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Washington University Magazine

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Highlights

This was Washington's University's 127th year. The University has changed greatly since the early days. Today, it is composed of ten separate faculties which cover a spectrum of educational endeavors. Students come to Washington University from all over the world. The accompanying pages touch on a few of the highlights of an eventful twelve months. The deans' reports tell of the operations and special achievements of the individual schools during the last academic year. The financial summary reviews the fiscal results of 1979/80. The Chancellor's comments discuss the complicated relations between Washington University and the business community.

No year goes by without notable losses, as well as gains. In June 1980, Samuel C. Sachs died. He was a devoted alumnus and hardworking trustee. He enthusiastically gave his time and support to the University. His contributions will influence this University and its students for generations.

In May 1980, Warren McK. Shapleigh became an emeritus trustee, after having served loyally and tirelessly as an active member for over fourteen years. Also in May, I succeeded a great man, Maurice R. Chambers, as Chairman of the Board. During his chairmanship, Mr. Chambers was an extremely effective leader for Washington University and its Board. I want to express to him the deep appreciation of the Board for his unswerving efforts. He has inspired us all.

As the University entered a new year, it suffered a grievous loss with the death of James S. McDonnell. Mr. McDonnell was a dear friend, personally and in our mutual associations with Washington University. He served as a trustee from 1960 until 1966 and as Chairman of the Board from 1963 until 1966. Without his vision and generosity, Washington University would not be the distinguished institution it is today.

George H. Capps
Chairman
Board of Trustees

Washington University's 119th commencement exercises on a wet May morning brought the 1979-80 academic year to an official close. The weather failed to dampen spirits, however, as 867 undergraduates and 841 graduates received degrees. Their final year here was filled with the wide range of activities that make up campus life and provide some of the memories and associations they will carry with them into the next century.

In the past year, the Washington University undergraduate student body included more than 500 National Merit Scholars, one of the largest enrollments of these scholars in the country. Yet, the collective talents of the students cannot be readily described. Their achievements in the National 1980 College Bowl Championship, the William Lowell Putnam Mathematical Competition, and the Fourth Annual National Scholastic Programming Contest offer continuing evidence of their ability. In the computer programming contest, the Washington University team triumphed for the second year running, edging out Purdue, Ohio State, and New York Universities. Again this year, Washington University's was the only one of twenty-one competing teams to solve correctly all four of the complex computer programming problems. Washington University contenders also starred for the fourth straight year in the Putnam Mathematical Competition, emerging as one of the nation's top ten teams. Finally, the University won the CBS Radio Division I College Bowl tournament by defeating MIT, and thus advanced to the championship match against the winners of the Division II title. Although defeated in this final match, they won $2500 in undergraduate scholarships for the University as victors of Division I. The significance of these collective successes is not so much in the individual triumphs as in the consistent emergence of Washington University students in the front echelon in competition with peers.

During the year, faculty research and scholarly activities continued at an impressive pace. In the fiscal year 1979-80, a total of $65.1 million from external sources, awarded almost entirely on a competitive basis, came to the University for educational and research projects. Of this amount, $60.3 million represents federal commitments.

Much of the scholarship done at a major university has limited appeal to the layman, so it is especially exciting when research results in a book of broad popular interest. Such a book is Russian Art and American Money (1900-1940) by Professor of History Robert C. Williams. Published by Harvard University Press, Professor Williams' book has been widely reviewed and was suggested as choice summer reading by The New York Times Sunday section.

A major event of the year was an exhibition at the Uni-
versity's Gallery of Art in Steinberg Hall of forty-five paintings by contemporary artist Joan Miró. Entitled "Joan Miró: The Development of a Sign Language," it was cosponsored with the Smart Gallery of the University of Chicago, where it was shown following presentation here. All of the works, many never before on public display, were selected by Assistant Professor of Art and Archaeology Sidra Stich, who served as guest curator. Gerald D. Bolas, Director of the Gallery of Art, coordinated the exhibit.

The exhibition attracted national attention. The New York Times featured on the front page of the Arts and Leisure section of a Sunday edition a review of the Washington University exhibition and a concurrent Miró exhibit at the Hirshhorn Museum in Washington, D.C. Reviewer Hilton Kramer described both enthusiasm and a concurrent Mira exhibit Leisure section of a Sunday exhibition and Professor of the University, where it was shown following presentation here. All of the works, many never before on public display, were selected by Assistant Professor of Art and Archaeology Sidra Stich, who served as guest curator. Gerald D. Bolas, Director of the Gallery of Art, coordinated the exhibit.

In this year of choosing a President, two of the faculty have assumed distinctive roles on the national political scene. Murray L. Weidenbaum, Edward Mallinckrodt University Professor and Director of the Center for the Study of American Business, is serving as one of twelve top advisors to Republican presidential candidate Ronald Reagan. Barry Commoner, University Professor of Environmental Science and Director of the Center for the Biology of Natural Systems, is running for President as nominee of the Citizens' Party. Professor Commoner will be leaving Washington University in February to accept an appointment at Queens College in New York.

Since its founding, Washington University has received— and depended on— generous support from the St. Louis community, from national foundations and corporations, and from alumni who are today located in all parts of the country. In this context, the past twelve months has been a banner year. The University received a total of $22.4 million in gifts, the largest amount in its history, with the exception of the total for 1977, when the Danforth Challenge Grant was received. Particularly heartening is the splendid support from alumni: $2.5 million. This, too, is a record amount from a record number of alumni donors. Total giving represents more than 20,000 friends and alumni of the University.

In this tradition of generosity, the University has been welcomed into the 1980s by a grant of momentous magnitude and impact: $5.5 million from James S. McDonnell for a Center for Studies of Higher Brain Function. This gift, made shortly before Mr. McDonnell's death last August, reflected his conviction that the degree of expertise in the neurosciences found at Washington University is second to none.

Mr. McDonnell's gift has a two-pronged importance. It comes at a time when the neurological sciences stand on the threshold of profound advances and when inflation is eroding the purchasing power of federal funds for fundamental research, thus threatening the momentum that has kept the United States at the forefront of scientific discovery.

Modernization of older buildings and other improvements to the physical plant are ongoing needs on any large campus. One of Washington University's most ambitious undertakings at present is a $5 million building and rehabilitation project which is designed to increase on-campus student housing capacity by 300. Three existing faculty apartment buildings on Millbrook Boulevard are being modernized and renovated, and a fourth building is under construction. All can be converted to apartments for faculty or doctoral students should the demand for undergraduate housing diminish. Progress on another major new construction and renovation project for the School of Engineering is reported in this compendium by Dean James M. McKelvey.

Three important administrative appointments were made in fiscal 1980. James W. Davis was named to the newly created position of Vice Chancellor and Associate Provost. He had been Associate Provost on a part-time basis since February 1978. A professor of political science, Davis has been a member of the Washington University faculty since 1974.

A Purdue University scientist and educator, Luther S. Williams, has been appointed Dean of the Graduate School of Arts and Sciences and Professor of Biology. He succeeds Professor David L. Kirk, who had served ably as Acting Dean since August 1979. Dean Williams is a nationally recognized scientist, academician, and administrator.

