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Thomas H. Eliot and friend on the terrace of the Chancellor's Residence. Tom Eliot retired on June 30 after nine years as Chancellor of Washington University. Eliot's retirement marks the end of his nineteen years of distinguished service to the University as professor of political science and head of the department, Charles Nagel Professor of Constitutional Law, Dean of the College, Vice Chancellor and Dean of Faculties, and Chancellor. For a few highlights of the Eliot Era in pictures, see Page 2.
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Editor
FRANK O' BRIEN

Associate Editor
and Photographer
HERB WEITMAN

Assistant Editor
DOROTHEA WOLFGRAM

Science Editor
ROGER SIGNOR

Designer
PETER GEIST

COVER: Graham Memorial Chapel by Herb Weitman. This beautiful and historic building, the scene of many great University occasions since 1909, is the subject of a Weitman photo essay beginning on Page 24.

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Photo credits: Page 7 (top) Fred Sweets; Page 34, Amazing Stories, April, 1935; Page 36, Astounding Science Fiction, July, 1938; Pages 38, 39, Don Schlueter; all others by Herb Weitman.

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The Eliot Era at Washington University ended on June 30, 1971. It is far too early to evaluate the full impact of the Eliot administration on the institution, but even at this close range, it seems certain that Thomas H. Eliot will rank with William Greenleaf Eliot, Robert Brookings, Arthur Holly Compton, and Ethan Shepley in the history of the University.

Building on the solid foundations laid by Compton and Shepley, Eliot completed the transformation of Washington University from a good, but relatively unknown institution, to a top level national university. Under Eliot, the drive toward real academic excellence begun under Compton and Shepley went into high gear; with Eliot, the University achieved national recognition commensurate with its academic standing; from Eliot, the University received the inspiration and the leadership to break new ground, to pioneer new programs, to function and grow in most difficult times. Tom Eliot had the misfortune, or the good luck, depending on how you look at it, to serve as chancellor during the turmoil that hit virtually all campuses in 1969 and 1970. Perhaps his greatest achievement is the way he reacted to student protests, demonstrations, and sporadic violence on his own campus. Thanks in good part to Eliot's judgment, Washington University survived the troubles with no real interruption of its main functions of teaching and research.

Dean Merle Kling summed up the Eliot Era best: "In an age of increasing bureaucracy, Eliot may be the last of the individuals who unmistakably leaves his personal stamp on an institution."
Chancellor Eliot presides at a regular Tuesday morning meeting of the "Chancellor's Cabinet." During the Eliot Era, the majority of the members of this top administrative body were full-fledged members of the faculty.

During Eliot's administration, the face of the campus changed dramatically as a series of new major buildings was conceived, financed, and constructed. Here he confers with architects and campus planners over a model of proposed new campus buildings.
A prominent faculty member who never really left the faculty when he became Chancellor, Eliot talks political science shop at a campus reception with William N. Chambers, Edward Mallinckrodt Distinguished University Professor. Interested observer is Nena Rubenstein, then editor of Student Life.

A vital part of any chancellor's job is raising money. During Eliot's administration, Washington University received more than one hundred million dollars in gifts and grants from private sources. Here, the Chancellor looks on as the papers are signed for a $2,000,000 research grant.
Meeting the great and near-great is part of a Chancellor's life. Here is Eliot with British writer C. P. Snow, who gave the 1963 Founders Day address.

Edward Kennedy "Duke" Ellington, recipient of an honorary degree from the University, holds forth for the Chancellor and friends at a Commencement Day reception.

In 1969, Eliot received the William Greenleaf Eliot Society Award for distinguished service to the University. With him is Morton D. May, president of the Eliot Society and member of the University's Board of Trustees.

Eliot, a former member of Congress himself, chats with Stuart A. Symington, U.S. Senator from Missouri, at a University gathering.
Eliot meets with black students who occupied the campus police office in a 1968 protest action. In presenting the Eliot Society award, Morton May said, "Chancellor Eliot's restraint, compassion, and insight in dealing with students helped to avoid violence."

Vice President Hubert H. Humphrey and Chancellor Eliot. The Vice President addressed the campus community at the field house in 1967.

Paul C. Reinert, president of St. Louis University and Chancellor Eliot with the St. Louis University flag that flew over Brookings during St. Louis University's sesquicentennial celebration.
First Lady of the campus in every sense of the word, Lois Elliot was a priceless asset to the University, the Chancellor’s Residence, and the Chancellor.

Meeting new students each year was a refreshing part of the Chancellor’s job. Here, Mr. and Mrs. Elliot welcome new freshmen to the campus.
The Chancellor and his wife were on hand for nearly every home football game. Judging from this happy scene, the Battling Bears must have been winning.

One of the Chancellor's first official duties was a most pleasant one—dancing with Homecoming Queen Ann Boyer at his Inaugural Ball.

The Chancellor and his successor. At left, William H. Danforth, former Vice Chancellor for Medical Affairs, who became the thirteenth Chancellor of Washington University on July 1.
The Washington University Tyson Research Center, twenty-five miles west of the main campus, is an idyllic place—2000 acres of rolling, forested Ozark foothills in a crescent of the Meramec River. An ecological preserve, it is a center for biological research. Investigators from a variety of other disciplines including medicine as well as practitioners of the arts also use the Tyson facilities and are most welcome as long as their work does not interfere with the fundamental ecological purposes of this unique University resource.

Dr. Richard W. Coles, Tyson Research Center director, is a scientist-administrator, whose work includes checking the area's dozen ponds.
TWENTIETH CENTURY WALDEN

THANKS TO A COVER story which Time magazine did on biologist Barry Commoner some months ago, millions of Americans identify him as the "Paul Revere of Ecology" and Washington University as his academic home. But only a comparatively few of these same readers, including a surprising number of St. Louisans, are aware that this University is important in ecological circles for still another reason.

It owns some 2000 acres of wooded, rolling land in west St. Louis County, known as the Washington University Tyson Research Center, which promises to become one of the significant oases in this country for the study and preservation of wildlife and environmental investigations.

In 1963 when the University received this sprawling tract as surplus property from the government, which used it during the Second World War for the storage of ammunition, 650 acres were set aside for ecological studies. But this spring the decision was reached to make the entire holding an ecological preserve—a commitment which is expected to have far-reaching consequences on the development of the site as a major environmental biological study center.

Other Washington University users of Tyson, and there are many, will not be excluded. Indeed, those already doing research in this secluded refuge, including a variety of medical investigators as well as assorted specialists from such diverse disciplines as physics and psychology, will be encouraged to continue and expand their work, as long as it does not conflict with the ecological purposes of the place.

Nor is Tyson to be restricted to those in the sciences. Sculptor Jim Sterritt of the School of Fine Arts and his students are already ensconced in a former warehouse, and this summer the School of Architecture will convert an identical building into a useable, ingeniously structured studio.

Tyson, then, is a new kind of melting pot—a place where practitioners of the arts and sciences can meet, mix, and mingle in an atmosphere which is a wilderness world away from the University's city campuses both at Skinker and Lindell and at the Euclid-Kingshighway enclave.

The man whose responsibility it is to see that nothing interferes with the ecology of Tyson and the individual efforts of its divergent users is its director, Dr. Richard W. Coles. Trained in vertebrate zoology at Harvard where he earned his Ph.D. degree, the thirty-one-year-old Coles, who assumed his Tyson duties last fall, classifies himself as a physiological ecologist, a rather ponderous title. But there is nothing pompous about this young scientist, a free-wheeling spirit despite his scholarly specialization, who can and does swap shoptalk with everybody at the Tyson preserve from animal keeper Lee Riley, to physicist Peter Phillips, one of whose concerns revolves around the question, "Is there an ether filling space?"

