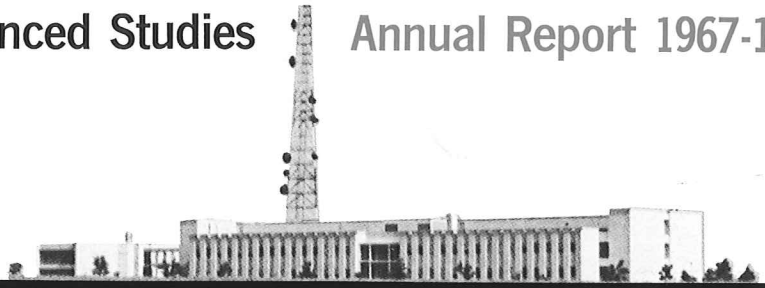
Southwest Center for Advanced Studies

Annual Report 1967-1968



Contents

Southwest Center for Advanced Studies

Annual Report, 1967-1968

Published at Dallas, Texas, by the Southwest Center for Advanced Studies
An independent, non-profit institution chartered by the State of Texas for purposes of fundamental research and advanced education, in the public interest

Printed in the United States of America

Cover Photograph

The Founders Building of the Southwest Center for Advanced Studies rises strongly from the blackland campus, as a symbol of substance in advanced education and basic research.

A view similar to that on the cover was presented in TIME on June 7, 1968, with a short statement of the SCAS mission and accomplishments. The Center herewith makes public acknowledgment of its gratitude to both the magazine and to President Morris Hite of Tracy-Locke Company, Inc., for the preparation and use of this advertising, without cost.

Release to Public Media

This report is released to public media upon distribution at the Annual meeting of the Center's Governors, Trustees, and Advisory Council, October 9, 1968, in the Founders Building.

SCAS and The State Master Plan

Next year our Legislature will receive a proposed master plan from the Co-ordinating Board of the Texas College and University System which, as the Board was charged to do, will set the state's course and pattern of growth in higher education for years to come.

Our North Central Texas region of 10 counties has the largest, fastest-growing urban concentration of people in the southern United States. Nearly one-fourth of Texas' population and that much or more of the total demand for education beyond the high school will be centered in our region by 1980. It is vitally important to North Central Texas that plans to fill these needs be adequately expressed in the state master plan.

The private colleges and universities of Texas, asked what they might be expected to contribute to growth of higher education in future years, have told the state they have the ability to grow as a continuing significant factor in the master plan; but, only if some way is found to obtain and use state funds to aid them in doing this. Such is the story across our nation today.

The Southwest Center for Advanced Studies has carried on the majority of its educational activities in co-operation with the private institutions. The numbers of such opportunities are diminishing somewhat by our collective inability to afford the expansion of graduate programs, except cautiously. Meanwhile the needs, particularly here in North Central Texas, continue to grow and are unfulfilled.

The SCAS now has the opportunity to join with The University of Texas, which is nationally recognized as one of the great state universities, to build significantly, and with high standards of quality, a great urban university here. This will come closer to adding significantly to higher education and graduate training with distinction in North Central Texas than any other single possibility, and it is consistent with the SCAS founding purpose.

This does not mean that we have turned our backs on other co-operative efforts or private education. On the pages immediately following, we review our summer programs, our joint programs, our faculty holding adjunct appointments or otherwise helping to teach in private and public institutions and our postdoctoral training. These should continue.

They can best be amplified and expanded on now by a judicious combination of state and federal funding and continued private support, used in such a way as to provide incentive to hold quality high and enrich the programs of the institution.

Among the several articles in this report, many of them highlighting a single facet of the SCAS research, we make a brief comment on "tighter times" in government support of research. We note that careful planning of research and education programs is the order of the day.

We see opportunities for new kinds of co-operative efforts through TAGER, such as the linking of computer facilities and libraries through which any student in North Central Texas might eventually be able to obtain access to new and powerful tools and a diverse display of references on his subject.

We hope to build on the experience gained in the past year in making our seminars (through the TAGER television system) a strong and significant element of advanced education; in particular, fitted to the never-ending education of the academic community and to the working scientist and engineer in industry.

The Southwest Center for Advanced Studies continues the dedication of its resources to doing what is best for education, with increasing emphasis on North Central Texas, and in co-operation with both public and private institutions.

Gifford K. Johnson

President
October 9, 1968

A Timely and Sound Way to Proceed

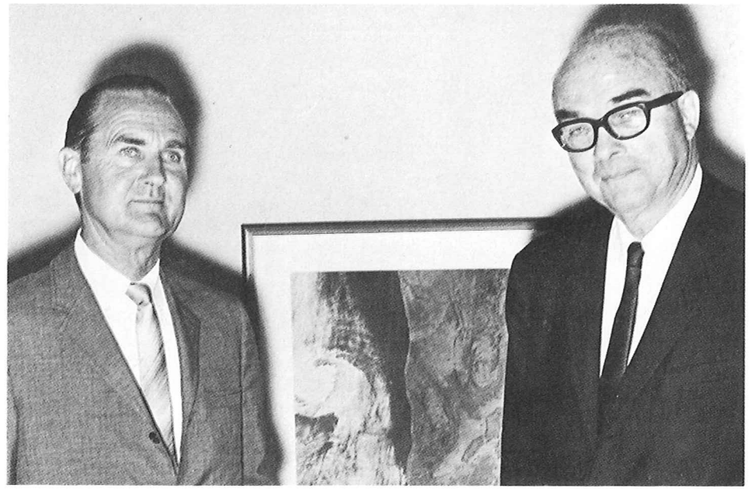
The Southwest Center for Advanced Studies had its origin in community concern that an ever-increasing population should have correspondingly greater educational opportunities in keeping with the evolving industrialized economy. It was formed in recognition of the fact that a climate for excellence was essential, and that there was a vital need for the presence of such a community of scholars as has been assembled in the SCAS.

At its July meeting, the Board of Regents of The University of Texas System unanimously expressed a desire to initiate a great urban university in North Central Texas through the combination of the ever-advancing University of Texas at Arlington, Southwestern Medical School, and the Southwest Center for Advanced Studies.

Speaking for the Board of Governors of the SCAS, we view this proposal as a timely, essential, and sound way to proceed. With the mutual interests of the entire North Central Texas region in mind, specifically in terms of educational and career opportunities for its young, we view with deep pleasure the forward-looking plan of The University of Texas.

To us it gives assurance that mutual interests of this vital part of our great state will be served and that progress toward expanded opportunities across a wide spectrum of academic disciplines can be expeditiously achieved. We have pledged our assistance toward its implementation.

The desire of the SCAS to promote and develop excellence has always been allied with the educational institutions of North Central Texas. The University of Texas System plan, we believe, will directly and greatly contribute to that end, and aid the co-operative efforts of all our public and private educational institutions.



President Gifford K. Johnson *Chairman Erik Jonsson*

I am reminded of the general goal for higher education adopted by area citizens (including representatives from Tarrant, Denton, and other nearby counties) in the program *Goals for Dallas.*

> It says in part that the "North Central Texas area can and must become one of the great education centers of the nation.
>
> "All programs should be of high quality with graduate programs reaching to become steeples of excellence."

We believe these mutual aims can be more thoroughly, quickly, and fully achieved by implementation of the principles to which The University of Texas Regents committed the System on July 26, 1968.

Erik Jonsson

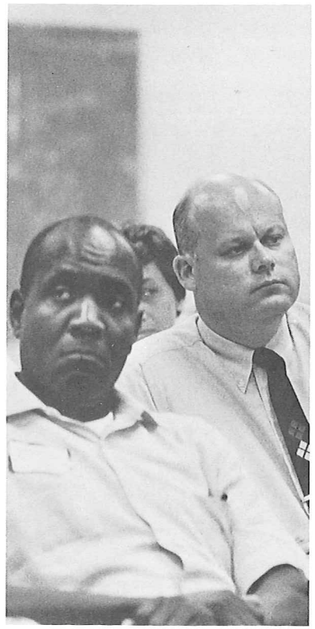
Chairman, Board of Governors

Regents' Vote for Urban University Came July 26

On July 26, 1968, the Board of Regents of The University of Texas System approved (by unanimous vote of those present) a proposal to create an Urban University organization in North Central Texas.

The SCAS would become The University of Texas Center for Advanced Studies under the proposal and serve as one campus emphasizing the sciences and related disciplines and professions.

In this Urban University organization under a regional administrator, the SCAS would join with The University of Texas, Southwestern Medical School in Dallas and The University of Texas at Arlington, to form a three-campus complex.



College teachers attended the 1968 Short Course in Molecular Genetics, offered for the first time.

SCAS Defines "Student" Broadly; Many Reached by Expanding Programs in Education During Year

What is the definition of a student? A *learner*, says the dictionary; an attentive and systematic observer.

This is an excellent definition, from the SCAS viewpoint. It places no limits on ages, achievements in education, or academic titles.

And the Center's education programs do reach out to touch many kinds of students: The *high school graduate* who is interested in science and has shown early abilities, for example.

The *college undergraduate* who can profit by a summer's exposure to research that lets him "get his hands dirty."

The *advanced-degree candidate*, whose research can be helped by use of the Center's facilities and supervision of its faculty, through co-operative arrangements by his home university.

The *high school teacher*, who attends special seminars and audits other presentations.

The *college teacher*, who can learn what is new in his field by coming to a short course in the summer.

The *college student*, undergraduate or graduate, whose class is taught by a SCAS faculty member either in the classroom or through TAGER television.

The working *engineer or scientist* who attends a SCAS seminar, at the Founders Building or by television; and the Center's own faculty members, who present them or attend such seminars to hear and exchange views with eminent visitors.

Also, the Center's *postdoctoral staff*, engaged in research and teaching that will fit them even better for the faculties of regional universities or the industrial research laboratories.

Numbers Are Becoming Impressive

The *numbers* reached by SCAS programs are building up to impressive totals for the Center's seven years.

During the past summer, 53 students took part in active phases of research. Of these, 18 were newly-graduated from high school. Eight of the high school graduates came to the SCAS under sponsorship of The Clark Foundation of Dallas; another was sponsored as a research trainee by Mr. Fred J. Agnich of Dallas, who is a member of the Center's Advisory Council.

Twenty candidates for advanced degrees were doing their thesis research, under supervision of the Center's faculty, as of June 30, 1968.

Thirty-two college teachers attended a three-week *Short Course in Molecular Genetics* during the summer. Major support for the study was provided by the National Science Foundation.

In addition to those studying at the Center, seven Dallas high school teachers audited the course by means of closed-circuit television.

Twenty-four more college teachers were here for the second *Short Course in Earth Sciences.* The National Science Foundation also provided support for this program, first taught in 1967.

Total of 41 Adjunct Appointments

During the past year, 32 members of the SCAS faculty held adjunct teaching appointments at six universities and colleges. The appointments totaled 41. *(See tabular summary).*

In addition to these appointments, teachers were provided for courses at Austin College, in Sherman, Texas, at Bishop College, and the University of Dallas.