Another deanship, that of the School of Law, has been filled by Professor F. Hodge O'Neal, a noted authority on private corporations and family-dominated companies, who is George A. Madill Professor of Law here. An eminent legal scholar and educator, he is also an experienced dean, having served in this capacity at two other institutions.

The Commission on the Future of Washington University, announced in the report of 1978/79, is now fully organized. Under the leadership of Chairman W. L. Hadley Griffin, it consists of 26 distinguished local and national leaders in business, community affairs, and education, who have a common interest and concern for the future of this institution.

Several of the Task Forces have virtually completed their work; their reports will be filed with the Board of Trustees during the coming months. Others are well along the road to completion, while a few are just getting under way, all in accordance with earlier plans.

Annual Report
Faculty of Arts and Science

Throughout the year, the vitality of faculty and student members of the Arts and Sciences community was manifested in commendations for distinguished scholarly and scientific achievements, in curricular and programmatic development, and in continuing examination of the quality of teaching and learning. Four members of the faculty—J. H. Hexter, Distinguished Historian in Residence; David T. Konig, Associate Professor of History; Stanley L. Paulson, Associate Professor of Philosophy; and Michael Rybalka, Professor of French Language and Literature—were chosen by the National Endowment for the Humanities to conduct summer seminars for teachers in liberal arts colleges. When scaled according to faculty size, this achievement was not equalled by any other institution in the United States. In addition, the American Psychological Association conferred upon Sol L. Garfield its 1979 award for Distinguished Professional Contribution to Knowledge, while Martin Israel, Professor of Physics and Associate Director of the Center for the Space Sciences, and his departmental colleague, Joseph Klarmann, were honored by the National Aeronautics and Space Administration for their roles in cosmic ray experiments conducted by NASA in connection with the launch of the Atlas-Centaur rocket last September.

Recognitions continued to rain upon the novelists and poets who are members of the Faculty of Arts and Sciences. The American Academy and Institute of Arts and Letters conferred its Hinda Rosenthal Foundation award upon Stanley Elkin for his novel, _The Living End_; and its Morton Dauwen Zabel Award upon Donald Finkel, Poet-in-Residence, for his contributions "as a poet of progressive, original, and experimental tendencies." Recognition also is owed to unusual examples of collective as well as individual merit. In this regard, the Department of Biology continued to excel in pursuing the multiple missions that belong uniquely to departments in the Arts and Sciences—the soundly effective teaching of undergraduate and graduate students, great enterprise in the activity of research, and constructive contributions to the processes of university governance.

Members of the Arts and Sciences student body emulated their teachers in the quest for excellence. Adam Helfer, a major in mathematics and physics, was awarded a Rhodes scholarship; it is the second time in three years that this honor has come to a student of the College. In the National Computer Programming Competition, the Washington University team which again included mathematics major Nathan Schroeder, finished first for the second successive year, ahead of teams representing more than one hundred other institutions. In the national William Lowell Putnam Mathematical Competition, the student team representing Washington University, which in the last two years has placed second and first, again showed its mettle by outdistancing more than three hundred competing colleges and universities.

Linda K. Salamon completed her first year as Dean of the College with a record which bespeaks administrative creativity and able leadership. The faculty approved a new program of interdivisional minors which will give Arts and Sciences undergraduates increased opportunities to complement their major concentrations in the College with coherent programs of study in one of the four undergraduate professional schools of the University. The establishment of a joint faculty-student committee to explore ways of meaningfully evaluating teaching also offers prospects of noteworthy developments. A grant from the National Endowment for the Humanities helped to launch a course of studies in Law and Liberty which draws together faculty members from English Literature, History, Philosophy, and Political Sciences, as well as those from the School of Law. The renaissance of undergraduate interest in the foreign languages, sparked two years ago by innovations in the teaching of French, not only continues to mount but promises to spread to Spanish and German as these programs move to adopt versions of the pedagogical methods that have proved so successful in French.

The Graduate School of Arts and Sciences will begin the 1980-81 year with a new Dean, Luther S. Williams. Dean Williams, an active and highly regarded member of the scientific community, comes to the University from the positions of Professor of Biology and Assistant Provost at Purdue University. His appointment is the happy result of the efforts of a search committee headed by Professor Larry Haskin, Chairman of the Department of Earth and Planetary Sciences. Dean Williams succeeds a fellow biologist, Acting Dean David Kirk, whose administration of graduate affairs during the year was characterized by exemplary intelligence and courtesy. Under Acting Dean Kirk's stewardship, a new Master of Liberal Arts degree program, designed especially for the so-called "nontraditional" student, began at mid-year with thirty matriculants. That the beginning class included persons from business, the learned professions, labor, and the ranks of retirees evinces not only the wisdom with which the program was conceived but that the life of the mind retains an appeal to diverse sectors of the public. The Graduate School, in collaboration with the College, also moved forward with plans for a course of studies leading to a combined Bachelor of Arts—
Master of Arts degree. The combined program, while preserving the integrity of each degree, will aim to afford new challenges of opportunity to a select number of highly motivated and accomplished students, especially in the physical sciences and mathematics.

The luster of individual and collegial accomplishment, however, was dimmed during the year by the death of Professor Richard Rudner of the Philosophy department, followed by the equally unexpected death of Professor Edward Kalachek of the Economics department. Both leave to their colleagues and students an enviable legacy of profound learning and service to the University.

The faculty members who advanced to the rank of professor emeritus at the close of the year constitute an illustrious class. They are Lewis Hilton, whose name is a byword in music education; Rosalie Wax, whose field work in anthropology has won her international acclaim; Samuel Weissman, whose achievements in chemistry are recognized by his membership in the National Academy of Science; and Edward Weltin, whose knowledge of history and religion is overshadowed only by the versatility of his talents.

The opening of the 1980-81 year will see changes of chairpersons in four departments or programs. In Economics, Associate Professor Laurence Meyer replaces Professor Charles Leven; in Philosophy, Professor Robert Barrett has as his successor Professor Jerome Schiller; in Romance Languages, Professor John Grigsby follows Professor Richard Admussen; and a long-standing administrative vacancy in Urban Studies has been filled with the appointment of Associate Professor James Little.

The life of the College and Graduate School is sustained not only by its faculty and students, however, but by the support of alumni, patrons, and friends. It is a matter of great moment, therefore, that the organization of the Arts and Sciences Task Force of the Commission on the Future of the University was nearly complete at the end of the academic year. The chairman of the Arts and Sciences Task Force is George E. Pake, vice president for research of the Xerox Corporation, who has served the University as chairman of the Physics Department and Provost, and continues to serve it as a member of the Educational Policies Committee of the Board of Trustees. The Arts and Sciences likewise is fortunate that John F. McDonnell, corporate executive vice president of the McDonnell Douglas Corporation and also a member of the Educational Policies Committee of the Board of Trustees, has consented to serve as vice chairman of the group. The Task Force will hold its first meeting in mid-September. It has as the target date for its report the end of the 1981 calendar year.
The Washington University School of Architecture was the first in the United States to institute in the late 1950s a change from the traditional five-year first professional degree program to an undergraduate-graduate two-degree sequence requiring at least six years of study. Since then we have gone through a number of reevaluations and reinterpretations of the curriculum. This fall, we are implementing changes which introduce at the early part of the profession a curriculum a pair of courses which focus on issues concerning architectural theory and principles. These will be taught by a rotating team of the architectural design faculty. The change requires a relocation of the "structures" course sequence at a more advanced level of the professional curriculum. Both changes will contribute to adjusting the curriculum to the present needs of our student body, as well as to a better distribution and utilization of our faculty resources.