It is fortunate for Dick Coles that he can switch mental gears so effortlessly, for his is a job that calls for the qualities of that almost extinct species, the old-fashioned generalist. To understand why Dr. Coles must be a kind of Renaissance quiz kid, one must understand Tyson.

VAST—it is roughly as large as the combined acreages of St. Louis's Forest Park and New York's Central Park—Tyson is some twenty-five miles from the main campus off Interstate 44. A great steel link fence topped with barbed wire surrounds the place, something that all the ecologists appreciate since it serves as a kind of twentieth-century moat, keeping out intruders who might upset the habitat and ecological investigations.
TWENTIETH-CENTURY WALDEN

Only those with official I.D. cards or letters of admission are free to come and go at the Tyson center, but about 800 persons a month pass through the guarded gate. Some are "return trippers," but, nevertheless, there is a good bit of traffic.

A visitor fortunate enough to be taken on an escorted tour by Director Coles will see a secondary oak-hickory forest, the original trees having long since disappeared as these Ozark foothills were successively burned, farmed, pastured, and cut for timber until all such activity ceased about forty or fifty years ago.

Before the coming of the white man, the Indians mined this region for flint, and you can still see evidence of the disturbance they made at Tyson. Much later, in the latter part of the nineteenth century, limestone was quarried at Mincke. Only traces of this ghost town are left at Tyson, but a great grotto dynamited out of the hills is a monumental reminder of how man scars his environment.

Nowadays, Tyson is a quiet place, a beautiful place, and an interesting place if one has the intelligence and patience to observe the wildlife. Some one hundred species of birds have been counted, and there are probably twenty different kinds of snakes, seven species of lizards, half a dozen varieties of salamanders, and more than one hundred deer. There are, moreover, coyotes, red and gray foxes, muskrats, raccoons, opossum, skunks, weasels, three types of squirrels, chipmunks, and four or five smaller species of rodent.

Only a few fish are present, however, because there was little water at Tyson in earlier days. The University has constructed a dozen ponds, which have rather pedestrian names, such as "Railroad Pond" and "Hidden Pond," probably because no poets with Wordsworthian souls have yet discovered Tyson. Quite a few of Professor Owen J. Sexton's students, including Dr. Kathleen Ochs, who wrote her doctoral dissertation on "The Exploita-

"Sarge," Dr. Coles' pet skunk, is aptly named. He has a chevron on his back. A healthy fellow, he has celebrated ten birthdays—quite a record, considering that most skunks depart this world after about seven years.

Tyson's flora is as diversified as its fauna and is typical of the drier parts of the Ozarks. A former graduate student, John Hawker, found more than five hundred species of plants on the tract, including day lilies, survivors of the gardens planted by the departed Mincke settlers.

More conspicuous reminders of former users of the land, however, are sixty-two concrete bunkers fitted snugly into the hills and some fifty odd buildings left behind when the government abandoned Tyson. Some of these bunkers are used as laboratories; others serve as storage areas for anatomical and radiological material from the Medical School, for books slated to be catalogued by the library, and for miscellaneous equipment from both campuses.

As an environmental research center, Tyson is an unusual resource, not only because it is almost certainly the only such place in the country where scientists are working in underground igloos, but because it is one of the few university-owned ecological tracts of substantial size to be located so close to a large city.

Its convenience makes it particularly useful as a training center for those specializing in ecology and biology as well as for those whose interest in science is strictly an avocation. "The latter may well include among their numbers our future Congressional leaders and PTA chairmen, and it is vital that these decision-makers have some understanding of ecological problems," Dr. Coles emphasized.

Dr. Sexton has taken the lead in bringing such students to Tyson, and Dr. Coles is anxious that others fol-
Students from Dr. Owen J. Sexton’s “Natural History of Vertebrates” class at Tyson. At left, Suzanne Keeney and Constance Mantis sight goldfinches in flight. At right, the class gathers around Dr. Sexton as he prepares to collect amphibian eggs from a Tyson pond.

Basking in the Tyson sun is this five-lined bluetail skink, *Eumeces fasciatus*. He is one of seven species of lizards found at the center.
Mary had one and so does Lee Riley, animal curator at Tyson. This little beauty is part of a flock at the center.

Pathologist Dr. Phyllis Hartroft surrounded by some of her Basenji dogs. These animals, natives of Africa, produce antibodies used in her research.
TENT CATERPILLARS or "BAGWORMS" build silken nets in the forks of trees for shelter.

Tyson is a paradise for bird watchers. Dr. Sexton's class learned to identify many species there.

low in his footsteps. "The reaction of students reared in the city when they get out and see animals is really spectacular," Dr. Sexton said.

In the field, ecology, which is simply the understanding of the interrelationships of organisms and their environments, comes alive. Students who sight a red-tailed hawk's nest atop a tall tree on a steep bluff, as some did in May at Tyson, become as visibly excited as their grandparents must have been when they took their first plane trip. It's that great an experience for a generation which has grown up dependent on television for too much of its visual experience.

When they first discover Tyson and what Thoreau meant when he said, "In wildness is the preservation of the world," students are apt to jump to the conclusion that ecology is a phenomenon of this Age of Aquarius. Actually, the subject is at least seventy years old, and there are some scholars who trace its beginnings back to 1864 and the publication of a remarkable book, *Man and Nature*, by George Perkins Marsh. His biographer, David Loventhal, credits Marsh with "an awareness of ecological relationships" as well as a fundamental understanding of "man's role in changing the face of the earth."

Despite the fact that it is no newcomer on the scene, however, it is only recently that ecology has produced techniques of analysis and perhaps answers for some of our most pressing social problems, and it is still only in its infancy as a true scientific discipline.

As a great outdoor field station where biologists can develop hypotheses about the relationships of man to plants and animals and then follow through with experimental investigation in the laboratory, Tyson is a marvelous research resource. It is also invaluable as a preserve not only for the observation of natural change, but as an experimental area for the manipulation of habitat and environment.

Tyson is, moreover, important not only as a conservation enclave for the protection of wildlife within its boundaries, but also as a center where Missouri species such as the wild turkey can be reintroduced into a section where they once flourished.

The possibilities of Tyson as a biological research center are limited only by the imagination of its investigators. Dr. David Kirk is conducting experiments in antibody production by chickens housed in Tyson's hog barn, and Dr. Sexton, with various associates, has been concentrating for some time on the study of the fence lizard, *Scoloporus undulatus*. Dr. J. Emil Morhardt and associates are continuing to use radio telemetry at the research center to study heart rate and body temperature in hibernating bats, woodchucks, and chipmunks. Dr. Kyle Barbehen, of the Center for the Biology of Natural Systems, plans to use animals kept at Tyson for his ongoing investigations of the rat-cat tapeworm and its possible influence on population densities of urban rats.

Soon to be initiated at Tyson is a *St. Louis Meteorex* study, a cooperative effort of the Illinois State Water Survey Board, the University of Illinois, Argonne National Laboratories, and the University of Wyoming. Their purpose is to study the meteorological effects of cities on the air that passes over them. Tyson will be the sampling station for air before it gets to St. Louis as part of a complex project which will seek to find out why there is increased rainfall downwind from this city.

*Under consideration* is the establishment of a canine center at Tyson, the only one of its kind in this country. Here such animals as wolves, including the red wolf now threatened with extinction, as well as coyotes and foxes, would be released on several acre enclosures for propagation and research purposes.

Canine research is already being conducted at Tyson by Dr. Michael Fox, associate professor of psychology, who is studying crosses of coyotes with beagles. Else-
Physicist Peter Phillips prepares to enter his bunker-laboratory at Tyson.