Including televised courses, the SCAS faculty taught a total of *35 semester hours,* with an enrollment of *142 students,* at other institutions.

The courses ranged from mathematics and theoretical physics, through Earth sciences, biology and physiology, to computer sciences and programming.

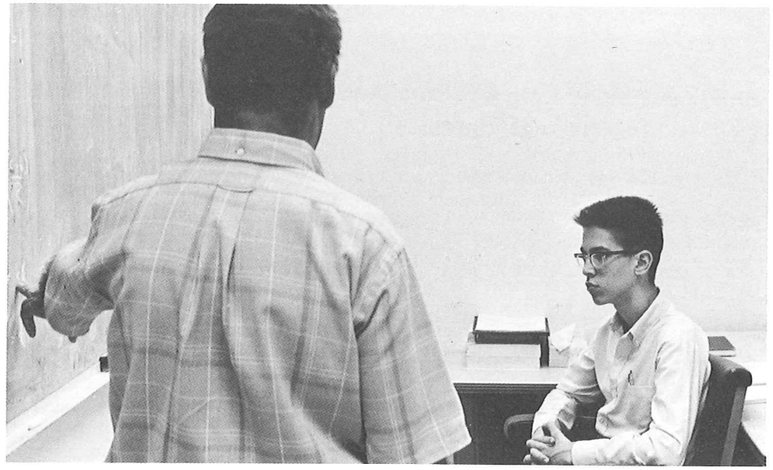
Seminar and lecture totals reached a new high of 259 during the year ended June 30. Of these, a record number of 163 seminars were given by the SCAS faculty and research staff. Visiting scientists gave 96 seminars and lectures. Most of the presentations were carried on the TAGER television system in a Monday-Friday afternoon schedule.

'Postdocs' Remain in Region

Since 1962, 58 postdoctoral research associates have been in residence at the Center. As of last June 30, 28 were here.

Of the 30 who had completed their postdoctoral study, 19 have remained in the Southwest, going to appointments in Texas, Louisiana, New Mexico and Oklahoma. These include appointments to the Center's own faculty.

For the third time, the Center has provided a department head to a Texas institution. On September 1, Dr. Gilbert N. Plass left the Atmospheric and Space Sciences Division faculty to head the Department of Physics at Texas A&M University.



Highland Park High School graduate Alfred T. Gengnagel, a Clark Foundation Research Trainee, discusses an advanced mathematical problem with Prof. Istvan Oszvath.

Eleven Aid Space Center Program

The 11 SCAS faculty in Atmospheric and Space Sciences Division received adjunct appointments to the Southern Methodist University faculty on May 27, 1968.

On that date, a new Space Sciences center and joint graduate programs were announced by Southern Methodist University and the SCAS. Dr. Francis S. Johnson was named Director of the new center, which forms a broad study area with a degree program in space sciences to be conducted in the Southern Methodist University Institute of Technology.

Both institutions will join in the recruiting of graduate students.

Degrees will be awarded by Southern Methodist "in co-operation with SCAS."

Five adjunct appointees from the Center's Geosciences Division continue a similar co-operative program first activated in 1963. Southern Methodist geosciences students have used the Center's laboratories for research since then, and enrollment in courses taught by the Center faculty during the past year was 24.

TAGER Provides Linkages for North Texas Education

TAGER, which is mentioned in this Annual Report by its familiar name, is *The Association for Graduate Education and Research of North Central Texas.*

The TAGER offices and key station in its regional, closed-circuit television network are located adjacent to the SCAS campus.

The SCAS is a charter member of TAGER, which was founded in August, 1965. Southern Methodist University and Texas Christian University, with the SCAS, obtained the State of Texas charter.

Also participating are Austin College at Sherman, Texas; Bishop College, in Dallas; Texas Wesleyan College, Fort Worth, and the University of Dallas.

TAGER has its own Board of Trustees, headed by Chairman Cecil H. Green. TAGER President is Robert W. Olson.

Private funding, including major gifts by Cecil and Ida Green, has enabled TAGER to construct television facilities that this fall link classrooms of five campuses and 10 industrial sites, chiefly for graduate education.

TAGER is not limited to a function in communications. Under its charter, TAGER works in any appropriate fashion to bring together education resources for the benefit of North Central Texas, especially at the graduate level in science and engineering.

SCAS Faculty Holding Adjunct Appointments

At North Texas State University
Dr. Carl B. Collins, Atmospheric and Space Sciences Division.

At Southern Methodist University
Dr. Walter J. Heikkila, Atmospheric and Space Sciences Division.
Dr. Wolfgang Rindler, Mathematics and Mathematical Physics Division.
Dr. Anton L. Hales, Dr. Charles E. Helsley, Dr. Mark Landisman, Dr. Ian D. MacGregor, Dr. Emile A. Pessagno, Jr., Geosciences Division.
Dr. Daniel L. Harris and Dr. Claud S. Rupert, Biology Division.

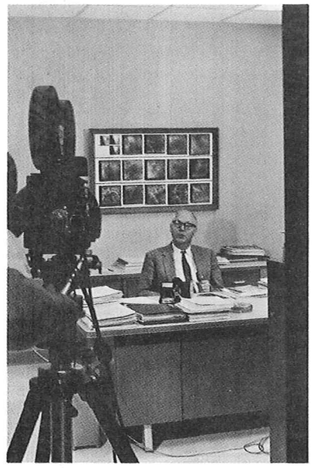
At Southern Methodist University, Space Sciences Center (Institute of Technology)
Dr. Carl B. Collins, Dr. William B. Hanson, Dr. Walter J. Heikkila, Dr. R. Richard Hodges, Dr. John H. Hoffman, Dr. Worth B. Hurt, Dr. Francis S. Johnson, Dr. James E. Midgley, Dr. Ricardo A. R. Palmeira, Dr. Thomas N. L. Patterson, Dr. Brian A. Tinsley, Atmospheric and Space Sciences Division.

At Southwestern Medical School, The University of Texas
Dr. Chaim Richman, Pion Therapy.
Dr. Ronald Bauerle, Dr. Hermann G. Bujard, Dr. Royston C. Clowes, Dr. John Jagger, Dr. Claud S. Rupert, Biology Division.

At Texas A&M University
Dr. William R. Sheldon, Atmospheric and Space Sciences Division.
Dr. Anton L. Hales, Dr. Martin Halpern, Dr. Charles E. Helsley, Dr. Mark Landisman, Dr. Dean C. Presnall, Dr. Glen H. Riley, Geosciences Division.

At Texas Christian University
Dr. Daniel L. Harris, Biology Division.

At Texas Technological College
Dr. Anton L. Hales, Geosciences Division



Dr. Francis S. Johnson comments on planetary exploration for a television program.

Soviets, Americans Stand Even in Venus Data; But Our Planetary Space Program Lags Theirs

"On the whole, we now know more about the atmosphere of Venus than that of any other planet, excepting only the Earth."

"Those of us who are interested in planetary science are faced with the prospect of seeing most of the major new discoveries come from the Soviet program during the next five or ten years."

These conclusions are voiced by Dr. Francis S. Johnson, who heads the Southwest Center for Advanced Studies' Atmospheric and Space Sciences Division.

Doctor Johnson is also Director of the Space Sciences center, Institute of Technology, Southern Methodist University, formed in May, 1968. He is a member of the Space Science Board, National Academy of Sciences; a member of the National Aeronautics and Space Administration's Lunar and Planetary Missions Board; and a member of The United States Air Force Scientific Advisory Board.

Russians Make Intensive Efforts

During the year, he has frequently pointed out that the wealth of data about Venus has come from combined efforts of Soviet scientists who flew Spacecraft *Venera 4* into Venus and Americans who sent *Mariner 5* past and behind Earth's neighbor planet.

The Russian scientists, Doctor Johnson believes, are likely to put a space station on Mars next year. The United States will not be able to do so until 1973, perhaps 1975.

He says: "The intensive space efforts of the Soviets are adding tremendously to their technological and management capabilities; this increased capability must spread in time through other areas of their economy, especially electronics, computers, and military devices.

"It is not just a matter of space exploration alone; *it is the technological and management capability that goes along with space exploration that influences the basic strength of a country.*"

Current fiscal savings may be false economy, he believes, if the United States is forced to make much greater expenditures in the future to catch up with Russia's planetary knowledge and techniques.

In the fall of 1968, the two nations stand about even in their contributions to the knowledge about Venus.

Scientists disagree on a few points. But it is clear, says Doctor Johnson, that Venus has an atmosphere that is very dense, dry and hot.

Thin, very high clouds (20 to 30 miles above the surface) cover the planet; the highest above Earth sometimes approach 12 mile altitudes.

'Hotter Than Your Oven'

"Hot" may seem to be an understatement. It's probably 700 degrees Kelvin on the surface of Venus. Doctor Johnson also puts it "hotter than your kitchen oven at full blast." Ovens exceed 500 degrees Fahrenheit in broiling range. Venus is near 800 degrees at the surface, according to American ideas.

The Russians reported surface temperatures just under 500 degrees from their parachuted instruments, detached from *Venera 4* into an atmosphere that is at least 90 per cent carbon dioxide. The Soviets claim a surface contact on the basis of their radio altimeter data, with radio transmissions stopped as their capsule tipped over.

American scientists believe the Soviet instruments simply stopped working about 18 miles above the surface. The idea of a mountain-top landing has been reviewed, but no one in America believes Venus has peaks something more than 100,000 feet tall.

Although the Russians recorded a pressure of 20 atmospheres, Doctor Johnson believes Venus must have a 100 atmosphere pressure at its surface, or 1,400 pounds to a square inch.

Venus Should Be Explored

Venus is hostile to life as we know it. Mars, which reaches temperatures like Earth's in some places at some times of day and has at least a little water, may be the place we'll prefer to visit in the future. But to say that Venus cannot support life of any kind or should not be further explored? Not Doctor Johnson.

He says "It might, and it should be."

The practical advantage of exploration by the best means available, he says, is in improved understanding of planets in general, and the application especially of this understanding to the Earth and its present state of organization in a geological sense.

Payloads, Rockets Hold "Ready and Waiting" for Observation of Random Polar Cap Events

A large explosion called a solar flare occurs on the visible disc of the Sun. Energy is carried out in various forms of electromagnetic and corpuscular radiation.

Some of this energy penetrates deep into the Earth's atmosphere and produces important geophysical effects. X-rays and ultraviolet light produce sudden ionospheric disturbances over the sunlit hemisphere. High-energy protons arrive an hour or two later, being deflected to the Earth's polar regions by the geomagnetic field; an intense proton flux may last for several days, producing a *Polar Cap Absorption (PCA)* event.

The protons interact with the atmosphere at heights of 30 to 100 miles above the Earth; the primary result is release of electrons from the atmospheric atoms and molecules, and the increased ionization at fairly low altitudes causes the absorption of radio waves.

