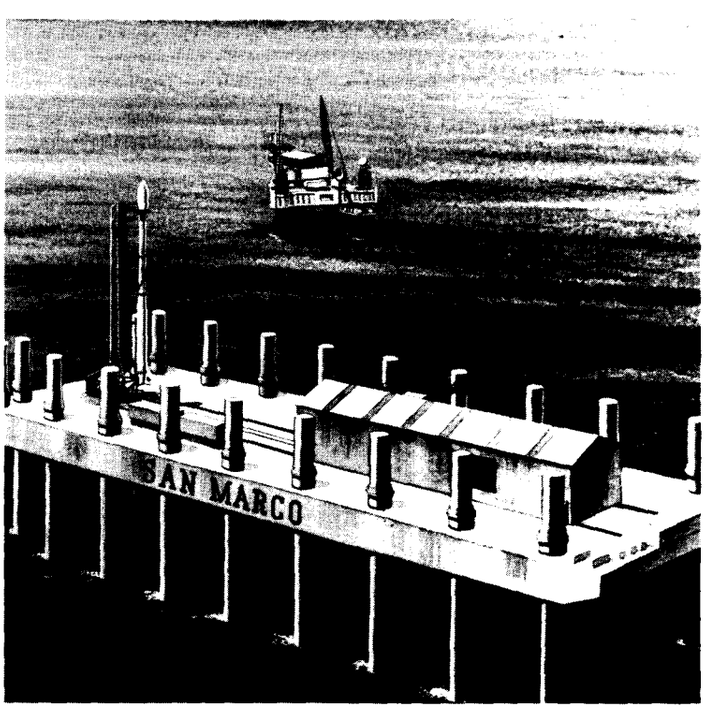
The payload, a 26-inch sphere weighing 285 lbs. and having a design lifetime of 5 months, will be launched by a 4-stage Scout rocket.

The orbital parameters sought for this launch are: inclination—3°, perigee—214 kilometers, apogee—800 kilometers.

Tracking and telemetry for the mission will be handled by our STADAN station in Quito, Ecuador, with Italy providing an additional telemetry station in Nairobi, Kenya.

"Considering the unique and rigorous conditions under which the project had to operate, the schedule of operations has proceeded surprisingly well," notes Anthony J. Caporale, San Marco Project Manager (SI&SR).

Although the spacecraft was designed, built, and tested by Italian engineers, a large share of credit must be attributed to the San Marco staff here at Goddard for their unstinting and generous support in the technical guidance area.



ARTIST'S CONCEPTION of the Indian Ocean platform that will be used to launch the second San Marco satellite early in 1967.

GODDARD'S SAN MARCO TEAM: Seated are Charles T. Tackett (left), Anthony J. Caporale, Project Manager; Maurice D. Handegard, and Charles E. White. Standing are Thomas J. Hennigan (left), Donald M. Shipley, William R. Witt, Jr., Head of the International Programs Office (SSD); Thomas E. Ryan, and Milton Schach.

The Goddard team, working with the Italians in developing the payload, include: Maurice D. Handegard (SI&SR), Project Coordinator; Thomas E. Ryan (POSD), Tracking and Data Systems Manager; Donald M. Shipley (T&E), T&E Manager; Milton Schach (STD), Thermal Systems Consultant; Charles E. White, Mechanical Structures Engineer; David S. Hepler (STD), Payload R. F. Systems Engineer; John K. Steckel (STD), Payload Antenna Engineer; Justin C. Schaffert (STD), Payload Instrumentation Engineer; L. Henry Anderson (DSD), Orbital Computations Engineer; Thomas J. Hennigan (STD), Power Sources Engineer; Bruce R. Pincus and Charles T. Tackett (SI&SR), Payload Telemetry Consultants; and William R. Witt, Jr., from the International Programs Office.

San Marco's Italian team includes: Professor Luigi Broglio of the Aerospace Research Center in Rome, who conceived the project; Professor Carlo Buongiorno, Technical Coordinator; Professor Nallo Carrara, an experimentor from the Italian National Institution of Miscrowaves in Florence; Professor Paolo Santini, trajectory computations; Dr. Giorgio Ravelli, Spacecraft Manager; Dr. Michele Sirinian, vehicle and operations; Dr. Ugo Ponzi, payload structure; Dr. Carlo Arduini, thermal systems and payload testing; Dr. Giuseppe Spampinato, vehicle assembly; Dr. Gennaro Orsi, platforms and power supply; and Giangrande Barresi, payload electronics.