These sheep look as if they belong in a Millet painting. They have been used for pediatric research.

where at Tyson, Dr. Phyllis Hartroft, associate professor of pathology, has developed a Tyson strain of dog from two mongrels found at the center, and has interbred a particular strain of Basenji for use in her medical experiments.

Dr. Hartroft, a researcher at Tyson since 1966, and her group occupy the only building constructed at the center by the University. Here she and a number of graduate students have done important research on hormones found in the kidney and adrenal glands which are associated with hypertension, the formation of red blood cells, and salt retention in the body.

It was Dr. Hartroft and her associates who were the first to demonstrate that a substance called renin was produced in the juxtaglomerular or "J.G." cells. They used a fluorescent antibody technique in this work which has been of major importance in the clinical diagnosis and understanding of specific renal diseases.

Now she and graduate student Marshall Bischoff are investigating another hormone, renal erythropoietic factor (REF), which is also produced in the kidney, possibly in the same cells that make renin. If they can make an extract of this renal erythropoietic factor, develop an antibody for it, and then with the same fluorescent technique discover precisely in which cells the REF is made, Dr. Hartroft and her associates will once again have pioneered on a new frontier.

Two other pathology graduate students, Maureen Frikke and Mrs. Pat Stranahan, are doing research on insulin, and another, Dick Ford, is studying the system of antibody production in rabbits at Tyson.

Meanwhile, Dr. Hartroft and her co-investigator, Dr. Charles Kuhn, III, assistant professor of pathology, in association with the School of Engineering, have applied for a major grant to study the effects of a continuous mixture of air pollutants on animals suffering from a variety of diseases. They propose to carry out this research in two Tyson bunkers equipped with controls which will prevent the polluted air from contaminating the Tyson environment.

In their work, Doctors Hartroft and Kuhn will use different types of animals, including rats, mice, and dogs. Many kinds of research animals are kept at Tyson. Currently, a flock of sheep, as well as rabbits, guinea pigs, mice, and rats are housed there for medical research.

Otolaryngologists Dr. Joseph H. Ogura, Dr. Goro Mogi, and Dr. Joseph E. Harvey until quite recently kept horses at Tyson to make antibodies needed for experimental work relating to larynx transplants in dogs; Dental School researcher Dr. Memory Elvin-Lewis worked with goats to produce anti-sera used in blood tests designed to provide more knowledge about the cause of canker sores and fever blisters; and Doctors David Goldring and Antonio Hernandez, Jr., both pediatricians, used sheep to study the effect of digoxin on an unborn lamb when the drug is given to the ewe. Other medical researchers who have used the Tyson facilities include Doctors Michael Ter-Pogossian, Dr. Judy Metzger, Dr. Steven Teitelbaum, and Dr. Phillip Needleman.

This cursory survey is not intended as a comprehensive or all-inclusive catalogue of who is doing what at Tyson. Rather, it is meant to convey an impressionistic concept of the variety of talents and training represented there. The heterogeneous group associated with this research center are, for the most part, rugged individualists who go their independent ways bound together by but a single bond—their common concern for the peace and beauty of Tyson. In a country bent on bulldozing into suburban sprawl those fields and forests which still rim the outer edges of such cities as St. Louis, Tyson stands in splendid isolation—a reminder of the high price we pay for what some call progress.
Environmental sculpture adds a new dimension to the Tyson scene. This work is by a student, Jeffrey Maron.

This cave, dynamited out of the limestone cliffs at Tyson years ago, is large enough to drive about in a truck.

Dianne Seale (right), a graduate biology student, and a friend, Martin Boraas, collect water samples for analysis.
This article outlines the work of Oliver H. Lowry, chairman of the Washington University Medical School's department of pharmacology since 1947. He is the most cited author in scientific literature. His department, formerly headed by Nobel laureate Carl Cori, is also distinguished for the calibre of students it has trained. Seven graduates have headed other departments: four in pharmacology, one each in clinical pharmacology, biochemistry, and psychiatry. In addition, over one hundred former students are staff members of various academic departments throughout the world.

OLIVER LOWRY: Searcher in the Microworld

By ROGER SIGNOR

That very serious-sounding field of science, biochemistry, is indebted to a premedical student for a facetious remark that he made nearly forty years ago. "Why don't you go into biochemistry?" he advised a young chemistry major. "You can do whatever you want and no one can prove you're wrong."

Biochemistry wasn't quite that wide open. But in the 1930s the field had considerably more elbow room than many other areas of chemistry. The advice of the irreverent premedical student was followed.

Today, the chemist, Oliver H. Lowry, is chairman of Washington University's pharmacology department and a leader in developing and applying new chemical techniques for a better understanding of the functions, the internal workings of life's basic unit—the cell. It's not surprising, though, that few people outside Dr. Lowry's field know anything about his work. As laymen, we are the poorer for our incomplete knowledge of basic research and of biochemistry in particular. For one thing, how well these scientists are able to define and relate the thousands of elegant chemical events that are the life of the cell will have much to do toward a complete understanding of most diseases.

Dr. Lowry, however, is quick to point out that he—as most honest men in basic research will admit—did not enter biochemistry with some grandiose vision of a Medical Breakthrough in mind. In his field, that would be about as realistic as entering the family's second-hand station wagon in the Indianapolis 500.

"As an undergraduate, biochemistry did seem to me as if it held a lot of opportunities—my friend's joke did have a point," Dr. Lowry said. "This business of dramatic motives in basic research is overdone." He explained that when he began his studies at the University of Chicago he learned that there was, indeed, a tremendous potential for biochemists who could come up with ways to do a seemingly ordinary task: to measure the components of cells and tissues with greater precision. "Before then I wasn't really interested in measuring anything. I hated quantitative analysis in college. But when I saw what could actually be done with better quantitative methods in biology, I got very interested."

And, as it has turned out, other biochemists have been quite interested in how Dr. Lowry has succeeded in this fundamental task. The magnitude of their interest was itself measured and published for the first time in 1967 as the "Citation Index" by the Institute for Scientific Information. The results were somewhat surprising and were reported as follows in the London Times: "A top-fifty chart of the world's most eminent scientists is in the current Nature Magazine... Scientific eminence is measured not in terms of how many articles you've written, but how many times other people have cited them in their articles. O. H. Lowry, an American scientist (who?) is well in front with 2,921 citations, and a cool 1,500 lead over number 2. Sir Neville Mott, Professor of Experimental Physics at the Cavendish Laboratory, has nothing to complain about at position 21 since he's three steps up the ladder from Sigmund Freud, lying twenty-fourth." (Dr. Lowry has led the Institute's Citation Index in subsequent years as well.)

One gets an idea of "who" Dr. Lowry is from his answer to why he heads the Citation Index. "The main reason for most of the citations was a paper we did on a method for measuring protein. The paper was a kind of potboiler, stupid sort of research—one of the least original things we've done. The method had been around
Dr. Lowry looks through microscope at sample on one of his most famous devices, the microbalance, which is capable of weighing single cells.

for a long time. We simply made it more accurate—and there are an awful lot of people studying protein.”

Dr. Lowry and his associates have done a number of other experiments, of course, and their reports on them are perhaps not as well cited as the protein paper. But they are nonetheless widely known and put to use throughout the field. Dr. Lowry’s gentle put-down of his place on the Citation Index brought to mind a visit to his former laboratory in the old South Building on the Medical School campus in 1966. It was just after he and Dr. Janet Passonneau had won the Borden Award, which is one of the top medical research prizes in this country. Dr. Lowry and Mrs. Passonneau (wife of Joseph Passonneau, former dean of the School of Architecture) had collaborated for several years in research on nerve cells.