Later, intense fluxes of electrons literally "rain" into the polar areas, and produce many observable effects. There may be large and rapid variations in the Earth's magnetic field. There may be bright, beautiful, but awe-inspiring auroral displays: the "northern lights" of the northern hemisphere.

Major Events Occur at Random

Dr. Walter J. Heikkila, of the Southwest Center for Advanced Studies' Atmospheric and Space Sciences Division, says that "while a broad picture of what happens in Polar Cap events, including auroral events, has evolved, many questions remain unanswered." To seek more answers, he has instrument payloads and rockets in at-ready status at Fort Churchill, Manitoba, Canada.

The problem in Polar Cap studies is that major Sun-born events occur at random, perhaps 10 times a year, when the Sun is at the peak of its eleven year cycle of flare production. Polar Cap events last only for hours or days, but it takes at least three days after an experiment arrives at Fort Churchill to launch it by rocket. The solution to having a payload in the *right place at the right time for a random event* might be simply put: "Be ready and waiting."

Small rockets are the best means for putting up experiments in the Polar Cap studies, because the events take place at altitudes too high for balloons and too low for satellites.

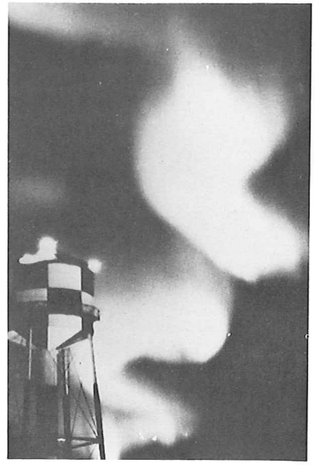
The compromise in readiness amounts to designing experiments that can be checked out by an automatic system, can be put on the rockets, and installed on their launchers. In effect, conduct the count-down to a point near T-minus-one hour, and then hold for warning of an event. Count-downs can be advanced to T-minus-five minutes or less and held for several hours, but range safety then involves a near-shutdown in other activities. The one-hour compromise permits minimum personnel stand-by. The Polar Cap program at the SCAS uses payload designs that are flexible and *recoverable.* The 110 pound payload includes a parachute pack; support system to provide power, timing, control, and radio telemetry; plus, groups of packaged experiments that can be interchanged. Some experiments cover the energetic particles that cause Polar Cap disturbances and some cover the effects caused by these particles.

Recovery May Allow Six Flights

With parachute recovery at 50 to 80 percent (related to numbers of flights) a practical matter, the three SCAS payloads ready in Canada this fall may allow six or more flights during Polar Cap events. Cost per launching can be significantly reduced through recovery. Costs of payloads far exceed the cost of small Nike-Apache rockets.

A significant feature of the reusable payload is the ease with which graduate students may participate in the program. The major task of payload system design and construction need not divert the student's attention away from his own experiment. As a result the time scale for his research is greatly reduced. Also, through recovery, he has the chance to try out his experiment several times if necessary because of instrument malfunction or lack of suitable geophysical conditions. This aspect of the program should be of great significance in the educational activities of the SCAS; for example, in the joint venture with the SMU Institute of Technology.

Doctor Heikkila's Auroral Zone Disturbance investigations are supported by grants from the National Aeronautics and Space Administration. The program was begun early in 1966.



Aurora Borealis (Northern Lights) over Fort Churchill.

Effects on Anoxic Tumor Cells Are Important in Physicist's Pion Dosimetry Research Project

The anoxic cells of a tumor are hard to kill by radiation.

Radiation therapy that does at least equal damage to oxygen-short and "healthy" cells in tumor tissue is important to human treatment.

That is why Dr. Chaim Richman, who has already laid a strong base for the use of *pi-mesons* in radiation therapy, has carried out experiments on anoxic cells during the past year.

Many tumors are not being killed by radiation, he explains, because their anoxic cells are three times more resistant to damage. "If we could overcome this, we would save more patients," he says.

Work Began Seven Years Ago

Doctor Richman, a physicist, began looking into the use of pi-mesons, or *pions,* for tumor therapy seven years ago. The pion is a fast-moving particle that can be drawn from the nucleus of the atom in an accelerator. It can be aimed at tumor cells by careful control of its energy, and produces a strong star-burst of radiation within its target.

Biological effects of the pion's concentrated energy-release are six to eight times greater within the target cells than in surrounding healthy tissue, or along the entry path of the accelerator beam.

During the past summer, Doctor Richman has directed pion beams produced by the Lawrence Radiation Laboratory cyclotron in California at anoxic cells from human kidneys. He has also observed effects on CHO (Chinese hamster cells). Both lines of experiment were directed toward finding the biological effects ratio in the resistant cells.

Neutrons Compared to Pions

He also made comparisons between pion and neutron radiation, in experiments at the Los Alamos, New Mexico, site of the Atomic Energy Commission.

Neutrons are another kind of energy particle from the atomic nucleus. They are being used for therapy in at least one location, London's Hammersmith Hospital.

The neutron radiation is more effective in anoxic cells than cobalt radiation. But healthy tissue in the neutron radiation path, at a 10 centimeter tumor depth, gets twice the dosage in comparison to the amount delivered in the tumor cells. Cobalt has a like effect on healthy tissue in its path.

Dr. Chaim Richman measures oxygen in cells.

The problem with pion radiation, which has the advantage of losing most of its energy in the tumor, is simply one of production. A "pion machine" that can produce hundreds of millions of particles per second is needed for human therapy.

Construction is going ahead on just such a machine, at Los Alamos. A large linear accelerator, to be completed by 1972 under present schedules, will have the needed output.

Doctor Richman's Pion Dosimetry Special Project, at the Southwest Center for Advanced Studies since 1962, is funded in part by grants from the American Cancer Society, the Atomic Energy Commission, and the Office of Naval Research.

Time Seems to Drag in January? Pulsars May Offer Chance to Test Einstein's General Theory

January *is* a long month. It not only seems that way, but Einstein's general relativity theory predicts that time on Earth should run slower when our planet is most deeply immersed in the gravitational field of the Sun.

The reverse should be true in July, when Earth and Sun are farthest apart.

The effect would not be very big; the time variations should be only one second in 50 billion. Fifty billion seconds is most of 2,000 years, so the predicted change per year is a very small fraction of a second.

It still might be measured, except for the fact that all Earth's timekeepers are subject to the faster-slower cycle each year. What's needed, from a mathematician's view, is a very accurate clock that can be read at a long distance from the Earth.

There may be some. Within the past *year,* at least seven *pulsars* have been discovered. These are powerful radio transmitters in deep space, probably more than a quadrillion miles away. Beyond that, no one knows what they are. Very small stars that have burned out and shrunk to incredible density (such that a cubic inch might weigh 100 million tons) and are spinning or throbbing rapidly?

The SCAS Mathematics and Mathematical Physics Division, headed by Prof. Ivor Robinson, will be host to an international discussion of pulsars and related topics in December, 1968. The Fourth Texas Symposium on Relativistic Astrophysics will return to Dallas, where the series began in 1963.

At that time, the name *quasar* became public. These giant centers of energy in space, also broadcasting strong and constant radio signals, were a central item of the discussions.

The pulsars are different. Their radio signals are a series of "pips" so machine-like in their regularity that they defy an explanation that does not do violence to physical laws. The signals arrive every 1.337, 1.273, 1.187, and 0.253 seconds, from the first four to be heard. The fifth, discovered June 15, ticks off at 0.7397 seconds.

They may provide the clocks that can test an Einstein equation.

Discovery of two others was made in August, in southern hemisphere skies viewed from Australia.

At the SCAS, Professor Robinson and Dr. Istvan Ozsvath have been co-organizers of the symposium. The committee includes Prof. Harlan J. Smith, who heads The University of Texas Department of Astronomy; Prof. Alfred Schild, Head of the Texas Center for Research in Relativity; Prof. Engelbert L. Schucking, also of The University of Texas, but presently working at the Courant Institute of Mathematical Sciences, New York City; and Prof. A. W. G. Cameron, Belfer Graduate School of Science, Yeshiva University, New York City.

New Reaction Rate Technique Relates Catalysts to Energy Transitions

A new technique of reaction-rate spectroscopy has been developed at the High Magnetic Field Facility, the primary laboratory in the Materials Research Division of the SCAS.

Dr. C. Girvin Harkins, working in association with colleagues at Rice University, has developed a new technique of reaction-rate spectroscopy for determining the surface states of catalytically active insulator and semiconductor solids.

This, along with other work in related areas, has shown that for the hydrogen-deuterium, or heavy hydrogen exchange reaction, the general active site on insulator-type catalysts is a surface trapped hole.

Hydrogen-deuterium is a hydrogen isotype twice the mass of ordinary hydrogen occurring in water. Magnesium oxide is an example of an insulator-type catalyst.

Doctor Harkins and his associates have found that the mechanism of the catalyzed reaction may change depending on the chemical properties of the material which traps the hole.

It has also been noted that the concentration of such surface hole traps in active sites depends upon the large number of secondary energy levels within the catalyst surface and subsurface phases.

Among the important findings pointed out by Doctor Harkins are that the active site is not necessarily a unique chemical species or a particular structural feature. It cannot function independently of its surroundings at the surface of the catalysts.

Also, the minority energy levels are important in insulator catalysts and must be considered in the electronic theory of catalysis for such catalysts.

The results of this work indicate that the relationships between the electronic structure of solids and the catalytic activity of solids is more complicated than previously thought.

Such studies are giving insight into the complexities of the phenomena of catalysis by solids.

1967-1968 Chronology

October, 1967

Dr. John R. Bradford, Dean of Engineering at Texas Technological College, told the 1967 Annual Meeting audience that graduate education must focus on a *third level,* with a scientific approach to the problem of providing continuing opportunity for professional men and teachers to keep current. (October 25).

"Graduate education is the core of modern adventure," said Dr. Detlev Bronk, 16-year-head of the National Academy of Sciences and the then President of Rockefeller University, in the SCAS luncheon address and an evening talk at the Dallas Assembly.

Ten SCAS Trustees were re-elected, and Mr. L. B. (Preacher) Meaders of Dallas was elected to a new three-year term.

Gifford K. Johnson was elected Chairman of the Board of Trustees.

SCAS Co-Founder Cecil H. Green spoke at dedication of the High Magnetic Field Facility.

November

Mr. William B. Frogue and Mr. T. Louis Austin, Jr., both of Dallas, accepted appointments to the Advisory Council.

December

PIONEER 8 lifted from Cape Kennedy (at 9:08 a.m. EST, December 13), carrying a third SCAS cosmic ray experiment into a deep-space orbit centered on the Sun. *PIONEERS 6 and 7,* launched late in 1965 and in the summer of 1966, carried similar experiments.

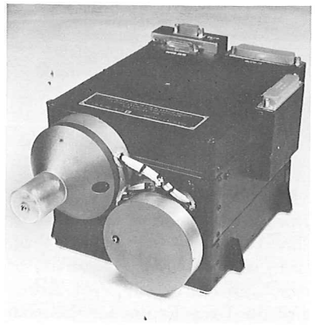
January, 1968

James W. Aston was named Chairman of the Development Council and $3 million Development Fund; C. A. Tatum, Jr., Patrick E. Haggerty, and Amon G. Carter, Jr., were named Vice-Chairmen.