Again in 1979-80 our Visiting Faculty program brought a number of distinguished individuals to teach at the advanced level of the Master of Architecture program. During the fall semester we hosted Zvi Hecker from Israel and Garland Okerlund from the University of Virginia. Onno Greiner, a Dutch architect, spent the spring semester with us, while John M. Woodbridge from Berkeley, California, shared responsibility for the Master of Architecture and Urban Design (MAUD) studio with Professor Frants Albert. We were, of course, very pleased to welcome back to the faculty for the spring semester Joseph D. Murphy, former Dean of the School, now retired, who taught with success an elective course in architectural drawing.

In the process of institutionalizing architectural education during the last one hundred years, the architectural design studio has always retained a special place as the spine of the curriculum. Individual study and teamwork are equally important; self-discovery, as well as learning from peers, adds richness to the educational experience of young people.

Two events characterized the peer-learning aspects of education in Givens Hall this past year: the third annual Spring Forum sponsored by the MAUD program, and an "infill housing" faculty competition sponsored by the Landmarks Association of St. Louis. The Spring Forum, presented during two days early in May by an urban design studio composed of MAUD and MArch students, dealt with an area of St. Louis which is typical of our national urban landscape. The Forum focused on efforts to understand the extent to which humane ideas and principles may be expressed by the physical environment. Participants in the Forum were prominent St. Louis civic leaders, as well as Elias Zenghelis, an internationally known Greek architect and planner currently visiting this country from England.

The Landmarks Association of St. Louis, in collaboration with the School of Architecture, sponsored a faculty architectural design competition for development of infill housing on a half-block site facing Hyde Park in north St. Louis. Eight faculty submitted individual or team entries. Visiting Architect John M. Woodbridge and Larry M. Malcie, a staff architect at the Urban Research and Design Center, were the winners of the first prize. The second prize was shared by two teams composed of Edward M. Baum and Ryszard Sliwka, and Thomas L. Thomson and Bece Fossey Michaud. Charles W. Moore, currently Chairman of the Department of Architecture at the University of California Los Angeles, was a member of the jury, while alumnus William P. Wischmeyer, counselor to the Board of Directors of Landmarks Association, was the organizer of the competition.

One of the major concerns of educational institutions for the 1980s is the issue of falling enrollments. This is an even more critical issue for small academic divisions such as ours, both in its financial implications and in terms of
critical mass of students. During the last seven years, the School has maintained a steady enrollment which has allowed us a welcome measure of flexibility in our studio and other curricular offerings. We would, of course, very much like to see this level of enrollment continued. I am happy to report that applications have remained steady, and the number of accepted students who enroll is high. In fall 1979 we registered a total of 324 students, 198 undergraduates and 126 graduates. Eighty-nine women, thirty-five foreign students, thirty-two minority students, as well as ninety students from Missouri were included in this number. At this writing, we expect the 1980 entering class to be one of the largest classes in recent years.

The summer of 1980 was the first since 1974 during which no remodeling project for the immediate needs of the School was under way in Givens Hall. Over the years we have upgraded a good part of our facilities, including the lower-level shop, most of the main-floor classrooms, and the third-floor skylit studios. We can begin now to plan the future upgrading of our studio equipment. In the event that anyone thinks that Givens Hall went through a summer without some audible and evident preparation for the future, let me quickly add that as part of a University-wide energy conservation project, Givens Hall has become a prototype building for testing the conversion of steam radiation to a hot water heat-

ing system. If the conversion taking place now proves successful, some twenty buildings on the campus will benefit from this experiment.

Last year's report of the School of Architecture mentioned the formation of a high-level Commission on the Future of Washington University, which would include as one of its twelve special study groups an Architecture/Fine Arts/Gallery of Art Task Force. It is appropriate for this year's report to include a brief outline of the activities of the Architecture Task Force during 1979-80.

Organized in June 1979, the Task Force met five times during the academic year and a final report of its activities is now being put together. The Task Force was exposed to a great deal of information regarding the development of the School during the past twenty years, its current status, and future plans and outlook. Educational and pedagogical attitudes, practices, and goals, as well as financial resources, were discussed at length with administration, faculty, and students of the School, and other Washington University colleagues.

It is difficult at this early stage to predict where the individual Task Force reports, and that of the overall Commission on the Future of Washington University, will lead. It is reassuring, however, to know that the Task Force membership, individually and collectively, has developed a good understanding of what the School is about, and that this understanding already is leading to a more creative relationship between the School and the architectural profession.
School of Business and Public Administration

During 1979-80 the School of Business formed a new institute, received approval of a change in its budgetary status, reached new heights in alumni activity, set a record in student enrollment, made progress in faculty recruiting, and registered many milestones and accomplishments by its faculty. These developments are but a few of the events of the year, but they serve to highlight our activities. These six areas merit special elaboration.

(1) In recent years the School's Finance Area has become very strong. Our Finance faculty's research has attracted wide interest. More of our students are pursuing careers in finance than in any other area. A cadre of leading financial institutions regards us as a primary source of new talent.

To spotlight this strength and to provide resources for incremental activities in the area, on February 26 the School announced the formation of the Institute of Banking and Financial Markets, directed by Professor Jess B. Yawitz. The Institute will sponsor research in banking and the financial markets; provide for meaningful interaction between our students and leading practitioners from financial institutions; work more effectively with our Finance students and the institutions recruiting them; and provide seminars on current topics for practitioners. Sixteen financial institutions from St. Louis and other cities make up the Institute's charter enrollment of full and associate members.

The Institute's formation is significant not only for the deserved recognition it brings to our Finance area, but also for the specific identification it gives us with this extremely important sector of economic activity. I believe that the very careful development of particular emphasis in areas such as banking is appropriate for our School.

(2) Historically, the Business School's budget has been combined with those of several other academic and administrative units into the central budget of Washington University. There has been a growing feeling that all interests might be better served if the School had greater fiscal autonomy. This arrangement would create much stronger incentives to develop the School financially and would more sharply pinpoint accountability within the School for the success of its operations.

Last October, the Board of Trustees approved a plan for the School to become an independent budgetary unit effective July 1, 1980. The plan fixes a maximum amount of additional subsidy which the University will extend before the School is expected to become free-standing financially.

I feel sure that we will meet the challenge posed by this vote of confidence in us. We start from a position of strength. We already stand among the top echelon of business schools. Our degree programs are very sound. We are operating at the break-even point, despite very small income from endowment, foundations, or sponsored research. Thus, any additional resources we obtain may go toward supporting incremental activities. Most importantly, I sense among all participants a genuine commitment to making this new status work and to creating an ever stronger and more successful business school at Washington University.