When questioned about the award, Dr. Lowry gave the major credit to Mrs. Passonneau. He very quickly changed the subject by conducting a tour of his then incredibly crowded and cluttered laboratory, proudly demonstrating its countless items of microglassware and other miniature tools made and used by his staff. He patiently answered all kinds of naive questions, making his non-scientist visitors feel that they were every bit as welcome as prominent biochemists or representatives of wealthy foundations.

Since that time Dr. Lowry and the rest of his staff, ten in number, have moved with much of the Medical School faculty into the new McDonnell Medical Sciences Building. On a visit this spring to these spacious and modern quarters, one might expect to find an administrator-researcher like Dr. Lowry in a plush office encircled by secretaries. He was in a far more pleasant office, to be sure; but it was small, sparsely furnished, and without a single secretary to guard the door. He was trying to finish his lunch, which he had brought to work in a paper bag, while listening attentively to a maintenance worker describing his problems in moving equipment to the new building.

There are few scientists who can conceal impatience or irritation at the average non-scientist’s ignorance of the field in question. Dr. Lowry is one of these rare gentlemen. After he had dismissed the Citation Index, he fielded desultory questions about his technical work without a wince and with gentle humor. He recalled that after getting his Ph.D. and M.D. in 1937, he went to work in the Harvard laboratory of an outstanding biochemist and former teacher at Chicago, A. Baird Hastings (affectionately known to his students as “Acid Base” Hastings). Professor Hastings, Dr. Lowry, and several other assistants in the Harvard lab measured the distribution patterns of various salts inside and outside body cells. Later, Hastings’ clinical students applied this basic work to gain a better understanding and treatment of dehydration in their patients.

In 1939 Dr. Lowry won a fellowship to study with another distinguished researcher, the late Kaj Lindström-Lang of the Carlsberg Laboratories, Copenhagen. Dr. Lowry had been dealing with minute biological entities up to that point, but working with Professor Lind-
strøm-Lang he developed one important microtechnique which he and his co-workers at Washington University have refined and used ever since. At the time, standard microbalances—very refined versions of the familiar twin balance scales—were quite sensitive, but not sensitive enough to measure the small clusters of cells that Dr. Lowry was studying. The available commercial balances weighed samples of around one ten-thousandth of a gram and Dr. Lowry was dealing with samples in the area of one millionth of a gram. The hasty assumption by a non-scientist is that the solution to this problem must have been extremely complicated.

"It was the simplest thing in the world," Dr. Lowry said. "Just a fishpole of fine quartz that sticks out in the air. You put your sample on the end of the quartz hair and it bends." He explained that fine quartz filaments had been used extensively in various delicate measuring devices. This first quartz microbalance was housed inside of a gallon tin can, similar to a cookie can, which he found in the Carlsberg lab. Since that time, the microbalance has been streamlined and is now capable of weighing single nerve cells and parts of cells. Dr. Lowry noted that after he made the original microbalance he read that a similar device had been put together in 1915 by a man named C. B. Bazzoni, but that this work had evidently gone unnoticed by contemporary biochemists.

During World War Two, Dr. Lowry joined Dr. Otto Bessey at the newly formed New York Public Health Research Institute, where they carried out nutritional studies of children throughout the city's boroughs. Putting some of his microtechniques to work, Dr. Lowry was the first to do vitamin assays of children from whom extremely small blood samples were taken by pinpricks at the tips of their fingers. Although pinprick tests are now standard procedure, tests for nutritional deficiencies had previously required much larger blood samples, thus prohibiting large-scale screening.

A comprehensive nutrition survey was made by the institute for the city government, documenting iron and vitamin C deficiency in some areas of the city. Later Dr. Lowry did a study of 100 Royal Canadian Air Force personnel to determine how much vitamin C can be retained by the body. It was determined that one 100 milligram vitamin C pill each day fills the body to its capacity for the vitamin, and that any more than this amount per day is completely wasted. Data from those carefully controlled measurements are quite relevant today in view of discussion on the desirability of taking much larger daily doses than 100 milligrams of vitamin C to prevent colds.

For the past twenty-four years at Washington University, Dr. Lowry and his co-workers have devoted themselves primarily to one of the most complex challenges to biochemistry: elucidation of processes in individual cells of the nervous system. The microbalance is only one of many microtechniques they employ. It is an important tool because the weight of a cell type or clusters of cells in an organ must be determined. Within the smallest cell are thousands of molecules, even the largest of which...
Student Larry Shapiro, left, Dr. Lowry, center, and Dr. Philip Needleman, right, assistant professor of pharmacology, conduct laboratory class for medical students. Dr. Needleman was voted by this year's class as one of the Medical School's two top teachers.

Following an experiment, Dr. Lowry and Mrs. Joyce Carter, research assistant, review data. The Pharmacology Department has received top national rankings in two independent surveys.
can be measured only by indirect methods. One ingenious method developed by the Lowry group is a chemical amplifying "trick" to measure the amount of certain reactive molecules in a cell. The minute products of these molecules are built up in controlled chemical reactions to the point where the final products can be measured with great accuracy and are unerring indicators of how much of the original reactive molecules were present in the cell. These critical reactive molecules are protein molecules called enzymes which exist by the thousands in the smallest cell, acting as catalysts in reactions vital to the life of the cell. The amplification technique to measure enzyme quantities is nearly limitless in its potential sensitivity and is an invaluable biochemical tool.

Being able to determine the quantity of cell components such as enzymes are essential first steps. But the raison d'être of this painstaking work is to understand the precise metabolic actions in the cell, such as those involving enzymes. To illustrate, it was found by Dr. Lowry and his associates that a certain chemical inhibits an enzyme which controls the breakdown of the sugar, glucose, in cells. It is interesting to note that in 1969 the late Dr. Helen T. Graham and Dr. Robert M. Burton of the Medical School wrote in nominating Dr. Lowry for an award: "Few, if any, others in the world have made equal contributions to the micromethods for enzymatic studies. Without these techniques detailed analysis of normal function and of disease in complex tissue would be impossible."

They also pointed out: "Professor Lowry's micromethods, while developed primarily to study the central nervous system, have been applied to many scientific areas. For example, we would like to quote references regarding two major nutritional diseases and their chemical study in which Dr. Lowry's methods were employed."

They went on to explain that these techniques were used in testing Guatemalan children suffering from kwashiorkor, probably the most widespread disease of severe protein deficiency. The techniques also were applied in the Philippines to test patients for beriberi, a nutritional disease induced by a deficiency of thiamine. Such applications derived from basic biological studies aren't unusual; they serve as good examples, however, that really fundamental findings are often beneficial to seemingly unrelated areas.

Another example of how microtechniques are applied in Dr. Lowry's lab at the level of the individual cell is the measurement in nerve cells of precisely what part of the cell uses up most of the energy during its electrical firing. This is a very basic observation, of course; but many such observations must be made and interrelated before there can be an understanding of general nervous system processes such as fatigue. These extremely detailed biochemical measurements are a far cry from romantic extrapolations in popular magazines and books to the effect that biochemists "soon will manipulate cell chemistry" as an engineer controls a computer, or that there will soon be chemicals, so-called "smart pills," to improve peoples' memory.

This kind of fantasy may be titillating to some, but the reality is that man's actual knowledge of cells, and of nerve cells particularly, is still at a primitive level. And Dr. Lowry and others are convinced it will stay there unless individual cells are first understood in much greater detail.

In giving one of the Harvey Society Lectures in New York City in 1962, which is a high honor for any scientist, Dr. Lowry concisely outlined the need for making detailed measurements of the many individual cell types of the nervous system or of other organs.