TAGER moved its offices to the SCAS campus, in its own building. The TAGER building, completed in the summer of 1967, also houses the key station of the regional graduate education network.

Dr. Claud S. Rupert was appointed to the Radiological Health Study Section, National Institutes of Health.

Dr. Leopold Infeld, Polish physicist and co-worker with the late Albert Einstein, died in Warsaw (January 16); he had been a visiting faculty member at SCAS in the winter of 1965-66.



SCAS' cosmic ray experiment is carried on PIONEER 8.

February

Mr. Omar Harvey and Mr. Sam Wyly, both of Dallas, accepted appointments to the Advisory Council.

Richardson school trustees voted to name a new high school, to open in 1969, *Lloyd V. Berkner;* the action honors the Center's first president.

Chairman Erik Jonsson of the SCAS Board of Governors, Mayor of Dallas, was named General Chairman of the 1968 Annual Meeting, American Association for Advancement of Science.

March

"Let us continue the search for fact, but also work on questions of society," was the summary view of a panel from the SCAS Biology Division, expressed in a televised discussion on biological research (March 15). The panel's moderator, Dr. Rudolf Hausmann, predicted: "Someday we will create synthetic life. We will start biological engineering, and a revolution in history equal to making tools and changing man's outer environment." The program was covered by the press.

"It is important to introduce macromolecular studies in the regular course structure of universities," said Dr. Charles G. Overberger, Chairman of the University of Michigan Chemistry Department, in an address (March 22). Doctor Overberger, past president of the American Chemical Society, spoke in the SCAS Chemistry Colloquium (March 22-23), which attracted more than 80 from industries and universities.

April

TAGER announced plans for extension of its television network to Austin

Please turn to page 15

Faculty and Scientific Staff

July 1, 1967 to June 30, 1968

Atmospheric and Space Sciences Division

Professor and Head
Francis S. Johnson, Ph.D.
Professors
William B. Hanson, Ph.D.
Walter J. Heikkila, Ph.D.
Kenneth G. McCracken, Ph.D.
(On leave: To University of Adelaide, South Australia)
Gilbert N. Plass, Ph.D.
(To Texas A&M University, September 1, 1968, as Professor and Head, Physics)
Associate Professors
Carl B. Collins, Ph.D.
John H. Hoffman, Ph.D.
James E. Midgley, Ph.D.
Thomas N. L. Patterson, Ph.D.
Assistant Professors
R. Richard Hodges, Ph.D.
Worth B. Hurt, Ph.D.
Ricardo A. R. Palmeira, Ph.D.
Brian A. Tinsley, Ph.D.
Research Scientists
Robert P. Bukata, Ph.D.
(Appointment effective November 1, 1967)
William D. Bunting, M.Sc.
Thomas W. Flowerday, M.S.
Ronald Giroux, B.S.
Philip T. Gronstal, M.S.
Edwin P. Keath, M.S.
William R. Sheldon, Ph.D.
(To University of Houston, September 16, 1968, as Associate Professor)
J. B. Smith, B.S.
Donald Sterling, M.S.
Jens Tarstrup, M.S.
Engineers
Richard L. Bickel, M.S.
(Supervisor, Engineering Support Group)
James M. Carroll, B.S.
James C. Corwin
Nick Eaker, B.S.
Harold W. Glasscock, M.S.
(To May 15, 1968)
Edward C. Lee, B.S.
Billy W. LeFan, B.S.
Charles R. Lippincott, M.S.
Joseph F. Metrailer, M.S.
Richard H. Morgan, B.S.
Felipe Selva, B.S.
Chester L. Shippy
Donald R. Stang, M.S.
Teddy Thomas, B.S.
Karl R. Tipple, M.S.
Richard G. Van Tyne, B.S.
Willie W. Wright, M.S.
Jack M. Younse, B.S.
Donald R. Zuccaro
Adjunct Associate Professor
Alexander A. J. Hoffman, Ph.D.
(To June 1, 1968)
(Texas Christian University)
Visiting Associate Professors
Nelson M. Duller, Jr., Ph.D.
(July 24 to September 8, 1967)
(Texas A&M University)
Grover C. Wetsel, Ph.D.
(Material Research Division and Atmospheric and Space Sciences Division)
(Southern Methodist University)
Visiting Assistant Professors
George W. Kattawar, Ph.D.
(North Texas State University)
(To Texas A&M University, September 1, 1968, as Associate Professor)
U. Ramachandra Rao, Ph.D.
(Physical Research Laboratory, Ahmedabad, India)
Post Doctoral Research Associates
John G. Ables, Ph.D.
(To University of Adelaide, South Australia, August 31, 1967)
Frank R. Allum, Ph.D.
Supriya Santani, Ph.D.
W. Hugh Wright, Ph.D.
(To University of Rhodesia, January 1, 1968)
Visiting Scientists
Forrest D. Colegrove, Ph.D.
(Texas Instruments)
Benjamin Gottlieb, Ph.D.
(Bishop College)
Arthur W. Green, M.S.
(Texas Instruments)
Ann Palm, Ph.D.
(University of California, Berkeley)

Pion Therapy

Professor
Chaim Richman, Ph.D.
Assistant Professor
M. R. Raju, Ph.D.
Post Doctoral Research Associate
Nabil M. Amer, Ph.D.

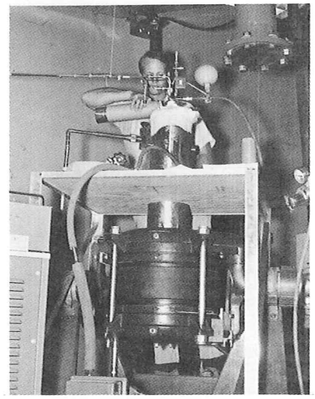
Mathematics and Mathematical Physics Division

Professor and Head
Ivor Robinson, B.A. (Cantab.)
Professors
Yuval Ne'eman, Ph.D.
(On leave: To University of Tel-Aviv)
Istvan Ozsvath, Ph.D.
Wolfgang Rindler, Ph.D.
Visiting Professors
Alfred Schild, Ph.D.
(To August 31, 1967)
(The University of Texas)
Andrzej Trautman, Ph.D.
(To August 11, 1967)
(University of Warsaw)
Associate Professor
Michel Cahen, Ph.D.
(On leave September 28, 1967)
Visiting Associate Professor
Manfred Trumper
(To November 30, 1967)
(University of Hamburg)
(To North Texas State University September 1, 1968, as Associate Professor)
Assistant Professor
Klaus Bichteler, Ph.D.
(To the University of Texas at Austin, January 1, 1969, as Assistant Professor)
Post Doctoral Research Associates
Ronald Kantowski, Ph.D.
(To University of Oklahoma, September 1, 1968, as Assistant Professor)
Elliott Krefetz, Ph.D.
(On Leave August to April, 1967-1968)
(To Boston University, September 1, 1968, as Assistant Professor)

Materials Research Division
High Magnetic Field Facility

Acting Head and Assistant Professor
C. Girvin Harkins, Ph.D.
(On Leave: To Rice University, September 1, 1968)
Adjunct Professors
Sybrand Broersma, Ph.D.
(University of Oklahoma)
Dayton D. Eden, Ph.D.
(Ling-Temco-Vought, Inc.)
Norman G. Einspruch, Ph.D.
(Texas Instruments Incorporated)
J. R. Sybert, Ph.D.
(North Texas State University)
Visiting Associate Professor
Grover C. Wetsel, Ph.D.
(Atmospheric and Space Sciences Division and Materials Research Division)
(Southern Methodist University)
Visiting Investigators
Prof. George W. Crawford
(Southern Methodist University)
Prof. Lloyd E. Gourley
(Austin College)
Prof. Mary F. Gourley
(Austin College)
Prof. H. J. Mackey
(North Texas State University)
Prof. Jack Yahia
(Oklahoma State University)
Research Scientist
Gerald J. Smith, B.A.
Research Assistant
Stanley E. Monroe, B.A.

Please turn to page 14



Dr. Truman Blocker of Texas Instruments uses the High Magnetic Field Facility for a low-temperature experiment.

Newspictures and Notes From Along the Way . . . .

Pictorial Review

1. Glassblower Lloyd E. Jones prepares a laboratory need in the SCAS shop; the glass is often worked in a lathe, with torches as the "tools."

2. Collins Radiomen Mike Wiggins and Emilio Martinez, working as high as 250 feet above ground, keep the TAGER television system antennas aligned. (*See page 5*).

3. Jay D. Jacoby, a Clark Foundation Research Trainee, adds finishing touches to a celestial globe that maps radiation centers in the Earth's night atmosphere. Jacoby, a Hillcrest High School (Dallas) graduate, completed the project during the 1968 summer, working with Dr. Brian A. Tinsley. *(See page 4).*

4. Dr. Beatriz Gomez is hostess to visitors from foreign lands; Nigerian and Belgian guests, among 27 diplomats from 21 nations, were in the group.

5. Scientist-Astronaut O. K. Garriott, NASA Manned Spacecraft Center, conducted a seminar on the Apollo moon-landing program.

6. The SCAS name went up in lights in downtown Dallas, through courtesy of Ling-Temco-Vought, Inc., as the 1968 Development Campaign began. (*See page 20*).

7. An hystrichosphaerid from the Cretaceous of Wyoming; magnified several hundred times, this photo was made in the SCAS electron scanning microscope among many hundreds of microfossil research pictures *(See page 18).*

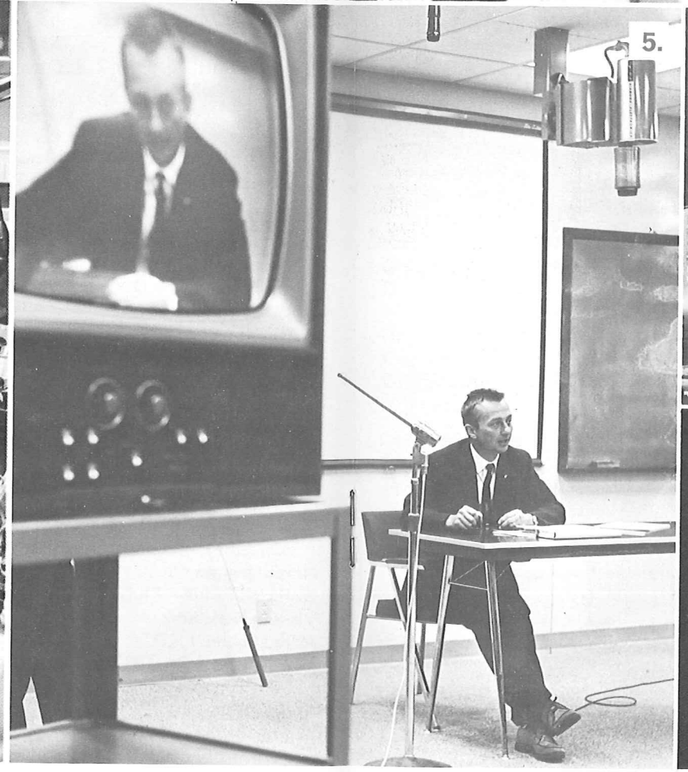
8. With every single connection checked in place, Dr. W. R. Sheldon provided the electronics system for the Texas-Toulouse Joint Cosmic Ray experiment, conducted last summer in the Mont Blanc vehicle tunnel between France and Italy. SCAS, Texas A&M University, the University of Toulouse, and the Nuclear Studies Center of Saclay joined in the observations.