(3) A chief reason for our secure current financial position is the gratifying annual support from our 6500 alumni. Nearly thirty percent of them contribute to the School. Their total gift of more than $156,500 is nearly double our alumni giving two years ago. The membership in our Century Club on June 30 stood at 521, compared to 409 a year ago. We are trying to do a better job of conveying to our alumni a sense of the vitality which typifies their School today. I believe we are succeeding.

(4) We generally are perceived as a relatively small business school. Thus, most people are surprised to learn that our enrollment in 1979-80 reached the new high of 800 students. It is a source of great pride and strength that in all programs, the quality of our students continues to rise. Our enrollment by program in 1979-80 was:

<table>
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<tr>
<th>Program</th>
<th>Freshmen</th>
<th>Through Seniors</th>
<th>M.B.A.'s, Full-Time</th>
<th>M.B.A.'s, Part-Time</th>
<th>Ph.D.'s</th>
<th>Total</th>
</tr>
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<td>B.S.B.A.'s</td>
<td>369</td>
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<tr>
<td>M.B.A.'s</td>
<td>212</td>
<td>211</td>
<td></td>
<td></td>
<td>11</td>
<td>803</td>
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An acid test of the professional program is how the graduates do in the marketplace. We have had another enviable placement record. Virtually all our 225 graduates, who worked conscientiously with our placement office, found satisfactory employment. Some 130 companies from across the U.S. recruited on campus. The most popular fields among our graduates were banking and investments, accounting, corporate finance, marketing, retailing, and management. Our graduates located in all parts of the country; however, St. Louis attracted more than forty percent. The estimated median starting salary was $15,500 for our undergraduates and $22,000 for our M.B.A.'s.

(5) More than anything else, I believe the key to the Business School's future development will be our ability to attract the very best scholars available to our faculty. As our new Institute dramatizes,
it is the faculty who make exciting things happen and attract the brightest students.

We worked very hard on faculty recruiting during 1979-80. Collectively we saw significantly better candidates than ever before. Our goal is to make two new absolutely top-rank senior appointments. Given our high standards and the extreme difficulty in moving established scholars, no appointments have yet been made.

On the junior level, we have made four outstanding appointments in Marketing, Finance, and Business Communications. A major disappointment was that for the second year we failed to appoint a new faculty person in Accounting. In this area there is a shallow pool of qualified Ph.D.’s being trained. This situation is intolerable, for we urgently need additional faculty in Accounting. Redressing this situation will be a high priority for 1980-81. This School’s long tradition of faculty excellence in accounting will continue.

There is another favorable development to report in recruiting. Nicholas Dopuch of the University of Chicago, editor of the Journal of Accounting Research and one of the foremost accounting scholars active today, has agreed to be Distinguished Visiting Professor of Accounting during the fall semester of the next three years. Dopuch visited here in 1978 and conducted a workshop for us throughout 1979-80. This unusual arrangement assures a continuation of the substantial contributions which he has been making here.

(6) While they were providing very sound management education to our 800 students and producing 225 highly qualified graduates, our faculty also were notching many individual accomplishments. Recognition by students and alumni for superior teaching came to Professors John W. Bowyer, Jr., John E. Walsh, Jr., and Michael E. Hemler. Professor Walter R. Nord was a resident faculty member at the National Seminar of Beta Gamma Sigma, the honorary scholastic fraternity in business. Our Management Study Program, directed by Professor Raymond L. Hilgert, was offered for the twentieth time. About one third of the faculty conducted seminars and colloquia at other universities or academic meetings.

A special milestone was reached when Professor Sterling H. Schoen resigned effective September 1, 1980, as Director of the Consortium for Graduate Study in Management to resume full-time teaching and research. Founded in 1966 by Professor Schoen, the Consortium provides an opportunity for minority students to pursue the M.B.A. at one of six member schools: our own, Indiana, Wisconsin, Rochester, North Carolina, and Southern California. To date, more than 800 minority students have embarked on the M.B.A. and subsequently on careers in business under Consortium sponsorship. As the Consortium’s founder and first director, Professor Schoen has made a signal contribution to the cause of equality in opportunity. He has brought great credit to Washington University.

In concluding, I should like to give special thanks to the people who are the lifeblood of the Business School: our faculty, students, and staff. They did very well in 1979-80.
School of Continuing Education

This year saw the introduction of two new degree programs at University College:

In the fall semester more than sixty applicants sought admission into a two-year intensive data processing baccalaureate program. Of these, thirty-two were admitted into a program designed to provide intensive training for adults who have an undergraduate degree, but no previous data processing experience. By the completion of the first year, these students had developed sufficient skills to enter the data processing profession as programmers. Twenty of the class are now working at their new careers; jobs were available for all other participants. The first class will graduate in May 1981.

This new degree program should not be confused with the program offering a master's degree in data processing, initiated a few years ago. The demand for knowledge of data processing is strong, and the latter continues to be a popular offering.

In the spring semester 1980, University College launched its second graduate degree program. In cooperation with the Graduate School of Arts and Sciences, we invited applications for the program leading to the Master of Liberal Arts degree. Currently thirty-three students from the local community have gained admission. They range in age from twenty-three to seventy, and in their professional or vocational lives they represent company executives, school teachers, stockbrokers, librarians, art editors, social workers, physicians, housewives, lawyers, and plasterers. Males and females are about equally enrolled.

The M.L.A. curriculum was developed under the careful guidance and dynamic leadership of Professor Robert C. Williams of the History department, who with Professors Wayne D. Fields, Thomas S. Hall, and Gerald N. Izenberg, developed and offered the initial colloquia. The program has received enthusiastic faculty support. For the coming year new colloquia have been proposed by members of the Chinese and Japanese, Classics, Comparative Literature, and Political Science departments.

These two programs represent the beginning of a new period of curricula development for University College. Plans are under way to introduce degree opportunities in physical therapy, nursing, paralegal studies, and communications. In addition, all existing certificate and degree programs are being reviewed and reexamined.

In 1979-80, enrollments in University College totaled 5017. This represents a small increase over the previous year. We hope this signals a trend that reverses the declines suffered in previous years. In May of this year the College awarded seventy-four certificates, 143 undergraduate degrees, and six graduate degrees.

The 1979 Summer Sessions enrolled 3332 students on the Hilltop Campus. Of these, forty-one percent were not regular Washington University students. They were, rather, undergraduate and graduate students who live in the greater St. Louis area but either are enrolled in other colleges or universities or are busy with their professions. They are an example of the latter. Summer registrations reflect a continuing strong demand for professionally related courses in such areas as architecture, business, and engineering.

The Division of Professional and Career Programs which creates and directs noncredit conferences, seminars, and short courses had an active year. Summer conferences were especially busy as the Division assisted twenty-one groups who brought more than 5000 conference participants to the campus. During the regular academic year, the Arts, Humanities and Sciences short course series, which is taught exclusively by faculty members from the College of Arts and Sciences, enrolled 496 participants, including twenty-nine Eliot Society members and several members of the School of Continuing Education Century Club, who are eligible to attend at no charge. Especially successful were programs on aesthetics conducted by Professor William H. Gass; an opera workshop led by Professor Harold Blumenfeld; and a special offering entitled "Creativity: What Is It?" moderated by Professor Burton M. Wheeler.