"It is not difficult to justify studies of individual cells," he began. "If every cell in an organ were alike this might not be true, but no tissue or organ in the body is built of a single cell type, and even a few special cells sprinkled through an organ may have great significance for function . . . cells otherwise identical may not all be in the same state of activity at any given time. In the extreme case, one really bad cell can multiply and cause destruction of the entire body. For these reasons and many others it seems necessary to study not only whole organs, but also individual cells of these organs.

"This is particularly necessary in the case of the nervous system because of its unusual complexity. The brain is a wonderful mixture of nerve cells of all sizes and shapes with a rich mixture of glial (structural) cells of several varieties. It would be hard to imagine that all components of the brain are chemically alike . . . certainly a homogenous brain could not do much thinking . . . I see no way to make the full chemical study of any living thing really simple. With thousands of enzymes and metabolites (food stuffs) present in every cell, and with an organ that has the anatomical and functional complexity of the brain there are bound to be complicated problems that can occupy many people for some time. We can agree that the brain is worth the effort."

To his students and co-workers Dr. Lowry shows a commitment to his work that isn't readily apparent to an outsider. A man who will always take time out to explain a point to a student or to make a visitor to the department feel at home doesn't exactly give the impression of J. D. Watson's model of the zealous scientist in the book The Double Helix.

Dr. Lowry is low key, but his deep commitment to his work was described by his former colleague, Dr. Pasonneau, to a reporter back in 1962 when they received the Borden Award. An outspoken and straightforward individual who is now chief of the National Institutes of Health Section on Cell Neurochemistry, she said, "I want to make it plain I'm no Madame Curie. I'm a competent scientist, but Dr. Lowry is the real genius behind this work . . . [In this research] you have to have the commitment that makes you never want to do anything second best. Dr. Lowry is my idea of a man who has that compulsion. He's a great scientist and it's not in the hope of getting the Nobel Prize, or anything like that. It's for the sake of the work itself."

23
There is an aura of expectancy which seems to hover over Graham Chapel. Since its dedication in 1909, the Chapel has been the scene of the University's great occasions, and to these occasions it has lent a presence of its own. Whether it thunders with the sound of its own organ, the laughter of an appreciative audience, or the applause of the University community, the Chapel speaks of dignity and warmth. The thirteenth building on the Hilltop campus, it was given by Mrs. Christine Blair Graham in memory of her husband, Benjamin Brown Graham. Its architect was James P. Jamieson, who had come to St. Louis in 1900 as the St. Louis representative of Cope and Stewardson of Philadelphia, architects of the new campus. Jamieson constantly denied that the Chapel was a copy of King's College Chapel at Cambridge, once rather haughtily pointing out that anyone who knew that magnificent structure could not entertain the idea. Yet he fought a losing battle, for the misconception, which seems to have originated in a University publication describing the chapel dedication, can still be heard today.
SUBJECT OF THE great 16th-century style east window of the Chapel is scenes from the court of Solomon, which must have been chosen as both appropriate for the University setting and as a neutral subject fitting the services which in 1909 were strongly Unitarian in tone. When the Jamieson family was in London in 1905, the architect worked with Messrs. Clayton and Bell, glassmakers, on the windows. His daughter recalls that among his concerns was the tint of the plain colored glass in the side windows, designed to filter and warm the light. The care to detail given to the building is perhaps most apparent in this comment evidently made by the English glassmakers. A study of the window notes the "richness of detail and depth of colour have been used to produce a window successfully adapted to the strong light prevalent in America." This meticulous attention to every detail of the chapel building is even apparent in the grey Tennessee marble floor, where the pattern of squares gives way to elongated tiles to mark the aisles. Jamieson describes the care taken in selecting materials and in supervising construction of all of the early campus in his Intimate History of the Campus and Buildings of Washington University, published privately in 1941.
The carved wooden figures which are among the Chapel's striking interior features are a part of an organ case described as one of the most distinctive in the country. Cabinet work for the original case was executed in Germany for Kilgen Organs of St. Louis. Although workmen undoubtedly exercised their own creative judgment in the carving, the overall design is believed to have been Jamieson's. Similar figures appear on each side of the case, but no two are alike. The same individuality marks the limestone bosses which are seen elsewhere on campus and are exceptionally fine on the Chapel. When the organ was rebuilt in the 1940's by M. P. Moeller Company of Hagerstown, Md., the original case was restored and enlarged. Having despaired of finding an outside cabinetmaker to match the early work, the Moeller company threw its own workmen into the project for four months.
During the early years of Graham Chapel, University organist Charles Galloway used to give Sunday concerts on the organ which he had designed for the building. That organ wore out in 1935. It was replaced by a Hammond which, although almost everyone agreed was unsatisfactory for chapel use, was used for about a decade. Then Miss Avis Blewett, a wealthy St. Louisan and a teacher of music, asked Howard Kelsey, who played in the Chapel but had refused to accept a permanent appointment as long as the Hammond was in use, to design a new organ. Her commission was to design the instrument Kelsey believed to be ideal for the building, regardless of cost. He selected a three keyboard, 3000-pipe organ.

On October 5, 1948, E. Power Biggs played the dedicatory concert on the Blewett Memorial Organ. Miss Blewett had not lived to hear the concert. The same year, Kelsey was named University organist and is, as well, administrator of Graham Chapel.
Professor Clark is a theoretical physicist whose special fields of interest include neutron stars, quantum mechanics, and most recently, theoretical biology, with special emphasis on mathematical models of human mental activity. He has published some twenty-five articles in scientific journals, primarily in nuclear many-particle theory. In this article, based on an address before the St. Louis Wednesday Club, Dr. Clark discusses science fiction's role in finite man's attempts to cope with an infinite universe.
SCIENCE FICTION
AND THE FINITUDE
OF MAN

In the beginning, the infant is the center of his universe, which is one with him. We know that this world view is not true, except perhaps in the most ephemeral sense. The child first becomes aware of the distinction between himself and the external world when he discovers there are some things about his surroundings over which he has no power. The full extent of the severe limitations of the human individual are realized, step by step, as a person grows up, and a sequence of painful mental readjustments must be made. Even so, a complete equilibrium between what an individual longs for and what he can actually achieve is never attained, for “man’s reach forever exceeds his grasp.” To us all, the source of most unhappiness is the temporal limitation imposed by the specter of impending death. Otherwise, one could take solace in the belief that, in time, all personal goals could be realized.

How can the individual come to grips with this unsatisfactory aspect of reality? The traditional answers are supplied by religion, and these answers divide naturally into two essentially incompatible classes: the Eastern, typified by Buddhism, and the Western, typified by the Judeo-Christian and Moslem faiths.

In the Eastern view, one must renounce all earthly desires, which can bring only unhappiness. One is implored to return to the infant state in the sense of negation of the distinction between self and universe.

The world, in the Western view, is made for man, who is qualitatively different from nature. The infant in a sense is right—man is the center of all things. But in a sense he is wrong—man is separate from the world. The notion that man's experience should be restricted to the brief span of his life on earth and that he should always be burdened with the limitations of corporeal existence appear unacceptable. It would not be worth creating a universe just for that. Thus an afterlife is conceived, in which all desires of a certain morally defined class will be fulfilled. The Eastern and Western views seem incompatible for the same reason that an infant’s view seems inconsistent, but we shall find that, in the ultimate issue, there is no contradiction.

A train of sobering scientific discoveries, beginning in the sixteenth century with Copernicus and continuing through Darwin in the nineteenth century to the present, has forced a steady retreat of man from his imagined place at the center of the scheme of things. Man is dwarfed to apparent insignificance against the backdrop of a spatially and temporally vast and indifferent universe.