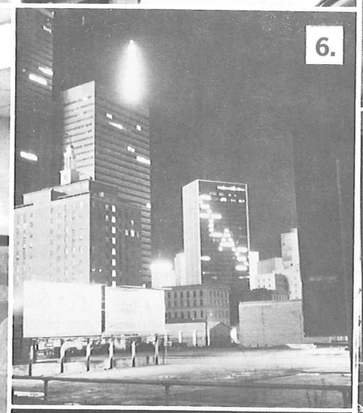

1.

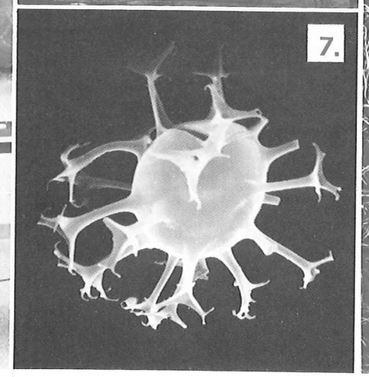

2.


3.


4.


5.


6.


7.


8.

Faculty and Scientific Staff *Continued from page 11*

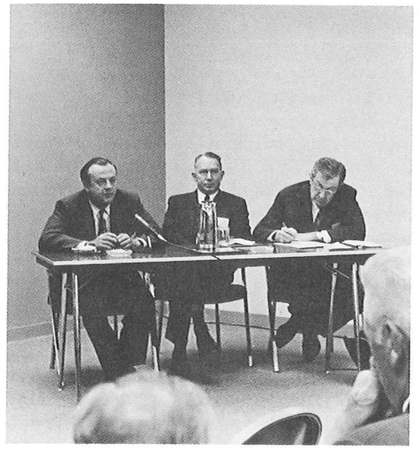
Dr. Royston C. Clowes was named Head of Biology Division on July 1, 1968.

Geosciences Division

Professor and Head
Anton L. Hales, Ph.D.
Professors
John W. Graham, Ph.D.
(Medical Retirement June 30, 1968)
Mark Landisman, Ph.D.
Adjunct Professor
Eugene T. Herrin, Ph.D.
(Southern Methodist University)
Consulting Professor
John S. Reitzel, Ph.D.
(University of Leeds)
Associate Professors
Charles E. Helsley, Ph.D.
Ian D. MacGregor, Ph.D.
Assistant Professors
Martin Halpern, Ph.D.
William I. Manton, M.Sc.
Richard M. Mitterer, Ph.D.
Emile A. Pessagno, Ph.D.
(Appointed Associate Professor, effective September 1, 1968)
Dean C. Presnall, Ph.D.
Glen H. Riley, Ph.D.
James B. Urban, Ph.D.
(Appointment effective May 1, 1968)
Post Doctoral Research Associates
Flavian Abramovici, Ph.D.
Hannes K. Brueckner, Ph.D. Cand.
Peter J. Burek, Ph.D.
James L. Carter, Ph.D.
Jack Dowling, Ph.D.
(To Texas Technological College, August 31, 1967)
Adam Dziewonski, Ph.D.
Hartmut Porath, Ph.D.
Visiting Professor
Yasuo Satô, Ph.D.
(October 2 to November 30, 1967)
(University of Tokyo)
Visiting Research Associate
Claus Propehl, Ph.D.
Visiting Scientist
Philip Horton, Ph.D.
(To July 31, 1967)
(Phillips University)
Research Scientists
Selwyn Bloch, B.Sc.
Ju-Chin Chen, Ph.D.
Rodleigh W. E. Green, B.Sc.
(To July 21, 1967)
Marion J. Roberts
(Appointment effective June 1, 1968)
Engineers
D. Lee Bacon
(Appointed Executive Officer effective July 1, 1968)
John A. Keiller

Biology Division

Professor and Head
Carsten Bresch, D.R.N.
(On leave: To University of Freiburg, July 20, 1968)
Royston C. Clowes, D.Sc.
(Appointment effective July 1, 1968)
Professors
Walter Harm, Ph.D.
Daniel L. Harris, Ph.D.
John Jagger, Ph.D.
Claud S. Rupert, Ph.D.
Consulting Professor
Charles A. Thomas, Ph.D.
(Harvard University)
Visiting Professors
A. N. J. Heyn
(August 1 to August 31, 1967)
Harold L. K. Whitehouse, Ph.D.
(To December 31, 1967)
Associate Professors
Hans Bremer, Ph.D.
Herbert Gutz, Ph.D.
Rudolph L. Hausmann
(To July 31, 1968)
Wolfram Heumann, Ph.D.
(To October 15, 1967)
Dimitrij Lang, Ph.D.
Yvonne Lanni, M.D.
Donald J. McCorquodale, Ph.D.
Harold Werbin, Ph.D.
Assistant Professors
Ronald Bauerle, Ph.D.
Hermann G. Bujard, Ph.D.
Myer L. Coval, Ph.D.
(To August 31, 1967)
Klaus Haefner, Ph.D.
(To March 22, 1968)
Klaus Heckmann, Ph.D.
(To April 30, 1968)
Winfrid G. C. Krone, Ph.D.
(To August 1, 1968)
Michael Patrick, Ph.D.
Philip Witonsky, Ph.D.
Research Fellow
Hideo Hirokawa, Ph.D.
Research Scientists
Ira Felkner, Ph.D.
(To Texas Technological College, September 1, 1968, as Assistant Professor)
Juergen Wiemann, Ph.D.
(To March 31, 1968)
Post Doctoral Research Associates
Peter Angehrn, Ph.D.
Horst Brunschede, M.D.
Rufus S. Day, Ph.D.
Beatriz Gomez, Ph.D.
Helga Harm, Ph.D.



Presidents J. Herbert Hollomon, Herbert E. Longenecker and Frederick E. Terman discuss "Changing Aspects of Research" at the Spring meeting of Trustees and Advisory Council.

Adelaide Macfarren, Ph.D.
Hildegard Michalke, Ph.D.
Wolfgang Michalke, Ph.D.
Kiyoshi Mizobuchi, Ph.D.
Karl Mueller, Ph.D.
Taizo Nisioka, Ph.D.
Narimasa Saito, Ph.D.
Christine Smith, Ph.D.
Derald Smith, Ph.D.
Hiraku Takebe, Ph.D.
Hans-Joerg Treichler, Ph.D.
Engineer
William J. Odom, B.S.

Computer Center

Director
Jack S. Donaldson, M.S.
Administrator
John R. Carpenter
Systems Programming Manager
Carl M. Peters, B.A.
Systems Programming Specialist
Louis B. Wadel
Scientific Programming Manager
Charles R. Shelton
Operations Manager
Bob J. Capers
Librarian
Kay Kimsey

1967-1968 Chronology *Continued from page 10*

April (continued)

College at Sherman; also to five industrial sites, including Bell Helicopter, Mobil Field Research Laboratory, Sun Oil Company Research Laboratory, AtlanticRichfieldCompany's Production Research Laboratory, and Texas Instruments Incorporated at Sherman.

Dr. Francis S. Johnson was elected President of the American Geophysical Union's Section of Geomagnetism and Aeronomy; Dr. Charles E. Helsley was named to the executive committee of the Section of Tectonophysics (April 26).

President J. Herbert Hollomon of the University of Oklahoma predicted that research and development will grow in step with national and regional economies in the immediate future, at about 3 to 5 per cent of productive income; but not at recent, higher rates. The former Undersecretary of Commerce for Science and Technology made his comment in a panel discussion at the Spring Meeting of Trustees and Advisory Council (April 30). He was joined by President Herbert E. Longenecker of Tulane University and President Frederick E. Terman of the SMU Foundation for Science and Engineering, with comment from the floor by Dr. Julius A. Stratton, Chairman of the Board, Ford Foundation.

President Hollomon was elected to the Board of Trustees. Retiring President George L. Cross of the University of Oklahoma was named Trustee Emeritus.

Additional new members of the Advisory council announced (April 30) were: Mr. Louis C. Bailey, Mr. Morris Hite, both of Dallas; Dr. William M. Pearce of Fort Worth, and Mr. George M. Underwood of Richardson.

SCAS ranked third in physical and biological sciences among 12 regional research-and-education institutions reporting their research dollar volume by fields in a survey published by *Industrial Research.*

May

Dr. Francis S. Johnson presented two papers (May 16) at the COSPAR 11th Plenary Meeting in Tokyo. COSPAR is the Committee on Space Research of the International Council of Scientific Unions.

A new Space Sciences center and graduate programs in space sciences were announced (May 27) by Southern Methodist University's Institute of Technology and the SCAS. Doctor Johnson was named Director of the new unit, and all Atmospheric and Space Sciences Division faculty members were appointed as members of the SMU faculty. Degrees will be awarded by Southern Methodist "in co-operation with the SCAS" under the agreement.

June

Fifty-three summer students began summer programs of research participation. Among them were eight high school graduates who were appointed as Research Trainees with the sponsorship of the Clark Foundation of Dallas. A ninth Research Trainee was sponsored by Mr. Fred J. Agnich of Dallas. A total of 18 high school graduates was reached in the 1968 summer program, in addition to college undergraduate and graduate students.

TIME magazine's Southwestern Edition (with a circulation of 205,000 in five states) carried a full-page advertisement stating the SCAS mission and objectives (June 7).

July

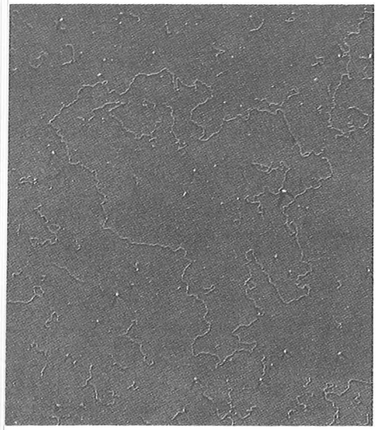
Thirty-two college teachers attended the first SCAS *Short Course in Molecular Genetics* (beginning July 8).

The Board of Regents of The University of Texas System, meeting at Midland, Texas, voted unanimously to create a University Sub-System for North Central Texas (July 26). Under the proposal, the SCAS would become The University of Texas Center for Advanced Studies.

August

Twenty-four college teachers attended the second SCAS *Short Course in Earth Sciences* (beginning August 5).