This past year was an important one for the Center for the Study of Data Processing. Not only did the Center initiate the new degree program described previously, but it also completely revised all course offerings in the undergraduate systems and data processing curriculum. Today this curriculum represents the most advanced development in data processing studies. Additionally, and most importantly, support from local companies whose employees regularly enroll in these courses has substantially increased. The number of corporate affiliates—companies that contribute annually—has grown to nineteen. In addition, two governmental agencies participate as program associates. The increase in corporate support reflects a growing awareness by local data processing professionals of the value and importance of the Center's professional development seminars and other services, including the library, audio-visual activities, and one-day programs that feature nationally known data processing experts. The Center has been fortunate to find three very competent and enthusiastic senior associates, Elizabeth...
A. Bloomfield, Gregory C. John, and Dennis M. Oliver. This professional staff, under the leadership of Associate Director Robert A. Rouse, has made important contributions to adult education opportunities in St. Louis.

One final mention should be given to the 950 alumni and friends of the School of Continuing Education who supported us with contributions in excess of $27,800. This total represents an increase of nine percent over the previous year. Their continued generosity is sincerely appreciated.
The School of Dental Medicine will begin the 1980-81 academic year with the largest enrollment in its 114-year history. We will have 340 men and women participating in the four-year program leading to the degree of Doctor of Dental Medicine, some twenty young dentists pursuing postdoctoral training in dental specialties, and several other candidates for a master's degree in pathology education.

This record enrollment is not entirely due to immense demand for admission to dental school, although the number of applicants for admission to our School continues at a fairly high level. It is partly the result of circumstance: this year we are completing our transition from a three-year to a four-year D.M.D. program and we have four classes of undergraduate dental students for the first time in some six years. When the three-year program was installed in the early 1970s, the size of each class was increased correspondingly from 62 to 85. When we decided to abandon the three-year program and return to the more traditional four-year curriculum, we decided also to retain the larger class size. The later decision dictated that our physical facilities would be strained to the utmost. Every effort has been made to improve and, whenever possible, enlarge those facilities.

Applications for this year's entering class of eighty-five men and women totaled some 2200, about the same figure as last year. We are comfortable with this ratio of more than twenty-five applicants for each available place. It enables our Admission Committee to continue to exercise the selectivity and care necessary to form a class of highly qualified future dentists. In general, it is our opinion and that of most other dental educators that the national decline in applications to dental schools has leveled off and that the figures should remain fairly stable for the next few years.

As a private school, however, we are deeply concerned lest the rapidly increasing cost of educating a dental student, combined with the disappearance of federal assistance, push our tuition to a point where dental education at Washington University simply is beyond the means of most applicants. We fear such a situation would result in a precipitous decline in applications.

With the imminent loss of capitation funds (per capita monies from the federal government to support dental education), our students have been informed that increases in tuition will be necessary to make up the difference. Such increases are painful for everyone, but we have no choice. As a reserve unit of the University, the School must operate on a balanced budget. Unfortunately, our students find themselves subjected to ever increasing financial pressures. Government loans and scholarships are rapidly fading from view, and the School's own funds for financial aid are woefully inadequate. We are redoubling our efforts to increase those funds through contributions from alumni and other friends.

The School is determined to continue to progress and improve, despite the need to operate within a very tightly controlled budget. A central focus of such improvement is the ongoing process of strengthening our vital cadre of full-time faculty members. We are very pleased to announce these recent additions to our full-time teaching staff:

Dr. Brian L. Cleveinger, Assistant Professor of Immunology, comes to us from the University's medical school where he has been a research associate and NIH postdoctoral research fellow for the past two years. Dr. David J. Davis, Assistant Professor of Removable Prosthodontics, is an alumnus of our School who recently has been serving as a chief dental officer in the Oklahoma Department of Corrections.

Dr. Michael J. Kasle, Assistant Professor of Oral Diagnosis and Radiology, has taught oral diagnosis and oral medicine for the past two years at the Indiana University School of Dentistry.

Dr. Russell B. Stoch, Assistant Professor of Endodontics, is from South Africa and has practiced dentistry in both Johannesburg and London. He recently completed postgraduate study at Temple University in Philadelphia. Dr. Warren Shiu-Wing Yow, Assistant Professor of Fixed Prosthodontics, received his dental degree from the University of the Philippines and has completed postgraduate training at the University of Missouri-Kansas City.

In addition, five faculty members have increased their...
participation at the School from part time to full time, further strengthening the teaching staff.

The arrival of Dr. Clevinger as our first full-time immunologist gives additional impetus to the School's efforts to reestablish research as an integral part of our educational program. In both biomedical and clinical sciences, the School is rapidly widening the scope and increasing the quality of research conducted by members of its faculty, and we anticipate much more progress.

Speaking of our faculty, we were very pleased to have a member selected again this year as a recipient of Washington University's coveted Faculty Citation for outstanding teaching. Dr. Mohamed Marzouk, Professor of Operative Dentistry and Chairperson of our Department of Operative Dentistry, is the honoree, and the School is very proud of his selection.

Preparations are under way for our 1980-81 schedule of Continuing Education courses for dentists, dental hygienists, assistant, and technicians. We presented nineteen successful courses last year and will increase that number during the current year. The quality of our C.E. courses is becoming ever more widely known. Although most of our participants continue to come from Missouri, Illinois, and surrounding states, others come from much greater distances. One course last year drew dentists from the Philippines, Alaska, and Wyoming.

Altering of the School's physical facilities has been confined this year to minor improvements. Sources of funding are still being sought for the long-awaited renovation, in conjunction with the School of Medicine, of the old A&P bakery next to the School.

The growing support and involvement of our dental alumni and friends is most heartening. Their giving in the fiscal year just ended was some $142,500, an increase of approximately $33,000 over the previous year and the highest total ever recorded by the School. Thirty-nine percent of our alumni contributed to the annual fund. In this percentage of giving, we out-rank all other divisions of Washington University.

The Dental Alumni Association held one of its most successful annual meetings in history in St. Louis last March. The Association's first Mid-Pacific Dental Conference, a continuing education program in Honolulu, followed. We will give a continuing education seminar in conjunction with a Caribbean cruise next March.

On a personal note, as President of the International College of Dentists, I recently went with Mrs. Selfridge on a month-long trip to Japan, Taiwan, the Philippines, South Korea, and Hong Kong, which included meetings with dental organizations, attendance at major dental convocations, and tours of dental schools in whose countries. It was an engrossing, exhausting, and utterly fascinating trip. Mrs. Selfridge and I were treated royally. I returned with many new insights into how dentistry is taught and practiced in other parts of the world and with a new understanding of the commonality shared by health care professionals everywhere. On our return we stopped in Hawaii and spent three days visiting with our large and enthusiastic alumni group there.

The School of Dental Medicine Task Force is hard at work helping us to shape a realistic program of growth and change for the future. There is much to be done, both in placing the School on a more substantial financial footing for the decades to come and in carrying forward our steady improvement as an educational institution. We look forward optimistically to those challenges.
School of Engineering and Applied Science

The 1979-1980 academic year was an excellent year for the School of Engineering and Applied Science. The undergraduate enrollment continued to be within its target range (950 to 1050 students), and the caliber of the undergraduate student body remained exceptionally high. Faculty research productivity maintained its steady growth; considerable success was achieved in the faculty recruitment campaign; substantial progress was made in the facilities improvement and expansion program; and the year closed with the School showing a financial surplus in its operations.