ITALIAN TEAM MEMBERS: Professor Carlo Buongiorno, Technical Coordinator; Professor Luigi Broglio, Project Director; and Professor Michele Sirinian follow the first launch of a San Marco satellite from Wallops Island on December 15, 1964.

Goddard People Present Papers In Madrid

Five Goddard employees presented papers at the 17th International Astronautical Congress held in Madrid, Spain, October 10 to 17. They were Wilfred E. Scull, Francis N. LeDoux, Paul Butler, Robert M. Rados, and Dr. Adolf A. Hanel.

The Congress, sponsored by the International Astronautical Federation, is held yearly to review the technical progress man is making in the space sciences.

About 1200 scientists from 32 nations, including the Soviet Union, gathered to take part in the presentation of some 250 scientific papers.

"The Congress provided an opportunity for participation and discussions with many persons from nations involved in astronautics or space," says Wilfred E. Scull, OGO Project Manager. "Major sessions included systems design, re-entry problems, applications satellites, bioastronautics, space law, astronautics and education, propulsion, astrodynamics, guidance, control, and tracking."

Francis N. LeDoux, Head of the Structural and Mechanical Applications Section (SI&SR), adds, "While the formal sessions were interesting, the informal discussions between sessions were more informative and provided an opportunity for personal exchange of ideas."

Other Goddard scientists who attended the Conference to present papers include: Paul Butler, IMP Project Manager; Robert M. Rados, TIROS Project Manager; and Dr. Adolf A. Hanel, of the Laboratory for Atmospheric and Biological Sciences.

Wilfred E. Scull

Robert M. Rados

***INFORMAL DISCUSSION.** Dr. Robert H. Page, Rutgers University; Dr. Guzamen, University of Colorado; Paul Butler, Goddard's IMP Project Manager; and Francis N. LeDoux, Head of Goddard's Structural and Mechanical Applications Section (SI&SR), hold an informal discussion during a reception held for delegates to the 17th International Astronautical Congress by the Air Ministry, Madrid, Spain.*

34th MEETING OF IRIG-TWG

The Telemetry Working Group of the Inter-Range Instrumentation Group (IRIG-TWG) held its 34th meeting in Washington, D. C., October 31 through November 3, 1966. On Friday, November 4, the group toured some Goddard facilities. They were welcomed by John T. Mengel, Assistant Director for Tracking and Data Systems, who 15 years ago was a member of the RDB (Research and Development Board), the group which preceded IRIG.

The IRIG-TWG is responsible for producing telemetry standards for use by the military missile ranges. The current standard, Document 106-66 *Telemetry Standards (Revised March 1966)* covers radio frequencies, frequency division multiplexing, pulse duration modulation, pulse amplitude modulation, pulse code modulation, and magnetic recording/reproducing. This document and its earlier editions have had a tremendous effect in the past ten years on telemetry and tape recording systems used in the United States, both by military and non-military agencies. At Goddard, FM subcarrier telemetry and instrumentation tape recorders are notable examples of systems in wide use which have benefited from the IRIG standards.