Dr. Francis S. Johnson was named to the United States Air Force Scientific Advisory Board (August 15).



Circular, episomal DNA from a bacterium carrying the R222 drug-resistance factor. Magnification is more than 12,000 times, as reproduced above.

New Density Bands Appear in DNA When Bacteria Carry Drug-Resistance Factors

Pathogenic bacteria, causing such diseases as dysentery, enteritis, and typhoid, were found resistant to a number of antibiotics normally used for their control some 10 years ago.

This resistance was also found to be infectious; it is transmitted from one bacterium to another by contact.

Especially important was another finding: that the genetic factors determining resistance can be carried by harmless bacteria in the human alimentary tract and then later transmitted to drug-sensitive pathogenic bacteria.

Over the past few years, an increasing proportion of bacteria involved in pathogenic outbreaks has been found to carry these factors. Also, the spectrum of drugs toward which single factors may carry resistance has increased.

The existence of infectious drug-resistance factors is, therefore, a problem of serious clinical importance.

Two Models for Evolution Factors

Their evolution is poorly understood. One idea is that drug resistance develops through mutation of a chromosomal gene, followed by "gene pickup" by a non-chromosomal transfer factor or sex factor which is infectious but carries no drug resistance.

An alternative idea is that mutation leading to drug resistance takes place on a genetic element outside of the chromosome; this element then "recombines" with other extra-chromosomal transfer factors.

Dr. Royston C. Clowes has attempted to gain insight into both of these evolutionary models by analysis of the molecular structures of drug-resistance factors.

Doctor Clowes has headed the Southwest Center for Advanced Studies' Biology Division since July 1, 1968. He joined the faculty in 1965.

Cells containing the resistance factors are cultured and the hereditary DNA material is extracted and purified in his research process. In a centrifuge, the DNA can be separated into bands of different densities.

Presence of a drug-resistance factor within a bacterial cell always leads to the appearance of new density bands. These bands can be separated and examined in a transmission electron microscope.

Drug-resistance factors are characterized by DNA molecules in the form of closed circles. In the case of one factor (222), circular molecules of three sizes at three different densities have been found, says Doctor Clowes.

The smallest molecule (six microns long, or six-millionths of a meter) is found at the highest density; the next smallest (29 microns) at the lowest density, and the third (36 microns) at an intermediate density.

These results suggest that this drug-resistance factor may take the form of a single molecule (36 microns) or of two molecules (29 and 6 microns). In the cell, the two smaller molecules might unite to form the large one, or the large molecule break down to form the two smaller ones.

Factors May Resist Several Antibiotics

More complex drug-resistance factors, carrying resistance to six to seven antibiotics, may evolve in a similar manner, by formation of larger circular molecules from smaller ones.

Existence of the closed-circle molecules tends to support the hypothesis that the original mutation occurs in extra-chromosomal elements which later recombine.

Doctor Clowes' research is supported by a grant from the National Institutes of Health, which was effective in September, 1967.

He came to the SCAS from a visiting professorship in microbiology at the University of California, but had served before then in the Medical Research Council's Unit of Microbial Genetics at London's Hammersmith Hospital.

His research, after graduation from the University of Birmingham in chemistry in 1942 and as a D.Sc. in 1948, began under Sir Alexander Fleming, the co-developer of penicillin.

Five years of service in the British Army interrupted his studies.

Healing Enzyme Observed in Action Through Flash Photolysis Studies

Living cells are readily damaged by ultraviolet radiation. But the healing action of an enzyme unique in the biological world can repair this damage.

Studies are now being conducted in the SCAS Biology Division to learn how and why this remarkable healing enzyme operates as it does.

The healing photoreactivating enzyme is a protein present in most living cells. Exposure to violet light activates the enzyme allowing it to repair damage produced by ultra-violet radiation in the genetic material of the cell (DNA).

Using a technique known as flash photolysis, the enzyme is subjected to very high intensity flashes of light that last only about a millisecond. During these flashes, scientists are able to observe the enzyme at work on damaged cells in the test tube.

Flash photolysis studies at the Center are being conducted by Dr. Claud S. Rupert and Dr. Walter Harm, with Research Associate Helga Harm.

Their research has shown that most of the repair produced by photoreactivation can be carried out under the influence of a single flash of light.

In the dark periods following the flashes, the enzyme frees itself from the damaged cell which it has repaired and attaches itself to other lesions.

By applying flashes at measured times, the scientists are able to observe the kinetics of the healing process.

These and other related experiments also show that the healing process of the photoreactivating enzyme may take as long as several minutes and that some lesions are affected by the enzyme more readily than others.

Although the action of the photoreactivating enzyme on lesions is sensitive to temperature and other factors, the flash photolysis technique does not alter the normal process being observed.

This puts flash photolysis a step ahead of earlier kinetic studies using continuous illumination in which the action of the enzyme and its photolysis were incompletely separated.

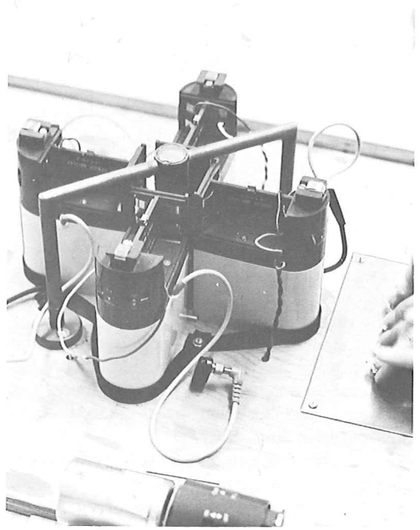
Flash photolysis studies are contributing much to our understanding of the way in which damaged cells are repaired, a fundamental phenomenon.

It is the failure of cells to repair or errors in repair that is thought to be involved in the cause of some types of cancer.

These studies are being supported by a three-year grant from the National Institutes of Health, which is part of the Department of Health, Education and Welfare.

Doctor Rupert received his Ph.D. in Physics from Johns Hopkins University and has been associated with the Center since 1965.

Both Dr. Walter Harm and his wife, Dr. Helga Harm, received Ph.D.'s from the Freie Universitat of West Berlin. Doctor Harm has been at the Center since 1964 and Mrs. Harm since 1967.



Dr. Emile A. Pessagno, Jr., poses a series of microfossil photographs for a television report.

Microfossils, Objects of Beauty, Are Tracers of Past Geological Periods

Tiny fossils sheathed in rock have a mysterious beauty. The artistry of nature is revealed in new forms, day by day, as the research camera records the wonderful microfossil world.

Microfossils and their relation to life's beginnings are the objects of new studies in the SCAS Geosciences Division.

Two scientists in the research fields of *paleontology* (the study of fossil remains as a key to past geological periods) and *palynology* (essentially the scientific study of pollen and spores) have joined the SCAS faculty in the past year.

Palynologist Dr. James B. Urban is engaged in studies of fossils from the Devonian period of about 400 million years ago.

Searches Cover Many Regions

His investigations for the SCAS have taken him principally to the Calloway formation of Missouri, the Woodford Formation of Oklahoma and the Cedar Valley Formation in north central Iowa.

Micropaleontologist Dr. Emile A. Pessagno, Jr., who came from the University of California, is devoting his attention to Upper Cretaceous radiolaria and planktonic foraminifera (microscopic, one-celled animals). He is currently studying radiolaria occuring in the upper Cretaceous strata of the California Coast Ranges, and planktonic foraminifera in the Western Gulf Coastal Plains of Mexico, Texas and Southwestern Arkansas.

To assist them, the first scanning electron microscope to be used exclusively for geological research in the United States was purchased and installed in the Geosciences laboratories in July, 1967.

This revolutionary new instrument enables the scientists to make exquisitely detailed, almost three-dimensional photos of the microfossils. The scanning microscope is capable of magnifications from 30 to 30,000 times.

Doctor Urban's investigations have yielded a rich lode of invertebrate and palynologic fossils which are excellent for cross-referencing.

The detailed study of such fossils provides a key to the history of rock formations reaching into the 60-million-year-long Devonian period. It also provides a record of some of the earliest vascular plants known. Vascular plants are those with channels to carry saps or body fluids.

Fossils Now Prove Significant

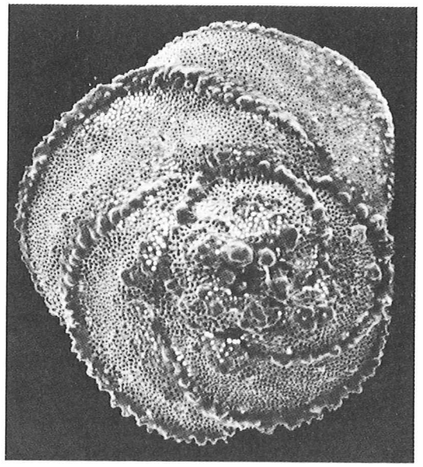
Doctor Pessagno's studies involve microfossils long thought by scientists to have little or no significance. Studies at the SCAS, however, show that both the planktonic foraminifera and the radiolaria make excellent index fossils for determining the ages of Cretaceous and younger marine strata.

During the 65-million-year span of Cretaceous time, which ended 70 million years ago, many species of radiolaria appeared and others became extinct. It is these first and last appearances of various species in a sequence of strata that enable scientists like Doctor Pessagno to determine the ages of the strata.

Because radiolaria are more abundant in the California Coast Ranges than most other invertebrate fossils, it is felt they will help unravel this region's complex geologic history.

Doctor Urban, a University of Oklahoma Ph.D., left his chairmanship of the Geology Department at Central Missouri State College in Warrensburg last fall to come to the SCAS.

Doctor Pessagno, a Princeton Ph.D., left his assistant professorship in the Department of Geology at the University of California at Davis to join the faculty.



Continental Drift, Real or Myth? Search Of Magnetic Records Supports Theory

Continental drift. Real or myth? The hypothesis that the present continents were once assembled into two great land masses that later drifted apart has intrigued and challenged scientists for years.

Although the hypothesis was discussed as long ago as 1620 by Francis Bacon and expanded by Austrian geologist Eduard Suess in the late 19th Century, it has been only in the last 20 years that independent studies of scientists from many fields around the world have added strength to the idea.

Dr. Anton L. Hales, who heads the Geosciences Division, has described himself as a *"reluctant drifter."* But he and others are digging into both the proofs of the hypothesis and the possible causes of drift.

At the SCAS, a research team in the Geosciences Division is conducting paleomagnetic studies to determine the movements of the continents during many millions of years.

In these studies, efforts are made to learn the direction and polarity of the earth's magnetic field at given time periods by studying the fossil magnetism acquired by the rocks as they were formed.

Magnetic Record Shows Polar Wandering

From the varying directions of rock magnetism it would appear that the North Magnetic Pole has wandered considerably during the past few hundred million years, says Dr. Charles E. Helsley.

As seen from North America, the polar wander path beginning about 500 million years ago proceeded from the South Pacific north through Formosa, onto the Asian mainland, then into the Bering Straits and on to the North Pole.