The School of Engineering and Applied Science last year granted 214 Bachelor of Science degrees to students from twenty-eight states and five foreign countries. About twenty-five percent of its students were from the St. Louis metropolitan area, and approximately half of these received some form of financial assistance from Washington University. Fifteen percent of the degrees granted were earned by women, and minority students earned three percent. About thirty percent of this year's graduates have elected to continue their education in various graduate and professional schools. Sixty percent have accepted positions in industry, and the remainder hold positions with various government agencies or have returned to their home countries.

The demand by industry and government for baccalaureate-degree engineering graduates remained exceptionally strong throughout the year. Most of the graduates seeking employment were able to choose among multiple offers of attractive, high-paying positions. As technology becomes increasingly complex and important, it is anticipated that the demand for technically trained people, particularly graduates of the major technical institutions, will not be satisfied in the foreseeable future. This demand should continue even though nationally the number of engineering graduates has been growing.

The success of the Engineering School's freshman recruitment program is evidenced by the approximately one thousand applications for the freshman class that were received and processed. The School's goal was to develop from these applications an engineering freshman class of 200 to 220 members who combined high academic abilities with strong motivation for the study of engineering and science. This goal, of course, had to be met within the constraint of the School's some-what limited financial aid budget. We are pleased that this goal was achieved.

The School of Engineering, along with most areas of higher education, continues to watch with caution for the projected decline in the population of college-age people in the United States, but also to anticipate with confidence that our academic strength and growing national recognition will enable the School to remain in a healthy state during the coming decade.

The School's Three-Two Program had a successful year. The Program's target figure of fifty admissions per year was again reached. Assistant Dean Franklin Johnson, Director of the Program, visited about half of the ninety liberal arts colleges associated in the Program with the School of Engineering. Students in the Three-Two Program spend three years at a liberal arts college and then two years at the Washington University School of Engineering. Students in the Three-Two Program spend three years at a liberal arts college and then two years at the Washington University School of Engineering. Receiving degrees from both institutions at the end of the five years. With approximately 200 students in each graduating class, the fifty Three-Two students now constitute about twenty-five percent of the engineering graduates.

Due to a severe shortage of qualified people interested in faculty positions, all engineering schools are experiencing difficulties in filling vacancies. This past year, however, the Washington University School of Engineering enjoyed considerable success in its faculty recruitment, with seven new faculty members accepting positions. Faculty attrition was only two, so the result was a net gain of five. The engineering faculty now numbers seventy-two full-time members, and we anticipate that over the next several years the faculty will continue to grow as the vacant positions are gradually filled.

In addition to the regular faculty members, fifty-three individuals serve as adjunct faculty, making many important contributions to the instructional and research programs of the School.

Three of the faculty were promoted to the rank of professor: David L. Elliott (Systems Science and Mathematics), David A. Peters (Mechanical Engineering), and Seymour Pollack (Computer Science). Tenure was granted to Professor Peters and to Associate Professor John K. Gohagan (Technology and Human Affairs).

The research productivity of the engineering faculty continued to increase. Research grants and contracts received during the year amounted to $5.3 million, up thirty-two percent from the previous year. On a national scale, the per capita research funding of the faculty ranks very high. A recent survey, based on FY'79 data, showed that the Wash-
Washington University School of Engineering ranked fourteenth nationally by this criterion, which is widely recognized as a measure of merit for a research-oriented engineering faculty.

As one of the reserve schools of Washington University, the School of Engineering operates essentially as an independent fiscal unit. Its operating budgets are determined by its income, meaning that over a period of years, expenditures cannot exceed income. During the 1980 fiscal year, the School's total income increased to $111.1 million, a rise of eighteen percent over the previous year. Of this total, $55.2 million was derived from tuition, $54.6 from research grants and contracts, $5.8 million from endowment and current funds, and $5.6 million from gifts and miscellaneous. Expenditures amounted to about $108.8 million, so the School ended its fiscal year with a surplus of about $4.4 million which will be retained in its reserve account.

The School of Engineering is in the midst of a major program of renovation and expansion of physical facilities. The increase in undergraduate enrollment that has occurred over the past five years. Ground was broken in June 1979 for a new building; December 1980 is the estimated completion date. The building will be named in honor of Stanley and Lucy Lopata. Stanley Lopata, a University Trustee and an alumnus, has been active in University affairs for many years. Intended as a multi-purpose building, Lopata Hall will provide six sorely needed new classrooms for engineering instruction. With the addition of these classrooms, some of the old classrooms in Cuples II can be converted to other uses.

In addition to the construction of Lopata Hall, extensive renovations to Urbauer Hall are in progress and should be finished at about the same time that the new building is completed. Urbauer Hall will have a new exterior skin which will correct serious problems with the original skin (e.g., penetration of rain and excessive heat losses). Urbauer will also have a completely new and energy-efficient heating, ventilating, and air conditioning system. A new addition to the Washington University power plant is under construction. This addition will house a central chilled water plant which will extend an energy-efficient cooling system throughout the engineering complex.

As part of the plan to finance this construction and renovation, the School of Engineering has undertaken a major capital fund drive. The goal of the drive is $5 million for construction and renovation and $1 million for an endowment to support the maintenance of the new space. During the 1980-81 academic year, a general campaign will be directed toward friends and alumni of the School. As of July 1, 1980, major gifts to the campaign have amounted to $3.1 million. It is, of course, especially important to the School of Engineering that the fund drive be successfully completed. Failing short of the goal would necessitate borrowing funds, and the resulting debt service would have to be borne by the School's operating budget.

During the past year, the Engineering Task Force of the Commission on the Future of Washington University held four meetings under the leadership of its chairman, University Trustee David Lewis. The purpose of the Task Force is to help the School analyze its strengths and weaknesses and to evaluate the School's goals and objectives for the decade of the 1980s. The interchange of ideas between the members of the Task Force and the engineering faculty and administration has been particularly helpful. There was strong agreement regarding the importance of the four-year engineering baccalaureate degree programs. It is anticipated that the Task Force will soon complete deliberation and submit its report to the Board of Trustees.
School of Fine Arts

Challenge—stirring both individuals and institutions to heights of performance—describes the tenor of our past academic year and characterizes the development and growth of the School of Fine Arts during its centennial. Challenge, perhaps best seeking its resolution through creative approaches, also reminds us that we can only briefly be satisfied by past accomplishments. As we enter a new era in our history, some old questions persist. We are working toward improving aging equipment and undergraduate facilities, presently situated in several locations. At the same time we are ever mindful of the ongoing imperative to sustain quality through the recruitment of outstanding students and faculty. These are among the considerations that continue to beg our attention.

Our primary task, the education and training of artists (and, secondarily, the development of a visual language literacy in university students), is, without doubt, a most difficult pedagogic objective. Economic uncertainty, decreasing numbers of prospective students, and a diminishing job market render that objective in the most somber tones. Nevertheless, the idealism, commitment, and energy of our students, alumni, and teachers, continually defy those doomsayers who would deny the value of a combined professional art and university education. The quality of the students we continue to attract enables us to maintain high academic standards and outstanding achievement in artistic development. We have a great deal of which to be proud.