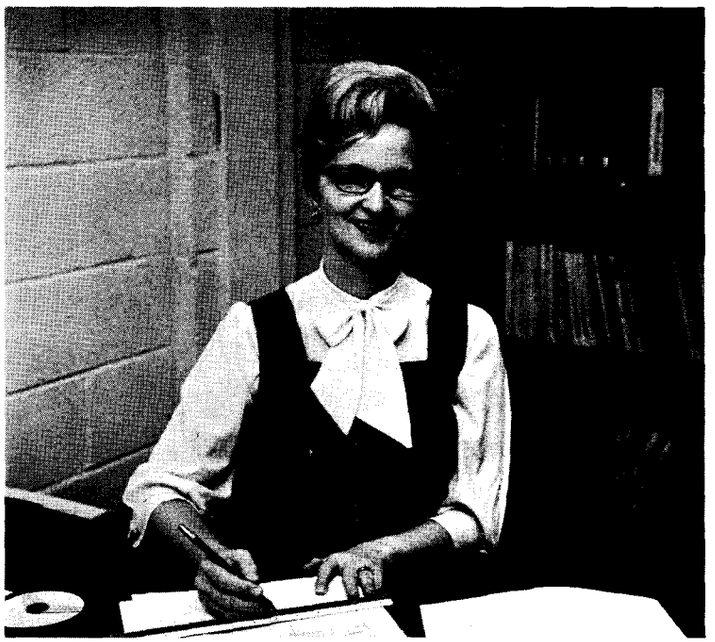
The IRIG members, who represented the Department of Defense and other Government or Government-sponsored activities in many parts of the country, were briefed on NASA Global Communications by Verne Stelter; Manned Flight Computer Support by James Donegan, STADAN Operations by Harold Hoff, and the STARS II telemetry data processing systems by Edmund J. Habib and Frank A. Keipert.

Dr. Robert Coates, Chief of the Advanced Development Division and Chairman of the GSFC Data Systems Requirements Committee, (which is responsible for writing Goddard data systems standards), addressed the group on the subject of NASA data systems and the standards activity being carried out here. A continuing objective of this work is to make Goddard and IRIG standards mutually compatible when possible. For this purpose, three NASA representatives, including one from Goddard, regularly participate as associate members in the IRIG-TWG meetings.

***DANIEL G. MAZUR**, Assistant Director for Technology, presents patent awards to Daniel J. Grant, Head of the Chemical Propulsion Systems Section (SD), and Thomas J. Hennigan, Head of the Electrochemical Power Sources Section (STD). Mr. Grant's patent is for a Photometric Fluid Flow Meter that will be used to measure and control the fuel consumption of microrockets. Mr. Hennigan's patent, entitled "Apparatus for Measuring Swelling Characteristics of Membranes," will be used in battery evalution and manufacture.*

PERSONALITY PROFILES

The second article in a series on Goddard people whose jobs or activities place them in personal contact with employees Center-wide.



Margaret A. "Peggy" Becker

Peggy Becker 'Helps Out' Center-Wide

Peggy Becker is perhaps one of the best-known employees at Goddard. As a publications specialist with Goddard's Visual Arts Branch (TID) and a coach for the Goddard Youth Bowling League, she has come in contact with people from all phases of center activity.

"Her efficient and pleasant manner have been a great asset to Goddard," says Don C. Hutchison, Chief of the Technical Information Division. "Since she helped organize the publications group in 1961, Mrs. Becker has been responsible for the preparation of thousands of technical publications here at Goddard. Her group performs an important service that is basic to the work of the center."

Her supervisor, Patrick M. Kelly, Head of the Visual Arts Branch, adds, "Mrs. Becker's extensive knowledge and experience in publications, plus her pleasing personality, make her outstanding in the visual arts field. She is a very enjoyable person to work with."

In her present capacity, Mrs. Becker supervises the design, layout, typography, and illustrations for such publications as the NASA formal publication series (Technical Notes, Technical Reports, etc.), Goddard Project Development Plans, Introduction to Space Science, etc. In addition, she coordinates the preparation of all GSFC forms and various journal articles as well as gives advice in the preparation of Goddard documents.

"I enjoy doing creative work and working with people," says Mrs. Becker, "and my job has given me ample opportunity to do both. In the 5½ years since I came here, I believe I've met or talked with just about everyone at Goddard. While the job entails much rush work and tension, I derive a great deal of satisfaction in assisting the scientific personnel in documenting and publishing their research and development here at Goddard."