Because all continents have different polar wander paths, the consensus of the scientific community is that the continents, as well as the poles, have wandered.

Going back in time, the shift in latitude of the southern continents was generally southward toward the South-polar regions.

Thus the polar wander paths are a useful means of going back through the years to trace the travel paths of continents and to determine the time of their parting.

Ideally, when the polar curves for two continents such as Africa and South America are traced, the point in time at which they become similar should signify when the continents were united.

Along with studies of rock magnetism on continents, there have been corresponding studies of the rocks in ocean floors.

It is now possible to date the ocean floors and to learn the direction and rate of their lateral motion by examining the striped magnetic patterns found in ocean basins.

Earth's Field Has Changed Polarity

These studies indicate that not only has the Earth's magnetic field changed direction in the past but that it has changed its polarity frequently.

The motion necessary to start reversals of the magnetic field and continental drifting is thought to be a response to the Earth's need to cool itself.

Hot material from the interior of the earth is thought to be transferred toward the surface along the mid-ocean ridges.

The resulting motion clears the ocean basins of sediments which are then added to the continental margins; thus, preserving deep ocean basins and adding to the continents.

Even though current continental drifting is too slight to measure by today's instruments (it is estimated the continents are drifting at the rate of 1 to 5 centimeters a year), scientists at the SCAS and elsewhere are working to add to the body of knowledge that supports the theory of continental drift.

Principal support for the research in rock magnetism is from the National Science Foundation.

Dr. Charles E. Helsley uses a core drill to take a rock sample for magnetic studies.

Mr. James W. Aston (center, at desk) is Chairman of the Center's Development Fund. Vice Chairmen, left to right, are Mr. C. A. Tatum, Jr., Mr. Amon G. Carter, Jr., and Mr. Patrick E. Haggerty.

Center Relies on Quality to Hold Present Level of Research Support in Year Ahead

Research Partners

More than four-fifths of the basic research at the Southwest Center for Advanced Studies is supported by grants and contracts. The SCAS is pleased to acknowledge these research partnerships.

During the year ended June 30, 1968, 118 research projects were funded, in whole or in part, by the following agencies:

Advanced Research Projects Agency
Air Force Cambridge Research Laboratories
Air Force Office of Scientific Research
American Cancer Society
American Chemical Society
Atomic Energy Commission
Life Insurance Medical Research Fund
National Aeronautics and Space Administration
National Institutes of Health
National Science Foundation
Office of Naval Research
U. S. Army Research Office (Durham)

The quality of research at the SCAS, which translates directly from the high quality of its faculty, should be strongly evident in this fiscal year.

There is a changing national pattern of research support, with budget cuts placing constraints on support levels; and, perhaps, a shift of emphasis toward social sciences and applied sciences in the longer term.

Some eminent scientists, who are members of the SCAS Board of Trustees, reviewed this pattern for the joint spring meeting of Trustees and Advisory Council *(See CHRONOLOGY, April, 1968, page 15).*

The current research funds outlook has been taken into consideration in planning the fiscal year budget for 1968-1969.

Education activities have shown a marked increase since 1966, and more education programs are planned, within the limits of the changing national budget.

In summary, the Center expects to do reasonably well this coming year, in maintaining its research support level, because of the quality of its faculty and their fields of research.

This, coupled with prudence and good stewardship, will hold the need for expenditures of private funding to around last year's level.

The 1968 Development Fund

Mr. James W. Aston accepted the Chairmanship of the Development Fund in January, 1968. Serving with him as Vice Chairmen are Mr. C. A. Tatum, Jr., and Mr. Patrick E. Haggerty, both of Dallas, and Mr. Amon G. Carter, Jr., of Fort Worth.

This $3 million fund program will carry on through the fall. More than $2 million in new pledges is in hand; most of these are to be paid over a three-year period.

We seek one-half million dollars, in the campaign, to use in construction of a Graduate Education Center building.

The 1963 Founding Fund

The Founding Fund program of 1963 has been concluded. Five-year pledges of this fund provided the "seed money" through which high-quality faculty could first be brought to the SCAS, and facilities provided to establish their research base.

Average private income, including pledge payments and additional gifts related to the Founding Fund, has been more than $1 million per fiscal year, 1964-1967.

Financial Report

Research

Continued growth in sponsored research is illustrated in the following table. The faculty and staff decreased from 382 to 348 during the past year.

	Sponsored Research	*Center Supported Research**	*Faculty and staff***
April-June, 1962	$ 28,059	$	19
July, 1962-June, 1963	615,835	101,804	100
July, 1963-June, 1964	1,893,286	446,756	184
July, 1964-June, 1965	2,662,718	575,575	227
July, 1965-June, 1966	3,551,146	727,490	342
July, 1966-June, 1967	5,267,855	633,872	382
July, 1967-June, 1968	5,335,723	600,044	348

**Including overhead at same rate as recovered in sponsored research.*
***Excludes summer students.*

Operations Summary

The Center's operating expenditures and income used in operations during the year ending June 30, 1968, are compared with the year ending June 30, 1967.

	Year Ending June 30, 1968	*Year Ending June 30, 1967*
Operating Expenditures		
Research and educational activities	$4,621,466	$4,836,951
Administration, interest expense, etc.[a]	1,926,965	2,059,238
Total Operating Expenditures	$6,548,431	$6,896,189
Income Used		
Sponsored research grants and contracts	$5,335,723	$5,267,855
Private gifts	924,649	1,063,496
Rent and miscellaneous income	197,071	91,063
Proceeds from sale of securities and from "Gifts in Kind"[b]	90,988	473,775
Total Income Used in Operations	$6,548,431	$6,896,189

[a] *Excludes depreciation of $434,174 for year ending June 30, 1968, and of $363,663 for year ending June 30, 1967.*
[b] *Additional securities were sold to make payments of $1,305,550 on loan principals.*

Facilities

During the year, the Center invested $520,823 in plant and equipment. The total investment in facilities at June 30, 1968, was:

Property, Plant and Equipment at Cost	*1968*
Founders Building[c]	$2,817,860
North Office Building	86,014
Site Improvements	575,736
Dallas Magnetic Observatory	49,015
Materials Research Laboratory	272,426
Equipment[c]	1,822,565
Land, Excluding Taxes and Interest	3,735,611
Construction in Progress	53,905
	$9,413,132

[c] *Alterations and fixed laboratory furnishings totaling $354,777 are included in equipment.*

Governors and Trustees

Members of the Board of Governors

Erik JONSSON, Chairman of the Board of Governors
Mayor of the City of Dallas
Honorary Chairman of the Board,
Texas Instruments Incorporated, Dallas
A. Earl CULLUM, Jr., Chairman of the Advisory Council
A. Earl Cullum, Jr., and Associates, Dallas
Cecil H. GREEN, Chairman of the Board, TAGER Director, Texas Instruments Incorporated, Dallas
Gifford K. JOHNSON, President and Chairman, Board of Trustees,
Southwest Center for Advanced Studies, Dallas
Eugene McDERMOTT, Director,
Texas Instruments Incorporated, Dallas
C. A. TATUM, Jr., President,
Texas Utilities Company, Dallas

Trustees Emeriti

Dr. George L. CROSS, President Emeritus,
The University of Oklahoma, Norman, Oklahoma
Dr. M. T. HARRINGTON, Co-ordinator of Programs,
Office of International Programs,
The Texas A&M University System,
College Station, Texas
Dr. Oliver S. WILLHAM, President Emeritus,
Oklahoma State University, Stillwater, Oklahoma

Trustees Ex Officio

Ralph N. STOHL, Vice President for Administration and Secretary and Treasurer,
Southwest Center for Advanced Studies, Dallas
James S. TRIOLO, Vice President for Development and Information, Southwest Center for Advanced Studies *(To September 1, 1968)*

Regular Members of the Board of Trustees

Gifford K. JOHNSON, President and Chairman, Board of Trustees,
Southwest Center for Advanced Studies, Dallas

Dr. Detlev BRONK, Chairman, New York State Science and Technology Foundation,
Albany, New York
Arthur A. COLLINS, President,
Collins Radio Company, Dallas
Dr. Carey CRONEIS, Chancellor,
Rice University, Houston, Texas
A. Earl CULLUM, Jr.
A. Earl Cullum, Jr., and Associates, Dallas
Robert B. CULLUM, Chairman of the Board,
Tom Thumb Stores, Inc., Dallas
Harvey GAYLORD, President,
Bell Aerospace Corporation, Washington, D. C.
Cecil H. GREEN, Chairman of the Board, TAGER Director, Texas Instruments Incorporated, Dallas
Dr. J. Herbert HOLLOMON, President,
University of Oklahoma, Norman, Oklahoma
Erik JONSSON
Mayor of the City of Dallas
Honorary Chairman of the Board,
Texas Instruments Incorporated, Dallas
Dr. Robert B. KAMM, President,
Oklahoma State University, Stillwater, Oklahoma
Murray KYGER, Chairman of the Board,
First National Bank of Fort Worth
James J. LING, Chairman of the Board and Chief Executive Officer, Ling-Temco-Vought, Inc.,
Dallas
Dr. Herbert E. LONGENECKER, President,
Tulane University, New Orleans, Louisiana
Lewis W. MacNAUGHTON,
Dallas
Stanley MARCUS, President,
Neiman-Marcus Company, Dallas
Eugene McDERMOTT, Director,
Texas Instruments Incorporated, Dallas
Dean A. McGEE, Chairman,
Kerr-McGee Oil Industries, Inc.,
Oklahoma City, Oklahoma
L. B. MEADERS, President, Halliburton Company, Dallas
Dr. Joseph C. MORRIS,
New Orleans, Louisiana
Dr. John D. MOSELEY, President,
Austin College, Sherman, Texas
Dr. James MOUDY, Chancellor,
Texas Christian University, Fort Worth
Dr. David W. MULLINS, President,
University of Arkansas, Fayetteville, Arkansas
Dr. Grover E. MURRAY, President,
Texas Technological College, Lubbock, Texas
W. W. OVERTON, Jr., Chairman of the Board,
Texas Bank & Trust Company, Dallas
Dr. Harry H. RANSOM, Chancellor,
The University of Texas System, Austin, Texas
The Honorable Winthrop ROCKEFELLER,
Governor, The State of Arkansas,
Little Rock, Arkansas
General Earl RUDDER, President,
Texas A&M University System, College Station, Texas
Dr. Frederick SEITZ, President,
National Academy of Sciences,
Washington, D. C., and President,
The Rockefeller University,
New York, New York
Allan SHIVERS
Austin, Texas
Dr. Julius A. STRATTON, Chairman of the Board,
The Ford Foundation, New York, New York
Dr. Willis M. TATE, President,
Southern Methodist University, Dallas
C. A. TATUM, Jr., President,
Texas Utilities Company, Dallas
Dr. Frederick E. TERMAN, President,
Foundation for Science and Engineering,
Southern Methodist University, Dallas
Provost Emeritus, Stanford University
Dan C. WILLIAMS, President,
Southland Life Insurance Company, Dallas