To brighten the festivities surrounding our centennial, the School of Fine Arts received a grant for the purchase of four turn-of-the-century reproduction chandeliers for Bixby Gallery. These beautiful chandeliers adorned the celebration of both the Beaux Arts Ball and the Bohemian Brawl, two traditional Art School activities brought back to life by the enthusiasm of our alumni, students, and staff. The annual Faculty Exhibition was given an extra dimension for the centennial by the inclusion of works by such illustrious artists as Philip Guston, Max Beckmann, Werner Drewes, Fred Conway, Oscar Berninghaus, and more than forty other distinguished artists, all of whom at one time taught at the School of Fine Arts. In addition, the works of over seventy alumni, some dating back to the early years of this century, were featured at a Centennial Alumni Exhibition.

Last spring our faculty was extended the unusual honor of being invited to present a group show at the Mitchell Museum in Mount Vernon, Illinois. Initiating a new tradition with the School of Fine Arts, Professor Edward Boccia attracted to Bixby Gallery an overflow crowd with an exhibition of work done during his prolific sabbatical the previous year. Our faculty’s accomplishments continue to be a source of great pride: Professor Lucian Kruckowksi was awarded a travel grant from the American Council of Learned Societies to present a paper at the Ninth International Congress of Aesthetics at Dubrovnik, Yugoslavia. The work of Associate Professor William R. Kohn was featured recently at “Currents 7,” a solo exhibition at the St. Louis Art Museum. Concurrently, he was honored by a retrospective of his work at the Timothy Burns Gallery. Adjunct Professor of Art and Washington University Photographer Herbert Weitman exhibited his intimate photographs of internationally known sculptor Alexander Calder at Laumeier Sculpture Park. “Artists in Clay—Ten From the Midwest,” a traveling exhibition that has already been shown at four museums, includes works by Associate Professor David Hershey.

This year our faculty was strengthened by the appointment of Edward Kenly White, our first full-time photography instructor, and two appointments in sculpture, Timothy P. Curtis and Jon E. Echternach. Numerous professionals from the St. Louis community continue to augment the teaching of our full-time faculty. Although the 1980-81 school year will hold for us the sad occasion of the retirement of two of our most dedicated and prestigious faculty members, Professors of Art William F. Fett and Arthur Osver, we are encouraged by the prospect of introducing to the School artists of comparable achievement and standing.

The Graphic Communications area of our Design Department continues its exemplary program of community support through the donation to not-for-profit organizations of services provided by students, who in turn receive quality "real world" learning experiences. Traditionally one of the strongest areas in our School, Graphic Communications also maintains close ties with the Business School. A team of business and fine arts students joined forces in the 1980 General Motors Intercollegiate Marketing Program Competition. A similar effort sponsored by both schools produced a winning combination of planning, presentation, and marketing strategy for Nabisco Snack Food Products in the regional competition of The American Advertising Federation. In a competition arranged by instructors in graphic communications and David Boss, Washington University alumnus and vice president of National Football League Properties, Inc., Paula Boyell produced the winning cover design for 50,000 programs distributed at the 1980 Pro Bowl Game in Honolulu. Kay Selle, a senior in the School of Fine Arts, was named the outstanding U.S. student designer of menswear by the Men's Fashion Association Press at
the 1980 Cutty Sark Men's Fashion Awards.

Our speakers' program is yet another important means of expanding the educational resources of the School. Among the eleven artists presented to students and the community this past year were: Lee Chesney, Louis D. Beaumont Distinguished Visiting Professor of Art; Nancy Graves, Dorothy Dubinsky Lecturer; and Patricia Duncan, a 1979-80 Distinguished Alumna. Many others visited the School in contexts of varying formats, providing less visible but equally important student/artist contacts.

The annual High School Art Competition, this year involving seventy-five students from twenty-five local high schools, represents a growing commitment to the promotion of arts programs on the high school level. Funded solely through gifts from fine arts alumni, the High School Art Competition also reflects one of several significant achievements in planning and organization by our alumni volunteers. Further testimony to an increasing alumni and friends' interest in the School is this year's fifty-six percent rise in unrestricted annual giving.

As part of an ongoing program to improve our facilities, Bixby Hall has undergone significant renovation. Completed in fall 1979, the junior/senior painting studio is now an expansive 3,125 square feet of work space located on the third floor. Perhaps the largest such facility of its kind in the Midwest, the studio is used solely by undergraduate painting majors. Though not as insignificant as it may at first seem, heat has been added to the list of amenities in the multimedia complex at our Tyson Valley Graduate Center. Through the generosity of special friends of the School, we have been able to improve and modernize our photography laboratories. Equipment for non-silver processes has been introduced, broadening the various image making techniques available to the student.

In its second year of operation, our Contract Print Shop, providing facilities and assistance for producing fine art print editions, has been successful in attracting established artists, both locally and nationally. These artists collaborate with our master printer to produce professional-quality graphic editions. Not only does the print workshop provide graduate students with hands-on working experience, but it also opens up important opportunities for our undergraduate students to participate in and benefit from the presentations of visiting artists.

Also in its second year, the Summer Art Institute has brought nationally known artists to St. Louis to work with advanced students and professionals in the arts. This year, students have had an opportunity to work with Dan Cytron, Ed Paschke, and Sam Gilliam in the Painting, Drawing and Printmaking Workshop, and with Gretchen Raber, Barry Merritt, and our own Heikki Seppa in the Metalsmithing Workshop and Seminar. The Summer Art Institute has been successful in presenting a variety of viewpoints to participants interested in pursuing contemporary issues and, at the same time, in encouraging those artists to compare their own points of view with those of the avant-garde.

Faced with shrinking numbers of prospective students, institutions of higher education must develop more effective recruitment and admissions procedures, and yet must not compromise the integrity of the educational mission and purpose.

We, too, have been subject to the pressures brought on by a faltering economy. Of challenges, we have our share. Yet the future of our School is founded upon the strengths of our past, and we remain cautiously optimistic. Although national enrollment statistics are down, we expect to maintain our share of artistically talented, academically gifted, and highly motivated students. The capability of our faculty, supported by the reputation of the University as a whole, continues to be the deciding factor. As the costs of college education continue to rise and the smaller number of prospective students becomes more selective, we feel that those qualities which separate us from the general rank and file of schools will become more apparent. Our commitment to growth, excellence in teaching, and creative research, backed by goals for facilities improvements, assertive admissions efforts, and faculty enrichment, reflect increasingly important criteria for the future.
Hodge O'Neal became Dean of the School of Law July 1, 1980. A lot more happened last year, but that was the main event.

The search for a new dean began in fall 1979 after I announced my intention to resign, having been dean since 1973. The Search Committee, chaired by Professor Jack Hexter of the Department of History, included seven law faculty members and two law students. An Alumni Advisory Committee of six assisted.