Mrs. Becker's creative and leadership abilities are not limited to her job. She is the founder of the Goddard Youth Bowling

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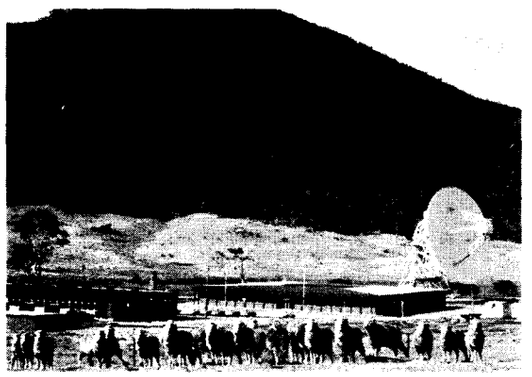
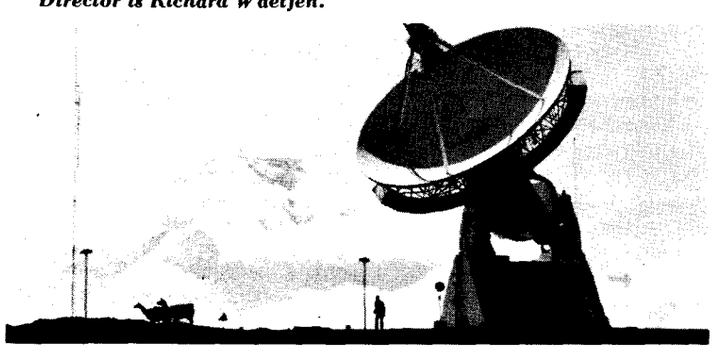
GODDARD AROUND THE WORLD

—News of NASA's Worldwide Tracking Stations—



***CANBERRA (ORRORAL), AUSTRALIA.** Sheep graze near the station buildings. The Station Director is Tom Reid.*

***LIMA, PERU.** Cesar Matto and John R. Laverty conduct a daily radio conference with Santiago and Quito. The Station Director is Richard Waetjen.*



***QUITO, ECUADOR.** Rosita and Pepito, llama pets of station personnel, wander past the 40-foot tracking antenna. The Director is Goddard's Eugene Young.*

***ST. JOHN'S, NEWFOUNDLAND.** Station houses and Minitrack antennas are built near the rugged Atlantic coast.*

PERSONALITY PROFILES . . . *from Page 6*

League and has been its coach for the past three years. Mrs. Becker enjoys the enthusiasm the young people bring to the game. A champion bowler herself, she won a $100 bond in 1963 as the winner of the annual Bowlers Victory Legion Tournament.

Before coming to Goddard, Mrs. Becker worked for private industry and later as a publications specialist with the International Bank for Reconstruction and Development in Washington. After her marriage she retired temporarily, but returned to private industry on a part-time basis to handle various publications.

A native of Boswell, Pennsylvania, Mrs. Becker graduated from Boswell High School in 1943. She has a certificate from the Baltimore Varityper School and has attended classes at Catholic University in Washington.

At the present time, she is trying to set up classes in the preparation of cold type at Montgomery Junior College.

She is a member of the National Space Club, and works on the PTA Executive Committee for Greenbelt Junior High School. She is a sports fan and wouldn't miss a Redskin game.

Her husband is Richard W. Becker, a sales supervisor with the Washington Coca Cola Bottling Company. They have one daughter, Barbara Ann, 13 years old.

They live at 7601 Villanova Road, College Park, Maryland.

DATA TOPICS

William Babcock Poland, Jr. is Head of the Processor Development Branch of the Information Processing Division (IPD). He came to Goddard in July 1963 after having spent 15 years at the Naval Research Laboratory, working on telemetry and data systems.

IPD'S MICROELECTRONIC WORK

By William B. Poland, Jr.

The potential value of ultraminiaturized circuits for spacecraft and other applications where size and weight are at a premium is obvious to all, but microelectronics also have potentialities for ground data processing applications which are not generally appreciated. For example, in the GSFC telemetry data processing facility, there are at present approximately 150 racks of non-microminiature special purpose data reduction equipment, 6 digital computers, more than 100 tape units, and much other miscellaneous equipment. All of this requires approximately 18,000 square feet of space, and conditions are so crowded at present that the STARS line currently under development (F-10) could not have been delivered as originally scheduled without removal of other equipment.

Microelectronic techniques have other advantages for ground data processing systems: miniaturization results in shorter leads, which permit higher speed; the manufacturing processes used give the prospect of greatly increased reliability; and, because they lend themselves to automatic fabrication, microcircuits are proving very inexpensive.