Advisory Council

A. Earl CULLUM, Jr., Chairman of the Advisory Council
A. Earl Cullum, Jr., and Associates, Dallas

Fred AGNICH, Investments, Dallas
James W. ASTON, Chairman of the Board, Republic National Bank of Dallas
T. Louis AUSTIN, Jr., President,
Texas Power & Light Co., Dallas
Louis C. BAILEY, Vice President, Texas,
Southwestern Bell Telephone Company,
Dallas
Perry BASS, Fort Worth
Clay P. BEDFORD, President,
Kaiser Aerospace & Electronics,
Oakland, California
Roland S. BOND, Jr., President,
Bond Operating Company, Dallas
Lloyd S. BOWLES, President,
Dallas Federal Savings and Loan Association, Dallas
Dr. Malcolm K. BRACHMAN
President, Northwest Oil Company, Dallas
Col. Charles F. BURLEY (Ret.)
Vice President, Saturn Industries,
Dallas
Col. D. H. BYRD, Dallas
Ben H. CARPENTER, Chairman of the Board, Southland Life Insurance Company,
Dallas
E. O. CARTWRIGHT, President,
The Cartwright Company, Dallas
W. W. CARUTH, III, Dallas
James F. CHAMBERS, Jr.
Chief Executive Officer,
The Dallas Times Herald, Dallas
William P. CLEMENTS, Jr.
Southeastern Drilling, Inc., Dallas
Dr. Donald COWAN, President,
University of Dallas, Irving, Texas
Jerome K. CROSSMAN
Attorney at Law, Dallas
Dr. Milton K. CURRY, Jr., President,
Bishop College, Dallas
R. H. DAVIDSON, President, Foods Division, Anderson, Clayton & Company
Dallas
A. I. DAVIES, Vice President,
Sears, Roebuck & Company, Dallas
Frank W. DAVIS, President,
General Dynamics/Fort Worth
E. M. (Ted) DEALEY, Publisher,
The Dallas Morning News, Dallas
Joe M. DEALEY, President,
The Dallas Morning News, Dallas
Andrew De SHONG, Jr.
Vice President & General Manager,
Dallas Chamber of Commerce, Dallas
J. Harold DUNN, Chairman,
Executive Committee, Diamond Shamrock Corporation, Amarillo, Texas
Beeman FISHER, Chairman,
Texas Electric Service Company,
Fort Worth
Dr. R. G. FOLSOM, President,
Rensselaer Polytechnic Institute,
Troy, New York
T. Carr FORREST, Chairman,
Forrest and Cotton, Inc.
Consulting Engineers, Dallas
J. D. FRANCIS, Chairman of the Board,
Mercantile National Bank at Dallas
William B. FROGUE, Regional Vice President, General Electric Company,
Dallas
E. B. GERMANY, Partner,
E. B. Germany & Sons, Dallas
R. A. GOODSON, President,
Southwestern Bell Telephone Company,
St. Louis, Missouri
Dr. John A. GUINN, President,
Texas Woman's University,
Denton, Texas
P. E. HAGGERTY, Chairman of the Board, Texas Instruments Incorporated,
Dallas
W. Dow HAMM
Dallas
Omar HARVEY, Branch Manager,
IBM Corporation, Dallas
John HEAD
Citizens State Bank, Richardson, Texas
Dr. William B. HEROY, Jr.
Group Executive, Teledyne Inc.,
Dallas
Dr. William B. HEROY, Sr., Dallas
Morris HITE, President,
Tracy-Locke Company, Inc., Dallas
Van Alen HOLLOMON
General Counsel and Treasurer,
Interstate Circuit, Inc., Dallas
W. Herbert HUNT, Vice President,
Hunt Oil Company, Dallas
Claiborne H. JOHNSON
Tobin Realty Company, Dallas
Edmund J. KAHN, Oil Operator,
Dallas

Please turn to page 24

Continued from page 23

Dr. John J. KAMERICK
Vice President and Provost,
Kent State University, Kent, Ohio
(President, North Texas State University, Denton, Texas, effective September 1, 1968)

John LAWRENCE
Chairman of the Board and President,
Dresser Industries, Inc., Dallas

Herman W. LAY, Chairman,
PepsiCo., Inc., Dallas

W. L. LINDHOLM, President,
Chesapeake & Potomac Telephone Companies, Washington, D. C.

The Honorable Eugene M. LOCKE
Locke, Purnell, Boren, Laney, and Neely, Dallas

W. W. LYNCH, Chairman of the Board,
Texas Power & Light Company, Dallas

G. L. MacGREGOR, Chairman of the Board, Texas Utilities Company, Dallas

Edward R. MAHER, President,
Ed Maher, Inc., Dallas

Henry Neil MALLON
Chairman of Executive Committee,
Dresser Industries, Inc., Dallas

Edward MARCUS
Chairman of the Board,
Neiman-Marcus Company, Dallas

Dr. James C. MATTHEWS, President,
North Texas State University,
Denton, Texas
(President Emeritus, effective September 1, 1968)

Frederick M. MAYER, Dallas

Fred M. MAYES, Director,
Production Research,
Sun Oil Company, Richardson, Texas

Avery MAYS, President,
Avery Mays Construction Company, Dallas

Dr. Abner McCALL, President,
Baylor University, Waco, Texas

Robert McCULLOCH,
Chairman of Executive Committee,
Ling-Temco-Vought, Inc., Dallas

Robert M. McKINNEY, Editor,
Santa Fe New Mexican,
Santa Fe, New Mexico

Dr. J. S. McNIEL, Manager,
Field Research Laboratory,
Mobil Research and Development Corporation, Dallas

A. H. MEADOWS, Chairman of the Board, General American Oil Company of Texas, Dallas

Clint W. MURCHISON, Jr., Partner,
Murchison Brothers, Dallas

John D. MURCHISON, Partner,
Murchison Brothers, Dallas

Peter O'DONNELL, Jr., Investments,
Dallas

Dr. William M. PEARCE, President,
Texas Wesleyan College, Fort Worth

Robert W. PORTER, Attorney,
Thompson, Coe, Cousins and Irons, Dallas

Lester T. POTTER, Chairman,
Lone Star Gas Company, Dallas

W. Dewey PRESLEY, President,
First National Bank in Dallas

John J. REDFERN, Jr., President,
Redfern Development Corporation,
Midland, Texas

Elgin B. ROBERTSON
Chairman of the Board,
Elgin B. Robertson, Inc., Dallas

Ralph B. ROGERS, Chairman,
Texas Industries, Inc., Dallas

Frank A. SCHULTZ
Geologist and Oil Consultant, Dallas

Dr. Law SONE, President Emeritus,
Texas Wesleyan College, Fort Worth
(Effective June 1, 1968)

Morris G. SPENCER
The Quadrangle, Dallas

Lee D. STARR, Vice President,
Group Manager, Pennsylvania Stores,
Allied Stores, Inc., New York

Dr. Marshall T. STEEL, President,
Hendrix College, Conway, Arkansas

John M. STEMMONS
Industrial Properties Corporation, Dallas

W. Dawson STERLING, President,
Southwestern Life Insurance Company, Dallas

Robert H. STEWART III
Chairman of the Board,
First National Bank in Dallas

W. B. STRANGE, Jr.
Vice President and General Manager,
Ling and Company, Inc., Dallas

J. T. SUGGS, Chairman of the Board,
The Texas and Pacific Railway Company, Dallas

Dr. Maurice L. TAINTER, Chairman,
Sterling Research Board,
Sterling Drugs, Inc., New York

Robert L. THORNTON, Jr., President,
Mercantile National Bank at Dallas

Leland S. TURNER, Jr.
President and General Manager,
Dallas Power & Light Company, Dallas

George M. UNDERWOOD, Jr., President,
Richardson Heights, Inc., Richardson, Texas

Thomas C. UNIS, Attorney,
Strasburger, Price, Kelton, Martin, and Unis, Dallas

Travis T. WALLACE, Chairman,
Great American Reserve
Insurance Co., Dallas

S. B. WHITTENBURG, Publisher,
Amarillo Globe Times,
Amarillo, Texas

Watson W. WISE, Tyler, Texas

Ben H. WOOTEN, Chairman of the Board, Dallas Federal Savings and Loan Association, Dallas

Sam WYLY, President,
University Computing Company, Dallas

Joseph ZEPPA, President,
Delta Drilling, Tyler, Texas

Officers

Erik Jonsson, Chairman of the Board of Governors

Gifford K. Johnson, President and Chairman, Board of Trustees

Ralph N. Stohl, Vice President for Administration; Corporate Secretary and Treasurer

James S. Triolo, Vice President for Development and Information *(To September 1, 1968)*

John S. Robottom, Assistant Corporate Secretary

Sol Goodell, Assistant Corporate Secretary

Administrative Staff

D. Lee Bacon, Associate Engineer and Executive Officer, Geosciences Division, *(Appointment effective July 1, 1968)*

David W. Canham, Research Support Coordinator, and Executive Officer, Materials Research Division and Mathematics and Mathematical Physics Division

Jack S. Donaldson, Director, Computer Center

Stewart C. Fallis, Special Assistant to the President

Richard T. Lipscomb, Development Programs *(Appointed Director of Development, effective September 1, 1968)*

Alfred T. Mitchell, Information Services *(Appointed Director of Public Affairs, effective September 1, 1968)*

Jim H. Mosteller, Acting Personnel Officer

Kenneth Murray, Executive Officer, Geosciences Division *(To July 31, 1968)*

Roswell C. Peavey, Assistant to the President

David C. Pfeiffer, Director, Campus Facilities

D. C. Rebok, Controller *(To August 21, 1968)*

John S. Robottom, Contracts and Grants Administrator, Executive Officer, Pion Therapy, and Assistant Corporate Secretary

Mrs. Jeanne M. Thweatt, Executive Officer, Biology Division

John W. Vanderford, Executive Officer, Atmospheric and Space Sciences Division

Annual Report, 1967-1968. Southwest Center for Advanced Studies
Produced by the Public Affairs Office.
Alfred T. Mitchell, Director
Patricia M. Atmar, Assistant

Design and Layout: By Horace Herron, Dallas. **Photographic Credits:** Northern Lights Over Fort Churchill (page 7), Public Relations, National Research Council, Canada; Pioneer instrument (page 10) and Visiting Diplomats (page 12), Robert Hume Photography; Jay D. Jacoby (page 13), Richard T. Lipscomb; SCAS in Lights (page 13), Jim H. Mosteller; Hystrichosphaerid (page 13), Dr. James B. Urban; Episomal DNA (page 16), Michiko Mitani; Globotruncana (bottom right, page 18), Dr. Emile A. Pessagno, Jr.; Dr. Charles E. Helsley working in the field (page 19), Bob Combs; Development Fund Leadership (page 20), Ed Benedict. Other photos by Mitchell. **Writing Assistance:** By Betty Clement, Dallas. **Lithography:** By Bennett Printing Company, Dallas.

Southwest Center for Advanced Studies