To summarize the bare facts revealed by some of these discoveries: We live on a small planet, circling an average star, the sun, which is one of some 100 billion stars forming a disc-shaped, spiral galaxy. Our galaxy is in turn only one of perhaps 100 billion similar star systems in the universe. In size the observable universe is to the earth as the earth is to the atom.

The universe has existed perhaps eleven billion years; the sun and earth, some five billion; life on earth, about three or four billion. Human life has been around perhaps a million years; we have less than ten thousand years of recorded history. Man is but an infinitesimal spark in a virtually boundless, ageless universe. As G. Feinberg boldly asserts in The Prometheus Project, a source for many of these ideas, “The scale of the universe is far too great for man to be its central theme.”

Man is a part of nature and is not qualitatively different from it. He is an animal distinguished from other animals only by the higher order of complexity and organization of his nervous system. Further, the behavior of all living things, including man, is ultimately describable in terms of the same laws of physics as govern the behavior of “innimate” objects—atoms, diamonds, ocean waves, stars. This presumably holds also for human mental processes. Living things are distinguished from the non-living only by a certain higher degree of complexity and organization which enables them to extract order from a formless and chaotic yet relatively stable environment, and to change themselves so as to maintain and improve this ability—to stay “alive” and evolve.

While these facts are sobering indeed to the ego of man, the scientific vision of the universe of which they are the barest summary is by no means mechanistic and
sterile, but is, rather, dynamic and full of potency. It has a certain undeniable austere beauty.

For as the life of man has its season, so does the life of the universe. The universe is observed to be expanding at a prodigious rate. The galaxies and dust clouds of which it is made are receding from one another at speeds up to that of light. A gigantic explosion is in progress. Some eleven billion years ago the universe was supposedly confined to a tiny space, formless, but possessing great potency, great energy. In an instant, the fundamental physical constants, like the charge on the electron, were decided by chance; then the physical laws of our universe took over and there was a tremendous explosion—the "big bang." Eventually the energy of the explosion will be used up, and the expansion will slow to a halt because of the gravitational attraction of all the pieces of matter for one another. The universe will thereafter contract, ultimately down to the same exceedingly tiny space in which it was born. The scenario will then repeat, with different fundamental constants. There will be a cyclic creation and destruction of universes, all subtly different. Each cycle is believed to take about eighty billion years, so there is no need to panic!

As the complete code for the individual man (or rabbit or rose) resides in a single set of his DNA molecules, so the complete code for an individual universe (and hence, in the case of our universe, for DNA, for man, rabbit, rose, Empire State Building, the sun . . .) resides in a single proton. One could take the DNA from a skin cell of a man and in principle build an identical copy of his body, but of course not the man's distinctive brain patterns. Similarly, one could take any proton and any antiproton in the universe and let them collide with sufficient energy, and an identical universe (and anti-universe) could be created. Essential to this assertion is the equivalence of matter and energy, discovered by Einstein. Out of the collision there could spew (in principle) man, rabbit, rose, Empire State Building, everything.

How, though, are we now to cope with the obvious finitude of man the individual, when faced with the scientific evidence for the finitude of man the species? The Eastern answer to the crisis of individual finitude still applies in this enlarged context: Accept the world for what it is and hope for no better. The Western response to the crisis of the individual also applies, if restated in a language consistent with the scientific world-view: Wait till later; all possible desires of a certain physically admissible class including virtual immortality can be achieved in time, the limitations of man can be reduced or eliminated, if not for ourselves then for our descendants. The mechanism envisioned is either natural evolution of man toward a more ideal state or direct intervention of man himself in this process. The extreme "activist" Western viewpoint is: Though science causes us to forgo hopes of individual transcendence, perhaps it can be enlisted to further the cause of transcendence of mankind as a whole. This is the prevailing Western attitude, typified at present by the American preoccupation with minimizing the limitations of man by technological control of the environment.

But it can go much deeper. If man is ever to amount to anything on the cosmic scene, he must rebuild himself on a grander scale. An underlying assumption in this attitude is that natural evolution is too slow or too devious. In a very real sense, of course, the distinction between natural evolution and evolution induced by man is artificial, since man himself is an agent of nature.

The most enthralling themes of science fiction may be interpreted in terms of this great adventure: the systematic exploitation of science and technology to erase man's limitations. In this view, science fiction is very definitely escape literature, but escape literature with a purpose, one might even say a spiritual purpose, since it directs thought toward the real problems and mysteries of existence: man's role in the universe of science, the nature of consciousness, the nature of time. Kurt Vonnegut, author of *Slaughterhouse Five,* *Cat's Cradle,* and *Player Piano,* has called science fiction "the apocryphal literature of the twentieth century."

The tone of this literary medium may be bright or dark, depending on whether the author views the prospect before us with hope or with horror. In using the term "man's greatest adventure," I have evidently adopt-
ed an optimistic attitude toward the self-transformation of man. Others may equally well, according to their own feelings, regard the notion as blasphemous, misguided, or just plain crazy. Surely there is inestimable evil as well as inestimable good along the path ahead. Such negative or critical attitudes are well represented in science fiction itself. There are hundreds of descriptions of ingeniously constructed hypothetical worlds in which disaster results from the application of some new scientific development.

The end or deferment of aging and death, and the creation of superior human species with vastly augmented brain capacity, and perhaps with potential immortality, are recurrent themes in science fiction. One might envision a succession of “artificial” human species, each more brilliant than the last and therefore capable of transcending himself in the design of his successor. The physical and temporal limitations of man the individual could be greatly diminished, but as long as mankind consists only of individuals, man will remain finite. At some stage telepathy (artificial or natural) may be introduced, however, and man may proceed to the next stage in his development toward infinity—a racial mind or racial consciousness may awaken. The racial mind, essentially that of a single organism, would surely possess immortality and powers far beyond our comprehension.

All the science fiction stories of supermen endowed with strange new talents, including ESP, fall into this general category, although in many cases the supermen are assumed to evolve naturally, without man’s intervention. The classics of the superman genre include: A. E. van Vogt’s Slan; Olaf Stapledon’s Odd John; Stanley G. Weinbaum’s The New Adam; Jack Williamson’s Dragon’s Island. Frank Herbert has written in somber tones of a world order based on biological engineering in The Eyes of Heisenberg. In Last and First Men, Olaf Stapledon has given us an uplifting chronicle of the future development of man from human species to human species, with the eventual emergence of group and racial consciousness.

The next development of man is also the subject of Arthur C. Clarke’s Childhood’s End and 2001, A Space Odyssey. In these, however, the development is instigated by a superintelligent “mindmind.” Another highly significant work, Stranger in a Strange Land, by Robert A. Heinlein, gives a vivid account of group consciousness mediated by telepathy.

Evolution of “computing machines” into thinking beings, eventually superior in mental capacity to human beings, is another prominent theme. It is anticipated that such mechanical brains will be able to learn, to think creatively, and to surpass present human beings not only in arithmetic but also in science and art. One may speculate that they will be conscious and purposeful. They may have mobile units which look and function like men—robots (hard) and androids (soft). An exciting possibility is that a “symbiosis” between man and thinking machine may be established. The connection need not be permanent. The human might establish contact only when he needs to do thinking that he can do faster and better when the machine is part of him. It may be that when man and machine are joined, a superconsciousness will awaken: Both machine and man will, in a sense, become the other. One superior being will come into existence.

It may be that when the human dies, this superconsciousness will go on, just as a human consciousness survives the loss of some brain tissue. For this to be true, the patterns of brain activity, not the brain tissues or relays, would have to be everything. If it were true, a type of human immortality would be possible, although perhaps not a type that would appeal to many people. The same sort of argument was of course implied in connection with the racial consciousness foreseen as the ultimate development of biological man. As a man does not die when he loses a few brain cells, so the racial mind would go on even if each individual must die.