Microelectronic hardware appears to be developing along two major lines. The most advanced techniques provide for placing a large subsystem, such as a large matrix or an arithmetic unit,

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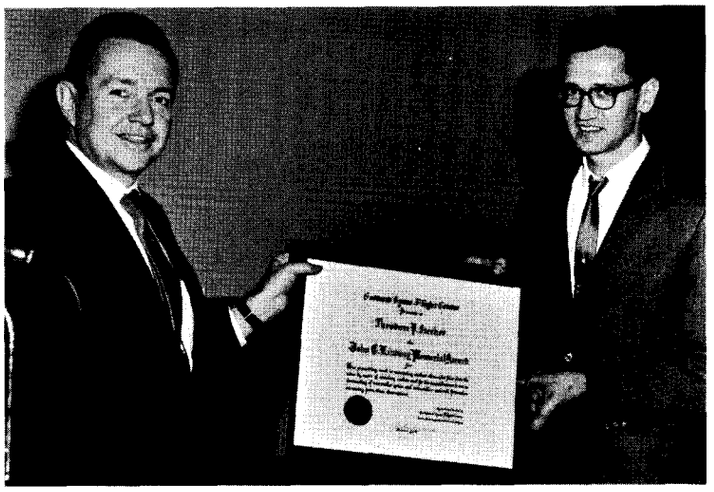
Ted Stecher Presented First John C. Lindsay Memorial Award



THEODORE P. STECHER, (right) of the Astrophysics Branch (LSS), is presented the John C. Lindsay Memorial Award by Dr. John F. Clark, Goddard's Director, at the Scientific Colloquium, October 28, 1966, for "pioneering work in measuring stellar ultraviolet flux distributions by means of sounding rockets and for contributions to our understanding of interstellar grain and interstellar molecule formation stemming from these observations."

This was the first presentation of the John C. Lindsay Memorial Award, which will be given annually to a Goddard employee for an outstanding contribution to science or technology. It is given in memory of Dr. John C. Lindsay, who headed solar research at Goddard until his death on September 26, 1965.

The Lindsay Memorial Lecture was delivered by Professor Bruno Rossi of the Massachusetts Institute of Technology. His subject was "Recent Results of X-Ray Astronomy."

Goddard Scientific Colloquium

November 18 4:00 p.m. Bldg. 3 Aud.

Donald A. Beattie
Office of Manned Space Flight, NASA Headquarters

POST-APOLLO LUNAR EXPLORATION

Extensive studies have been conducted by NASA during the past three years to define a comprehensive lunar exploration program. This effort has been supported by the National Academy of Sciences which has outlined the major scientific questions which should be studied during exploration. From this a recommended program has evolved based primarily upon projected scientific accomplishments in the "geosciences" and astronomy.

PIX QUIZ

ANSWER TO PIX QUIZ ON PAGE 2. It's an inflated protective cover, shielding a backscatter antenna located on the hill in Goddard's Network Test and Training Facility area. Photograph by Ted Hopkins, PIO Staff Photographer.

Meet Our People

Another biographical profile in the series on Goddard people.

Albert Glenn Ferris

Glenn Ferris is one of NASA's pioneer engineer-designers of space data handling and processing equipment. He is Chief of the Project Operations Support Division (POSD) in Goddard's Tracking and Data Systems Directorate.

His division is responsible for the establishment and operation of control centers, the scheduling and control of the Space Tracking and Data Acquisition Network (STADAN) as well as operations evaluation. In discussing his area of responsibility Mr. Ferris stressed the ever-present challenge in operations today and its many opportunities for creativity and originality.

Mr. Ferris came to Goddard in 1959 as Head of the Digital Systems Design Section, Data Systems Division, and as one of the senior design engineers, he was responsible for the design of the early Satellite Telemetry Automatic Reduction System (STARS) and also a number of other special purpose data reduction systems. He became Head of the Space Data Control Branch when the Space Data Acquisition Division was formed, and in 1964 was named Assistant Chief for Control of the Network Engineering and Operations Division. He was also Ground Systems Manager for the OAO.