At any rate, a new dimension might be added to human life, and the physical and temporal limitations of individual and race further diminished. The whole human race could be joined by machines to form a superorganism, presumably exhibiting consciousness of a very high order. But, inevitably, man becomes less man.

All robot and android tales fit into this general category, but they are essentially trivial in view of the awesome possibilities. I, Robot, by Isaac Asimov is a delightful robot book, and The Humanoids, by Jack Williamson, a very good android book Karel Capek’s classic R. U. R. should also be mentioned. As for superintelligent computing machines, the HAL computer in 2001 comes immediately to mind.

The human brain contains some 100 billion neurons, or nerve cells. The state of the brain is specified by the state of this collection of neurons. Roughly speaking, a single neuron has two states, “firing” or “not firing.” It is surely the behavior in time of the pattern of neuronal firings which corresponds to human mental activities. The analog of the neuron in a computing machine is some sort of “relay,” which is either on or off. Within the next century, machines will be built with enough such units to approach, if not to exceed, the brain’s capacity.
Since machines can be designed for specific purposes, and since a large fraction of the theoretcal capacity of the human brain does not appear to be accessible or is specialized for vision, it seems likely that the construction of machines superior to man in practically every facet of mental activity will be feasible. Already there are machines which can learn from their experience and machines which can prove mathematical theorems by symbolic logic.

**Contemporaneous** with man, there exist other intelligent beings residing elsewhere in the universe. These creatures may be similar to man, or they may be vastly different. If they are alternative expressions of life as we know it, based like us on an advanced DNA code, then they must reside on planets. But other forms of life are conceivable and may inhabit stars or even interstellar space.

Even if intelligent beings evolve on a planet virtually identical to earth, the chance that they will be identical to man is remote. There are so few combinations of evolutionary choices leading to man, and so fantastically many combinations of evolutionary choices that are possible. The real question is: Can we communicate with extraterrestrial minds? Probably only if they are similar to man. This means we must look to planets circling other stars, most likely stars resembling our sun. From actual inspection, it does not appear that any other planet in our solar system can harbor intelligent life similar to man.

Radio communication with kindred beings in other nearby planetary systems, within say ten light years, seems an intriguing possibility. More adventurous souls may propose direct visitation once communication has been established. Presently conceivable spaceship drives, which operate at sub-light speeds, would involve voyages of hundreds or thousands of years or longer. The crew would have to be put into suspended animation, or the ship would have to be large enough (a small planetoid powered by nuclear energy) to sustain more or less normal human activity for many generations. More optimistically, one anticipates the development of some kind of near-light-speed drive or even, if somehow Einstein’s geometry of space-time can be thwarted and the light barrier broken, a super-light-speed or “hyper-space” drive, a “space warp.” Then the elapsed time on shipboard may be quite short, and incredibly long journeys, perhaps even to neighboring galaxies, would be feasible.

Contact with other galactic civilizations and ultimately with extragalactic civilizations, either by radio or by actual visitation, would allow the formation of a community of minded worlds. Whatever the mode of contact, the time scale of this endeavor as viewed by a given civilization would be enormous—thousands, millions, even billions of years. The full benefits of such intercourse could be reaped only by the virtually immortal racial mind of some future telepathic human species or by the superconscious symbiotic association of humanity and intelligent machines. Further, only such highly evolved forms of man might hope to be able to communicate with those types of intelligent beings vastly different from our present form—flame inhabitants of stars, cloud inhabitants of space—whose behavior would be meaningless to us. The building of a community or worlds throughout the universe would enrich each participating civilization immeasurably. Man would no longer be alone in an uncharted and uncaring universe.

**The themes** of interstellar communication and travel, and of extraterrestrial beings, are perhaps the most popular in modern science fiction. Radio contact with alien beings and its possible consequences are treated with convincing scientific authenticity by the noted astronomer Fred Hoyle in *The Black Cloud*, *A for Andromeda*, *Andromeda Breakthrough*, Fifth Planet, and October the First Is Too Late. In the Andromeda novels, the aliens send a code for the biological construction of an alien adapted to the earth’s environment! The vagaries of interstellar travel on a several-generation time scale are detailed in *Universe*, by Robert A. Heinlein, and *Rogue Ship*, by A. E. van Vogt. *Voyage of the Space Ship Beagle*, by A. E. van Vogt, describes a galactic “zoological” expedition. Passing over the endless literature on BEM’s (bug-eyed monsters), the most profound comments on extraterrestrial intelligence are to be found in the previously cited works by Arthur C. Clarke and Fred Hoyle, and especially in *Last and First Men* and *Star Maker* by Olaf Stapledon.

Scientifically, we are already capable of receiving radio signals from alien technologies only slightly more advanced than ours. A few years ago, Project Ozma, using the radio telescope at Greenbank, Virginia, was organized to listen for signals from neighboring stars of solar type. No signals were detected, and unfortunately the project was abandoned. I am optimistic that eventually contact will be made, but since space is so enormous, it may take hundreds or thousands of years.

Estimates of the number of extant advanced technical civilizations in our galaxy depend on such unknowns as the fraction of stars with life-supporting planets and the average lifetime of technical civilizations. Some reputable astronomers estimate this number to be about one million. If this estimate is right, there should be several
comrades for mankind within a hundred light years. As to actual manned voyages to nearby stars, this looks overwhelmingly difficult, even with an optimistic extrapolation of present technology. The star nearest to our sun is four light years, or ten million million miles, away.

On the other hand, unmanned probes to other planetary systems appear possible. We would have to wait hundreds of years for a telemetered report, but so would we if a manned expedition were sent. At present scientists see no way of breaking the light barrier, because faster-than-light travel by message or messenger is theoretically impossible in our universe.

Some interesting proposals for near-light-speed drives have been offered, however, including a matter-antimatter drive involving complete conversion of mass to energy, and an interstellar ramjet, involving thermonuclear fusion of the interstellar medium swept through. If such a drive could actually be made to work and refined so as to achieve a steady acceleration of one earth gravity, then by Einstein’s time dilation effect the problem of elapsed time for a human crew could be solved. The Andromeda galaxy, the sister of the Milky Way, could be reached in thirty years ship time, though approximately five million years would pass on earth before the round trip would be completed.

Is it not conceivable that in the far, far distant future all the world-minds of all the intelligent races in our envisioned community of worlds will somehow merge to form a universal consciousness? Man, no longer alone and insignificant in an indifferent universe, would truly be liberated from the constraints of space and time—except of course as the spatial and temporal extent of the universe itself is finite. In this culmination of all life’s striving, the awakening of the cosmic spirit, the universe would become one vast living organism, self-aware at last. That which is most precious to and characteristic of man, his self-awareness, would be maintained at each stage in his growth toward universality.

Nevertheless, we return full circle to the renunciation of the distinction between mind and nature urged in the Eastern religions. But this comes to pass at a stage of the development of mind in which nothing precious is really sacrificed, since mind, being all, maintains its integrity and all sane desires are forever fulfilled.

This is the cosmic vision of Olaf Stapledon in both *Last and First Men* and *Star Maker*, the two deepest and most original works of science fiction. In the latter, Stapledon’s Cosmical Spirit awakens in the dying eons of the universe and is troubled by its own finitude.

Is there any scientific basis for this staggering vision? The answer has to be no, because the scientific basis for consciousness has not been explicated. I believe that real progress on the understanding of consciousness, which is obviously the most important and most puzzling aspect of human existence, can be made, particularly in the context of man-machine symbiosis. Be that as it may, the postulated evolution of a racial mind from the totality of individual minds and of a universal mind from the totality of racial minds is in essence a daring extrapolation of the observed evolution of biological entities from the simplest structures, through combination and specialization, toward ever more complicated yet ever more harmonious forms.