Before coming to Goddard, he was with the Naval Research Laboratory (NRL) for over eight and one-half years as an Electronic Scientist in progressively more responsible positions. As Head of NRL's Detection Studies Section of the Search Radar Branch, Mr. Ferris was responsible for the design and development of data systems for shipborne and airborne search radars. He also supervised a field facility in an investigative program aimed at determining special target characteristics of rocket launch vehicles and spacecraft.

A native of Toledo, Ohio, Mr. Ferris was graduated from the Central Catholic High School in that city, and earned his BSEE degree at the University of Detroit. He did graduate work from 1951 to 1953 at the University of Maryland.

He is a member of Eta Kappa Nu, the electrical engineering honor society, and in 1950-1951 was president of its Beta Sigma Chapter at the University of Detroit. He is also a member of Tau Beta Pi, the general engineering honor society.

Mr. Ferris, who plays the piano (for fun, he says) is fond of all kinds of music. His other favorite pastimes are boating and reading.

He and his wife, Frances, have one child: a daughter Linda, who will soon be 16 years old. They live at 13006 Peaceful Terrace in Silver Spring, Maryland.

DATA TOPICS . . . *from Page 7*

on a single substrate by means of photoetching and deposition techniques. The size of the subsystem so fabricated is usually limited only by problems of interconnection, or of yield and reliability (since such subsystems are generally unrepairable, there is a break-even point beyond which too large a system will prove unacceptably costly and difficult to manufacture in quantity, or to maintain). Large electronic systems manufactured by these techniques may show a volumetric compression of the order of 100:1 over conventional transistor circuitry. Their use represents a major change for designers of data processing systems, since one is forced to commit oneself to expensive hardware at a much earlier stage in design with a much smaller possibility for modifications later. The only answers we presently see for this constraint are: increased use of automated design to eliminate human error, simulation to thoroughly check out our designs before they are committed to hardware, or increased use of general purpose stored-program processors as integral parts of data processing equipment. Although the last approach is probably the best, there are at present administrative restraints which make it very difficult to pursue.

The other form being taken by much current microelectronic hardware for ground applications is an intermediate approach which requires fewer innovations and is generally easier for the designer to handle. Circuits such as flipflops or shift register stages, packaged in flat packs or some other form of small submodule, are mounted on cards much as individual components were mounted formerly. These cards can then be handled by familiar design techniques, and generally represent nothing more than a better implementation of the conventional logic module. The number of functions on a card may be increased until a practical limit is imposed by the maximum number of interconnections available in a plug-in connector (typically 10 or 20 functions requiring about 50 signal connections). Some significantly improved capabilities are available in these microelectronic submodules provided they do not require excessive interconnections: for example, a 100-bit shift register with a single input and output mounted in a TO-5 can (i.e., a standard transistor housing). The most recent STARS Time Decoder, using microelectronic modules, was packaged in one third of its former volume. It is estimated that, under some circumstances, up to 10:1 decrease in size could be realized using this intermediate approach.

The Processor Development Branch of IPD is preparing to make use of automated design and simulation techniques to exploit the potentialities of mircocircuits. However, our greatest interest at the present time is to set up a sound method for obtaining microelectronic modules on a competitive basis. This will require solving some difficult problems of establishing compatibility and performance parameters. It might be desirable to adopt an approach modeled on the current method for procuring magnetic tape at GSFC. Not only would a demanding set of specifications not hitherto achieved in our logic module procurements be required, but a means for inspecting and, if necessary, rejecting incoming modules would have to be set up. The potential benefits to GSFC of this approach can be guessed from the variety of incompatible circuits now available. The latest D.A.T.A. Tabulation lists approximately 4600 logic circuits made by 94 manufacturers of conventional and microelectronic modules. Virtually none of the various series, consisting typically of a few to a few dozen module types, is guaranteed to be compatible with any of the others. By contrast, in the fields of magnetic tape recording or FM telemetry where IRIG Standard 106-66 operates, there is widespread compatibility of equipment, and many sources are capable of efficiently manufacturing IRIG tape units or subcarrier oscillators and discriminators.

Now that a major shift from conventional to microelectronic modules is about to begin, it would seem an opportune moment to institute some standardization, at least for routine applications not requiring many special modules. If this activity could be broadened to include groups outside of IPD, the effectiveness of the approach would be further increased and the benefit to the Government would be that much greater.