One more thing in a scientific vein can be said of our imagined self-aware universal creature. Its concept of “now,” its concept of “present time,” would have to extend over millions or billions of years because of the time lag in the communication between its diverse parts due to the finite speed of light.

I close with this quotation from one of the doomed “last men,” the eighteenth human species, in Stapledon’s masterpiece, *Last and First Men*:

And so in vain we ask, will ever spirit awake to gather all spirits into itself, to elicit from the stars their full flower of beauty, to know all things together, and admire all things justly.

If in the far future this end will be achieved, it is really achieved even now; for whenever it occurs, its being is eternal. But on the other hand if it is indeed achieved eternally, this achievement must be the work of spirits or a spirit not wholly unlike ourselves, though infinitely greater. And the physical location of that spirit must lie in the far future.

But if no future spirit will achieve this end before it dies, then, though the cosmos is indeed very beautiful, it is not perfect.
The afternoon was devoted to fun and games. Above, Dean Wheeler joins a lively game of volleyball. Below, students representing the Association of Black Collegians give their tug-of-war opponents a rough time.

At a brief ceremony in the Quad, Dean Wheeler received an assortment of novel gifts. Above, he and wife Jackie recline on a waterbed, a gift from students on the Council of Arts and Sciences.
The campus experienced a kind of planned happening one day this spring when several hundred students, faculty members, and staff turned out on Brookings Quadrangle for an egg toss, volleyball games, tug-of-war contest, and other light-hearted antics. The end of finals? Spring fancies gone mad? No—a celebration, a day dedicated to Dr. Burton M. Wheeler, Dean of the University's College of Arts and Sciences and professor of English. As the pre-Happy Burt Wheeler Day signs and posters read, "No, he's not leaving. We just love him."

Planned by students and faculty of the College of Arts and Sciences, with enthusiastic support from others throughout the campus community, it was a busy day—a reception in Wheeler's office, games, speeches, and the presentation of gifts in the Quadrangle, a spirited softball game, a hot croquet match, and a dinner in the Dean's honor at the Faculty Conference Center in Whittemore House. Among the after-dinner tributes to Dean Wheeler were a toast by the in-coming Chancellor, William H. Danforth, and an original poem by the out-going Chancellor, Thomas H. Eliot. All in all, it was a happy Happy Burt Wheeler Day.

Brookings Quadrangle came alive at noon as faculty, students, and staff gathered to share picnic lunches on the grass and await the afternoon's festivities.

Balloons, carnations, and children in brightly colored clothes added to the festive atmosphere.
Commencement, 1971, marked the last public appearance of Thomas H. Eliot as Chancellor of Washington University. In a complete departure from previous Commencement ceremonies, the Chancellor made the Commencement address himself.

His address was essentially a plea for both the independence of the youthful spirit and the value of continuity. Washington University, Chancellor Eliot says he likes to think, "represents both."

When students go to college, Eliot pointed out, "they are indeed leading their own lives, in ways that we may or may not like." But, he asked, "Aren't they also learning, and of necessity, learning from and with their elders? And isn't the institution which they attend a bridge between all humanity's mansions of the past and their houses of tomorrow?"

The very ceremony at which he spoke, Chancellor Eliot emphasized, is a reminder of this sense of continuity. "There are a few," he remarked, "who say that Commencement is obsolete, and even that universities, as we have known them, are obsolete. But a happy and warm observance of an important event in our lives can never be obsolete."

"Washington University is anything but obsolete," he added. "Its abiding traditions are those of constant change, free expression, the expansion of knowledge, and the deepening of wisdom. Readiness to change, to welcome reform, has illumined our work here and kept us from stagnation. The need for knowledge and even more, for wisdom—for clear, informed thinking and sound judgment—is never-ending."

A surprise ending to the 1971 Commencement ceremonies was provided by the awarding of a joint honorary Doctor of Humanities award to Chancellor and Mrs. Eliot.

At the very end of the ceremonies, just when everyone was beginning to clear his throat for the singing of the Alma Mater, Dr. Charles Allen Thomas, chairman of the Board of Trustees, came to the microphone to ask that the Grand Marshal escort Mrs. Eliot forward. Mrs. Eliot, who was sitting in the audience, seemed somewhat stunned by the request, but she made her way forward, donning the academic robes the Grand Marshal produced for her. Dr. Thomas then asked that the Chancellor, who seemed equally surprised, be brought forward.

In presenting the joint degree, an honor unique in academic circles so far as we know, Dr. Thomas said:

"To Thomas Hopkinson Eliot and Lois Jameson Eliot, whose combined and boundless dedication, in the great Washington University husband and wife tradition of Carl and Gerti Cori, has lead Washington University to national prominence with grace, warmth, and charm... I confer upon you jointly its honorary degree of Doctor of Humanities."

On June 18, it was announced that Chancellor Eliot has been elected president of the Salzburg Seminar in American Studies. He will assume his new post on November 1, succeeding Paul M. Herzog, who has headed the Seminar since 1965.

Founded in 1947, the Salzburg Seminar brings together younger government officials, scholars, journalists, and professional men and women from over twenty European countries for month-long sessions on such subjects as American law, management, the arts, American politics, urban planning, and the impact of technology. The fifty participants in each session all live in a 250-year old castle on the outskirts of Salzburg, Austria.

The faculties, mostly American, have recently included such men as Justices Potter Stewart, and Byron S. White of the U. S. Supreme Court; Willard Wirtz, former Secretary of Labor; Monte C. Thordahl, vice president of Monsanto Co.; Carl Kaysen, director of the Institute for Advanced Studies at Princeton; Robert Anderson, playwright; and Francis Keppel, former U. S. Commissioner of Education. Mr. Eliot was a faculty member at Salzburg in the summers of 1966 and 1970.

A director and former faculty member of the Seminar, President Kingman Brewster of Yale, said of the Eliot appointment:

"Tom Eliot is the right man to head what I consider to be the most effective enterprise in international education. The Salzburg Seminar, reaching far beyond the campuses, is a meeting place and training ground for the rising intellectual and professional leaders of Europe, and provides an atmosphere of friendship and cooperation that transcends national boundaries."

The Eliots will divide their time between Salzburg and Cambridge, Massachusetts, where the Seminar has its American office, as Mr. Eliot's chief task will include the recruiting of faculty in the United States. Before entering their new career, however, the Eliots will spend the summer in Maine for, what everyone agrees, will be a well deserved rest.

-F.O.B.
Dr. Samuel B. Guze, professor of psychiatry and nationally known clinical researcher, has been named Vice Chancellor for Medical Affairs. He succeeds Dr. William H. Danforth, who became Chancellor on July 1. A 1945 graduate of the University's School of Medicine, Dr. Guze interned at Barnes Hospital and was awarded fellowships in medicine and psychiatry at Barnes and at the School of Medicine. He was appointed to the Medical School faculty in 1951, became associate professor of psychiatry in 1959, and a full professor in 1964.

Dr. Guze brings to his new position long and intimate knowledge of the operations of the School of Medicine and its allied hospitals. In addition to his appointment in psychiatry, he has served concurrently as director of the University's Psychiatric Clinic, associate professor of medicine, assistant to the Dean of the School of Medicine, and consultant in psychiatry to the Barnes ward services.

In recent years, Dr. Guze has gained wide experience in University-wide affairs. From 1954 to 1960, he held a joint appointment in the School of Social Work on the main campus, he is a long-term member of the University Faculty Senate and has served as its chairman, and he was a member of the Committee on University Goals and Objectives. Dr. Guze is a fitting successor to William Danforth and Carl Moore, his two illustrious predecessors, in a key University position.