Chosen from among eight prospects considered, Dean O'Neal was hardly a surprise. He is nationally known and respected, not only as a scholar in the field of close corporations, but also as a former dean at the Duke University School of Law and at the Mercer University Law School. That he accepted was a surprise to some, a delight to those who wish this School well. Transitions from one dean to another are not always smooth. In recent years, several top law schools have taken a long time to find a dean. An institution's aspirations for leadership do not easily intersect with reality. Ours did.

Dean O'Neal's priorities will be increasing resources for the school, encouraging continuation of a high level of scholarly productivity, reexamining the curriculum, especially the "clinical" segment, and maintaining a strong student body in a period of declining applications.

Annual support in unrestricted giving from alumni and friends reached $135,000, the highest ever. The Law Eliot Society has forty-three members, the Dean's Committee eighty, and the Century Club 270. The Alumni Association elected Maury Poscover president, replacing Philip Maxeiner. Paul Rava, whose gift of 350 rare Italian law books is a welcome addition to our collection, is the new chairman of the Law Library Association Committee. Nothing has been more gratifying to me as dean than the generous support and confidence of our alumni.

Having welcomed four new members to our faculty in 1979-80 (one experienced professor from another school and three beginners), and with a dean to choose, we slowed the pace of faculty recruiting during 1979-80, but did appoint two new assistant professors: Kelly Weisberg, a graduate of Boalt Hall School of Law, University of California at Berkeley, who also has a Ph.D. from Brandeis University; and Karen Tokarz, a graduate of St. Louis University Law School, who taught with us last year as a clinical teacher. Professor Tokarz is also Acting Director of the Clinical Program. Robbye Hill, who graduated from our school in May, is the new Assistant Dean for Administration. All are fine additions.

We will miss greatly Associate Professor Patrick J. Kelley, who resigned to practice law.
School of Law
Edward T. Foote, Dean
1979-80

in St. Louis, and clinical
teacher Patricia E. Rousseau,
who has joined the law faculty
at Rutgers University-Newark.
Both served our school
extremely well.

In these tasks, he and the
faculty will be aided by the
report of the School of Law
Task Force, which met five
times during the 1979-80 year
under the leadership of alumni
Judge William H. Webster,
director of the F.B.I., chair­
man, and William Van Cleve,
managing partner of the St.
Louis law firm of Bryan, Cave,
McPheeters and McRoberts,
vice chairman. The Task
Force examined the school
from top to bottom, found
much to praise, and submitted
a number of recommendations.

No one, including members
of the Task Force, can study
an institution of private higher
education today without a
sense of concern about ade­
quate funding. Tuition (55,000
this year) will never be suf­
ficient. The need for generous
support from alumni and
others has never been more
urgent.

We are gladdened, there­
fore, by two splendid gifts:
one, approximately $500,000,
from the estate of Edna I.
Fisse, for scholarships, library,
and general support; the
other, $100,000, from Mrs.
Alvin G. Whitehouse, in mem­
ory of her husband, for books.
We are most grateful to Miss
Fisse, a St. Louis teacher for
fifty years whose father and
cousin were graduates of the
School of Law, and to Mrs.
Whitehouse, whose husband
was an alumnus. A second
grant of $10,000 from the
Gaylord Foundation (for a
total of $30,000 granted to
us recently by that foundation)
assisted in our retrospective
library collection building.

Applications to study law
decreased here, as elsewhere.
For the freshman class, 1,250
people applied, as compared
with a peak of over 2,000 in
the early 1970s. Legal educa­
tors watch this trend nervously,
but the best predictors
suggest that the demand
should remain high enough to
insure a student body of high
quality. Graduates continue
to compete well nationally in
a tight job market. One hun­
dred and ninety-six graduated
in May.

I will miss my colleagues
on the faculty and staff, and
the 1494 students who gradu­
ated while I was Dean. It has
been more than a privilege to
be Dean of the Washington
University School of Law. It
has been a pleasure. I am
honored to have passed this
way, and I leave confident
that the School of Law is
strong and in good hands.

I close in sadness, remem­
bering the good life of Pro­
fessor Robert G. Dixon, Jr.,
who died unexpectedly on
May 5. Professor Dixon, one
of the fine senior scholars
I had the good fortune to hire
while I was Dean, joined us in
1975 from George Washington
University Law Center. A
former Assistant Attorney
General of the United States,
he became at once a pillar of
this faculty. Prolific author,
dedicated teacher, fun and
feisty colleague. Bob exem­
plified much that is good in
the law and those who serve it.
School of Medicine

The School of Medicine had another very good year in 1979-80, and I am pleased to describe some of the salient features.

The number of students enrolled in the School in pursuit of the degree of Doctor of Medicine increased steadily during the late 1960s and the early 1970s, and has remained rather stable for the last five or six years. In 1970 our total enrollment for all four classes was 401, while in 1979-80 it was 555. The number of applications remains very high. In 1978-79 there were 6731 applicants for the first-year class.

Of the total number of students enrolled in the School of Medicine, twenty-four percent are women. In 1979-80, forty-four states, the District of Columbia, and five foreign countries were represented in the enrollment. The 1979 entering class carried an undergraduate grade-point average of 3.66 in science courses and 3.60 in non-science courses, for an overall grade-point average of 3.65 on a 4.0 scale.

Last year a total of 210 students, located primarily on the East Campus, were in pursuit of the Ph.D. degree in one of the biomedical sciences. The number of such students has been steadily increasing over the last ten to twelve years. From this group of young people will emerge the teachers and scientists who will form tomorrow’s medical faculties.

We continue to have an increasing number of students in the paramedical fields. In 1979-80 there were seventy-eight students in the Health Administration and Planning Program; sixty-one in the Program in Occupational Therapy; forty-one in the Program in Physical Therapy; fourteen in the Pediatric Nurse Practitioner Program; thirty-two in the X-ray Technology; five in Nuclear Medicine Technology; and four in Radiation Therapy Technology.

Postdoctoral education continues to be a very important effort in the Medical Center. This past year there were 122 interns; 438 residents; and 207 postdoctoral fellows and trainees.

On May 16, 1980, a total of 141 young men and women were granted the degree of Doctor of Medicine. After the commencement exercises on the Hilltop Campus, the graduating seniors were recognized individually in a second ceremony downtown at the Cervantes Convention Center. The featured speaker on the program this year was Dr. W. Maxwell Cowan of our own faculty, who spoke on “An End and a Beginning.”

Sadly, one of the most significant events of the past year was the loss of Dr. Cowan to the Salk Institute in California. He has been one of the most distinguished members of our faculty for the past thirteen years, having served as Edison Professor of Neurobiology and Head of the Department of Anatomy and Neurobiology, and recently as Director of the Division of Biology and Biomedical Sciences of the University. We certainly wish Dr. Cowan every success in his future efforts.

As everybody knows, the reputation of a medical school rests upon its faculty. We continue to have three who are members of the National Academy of Sciences, and the number who are members of the Academy’s Institute of Medicine has now increased to nine. Twenty-nine faculty members serve on National Institutes of Health Advisory Boards and Committees and eight on Health Resources Administration Advisory Boards and Committees. In January, two of our faculty, Professor Leonard J. Banaszak and Professor David Schlessinger, were named Macy Faculty Scholars for 1980-81. These awards from the Josiah Macy, Jr. Foundation enable selected senior medical scientists to spend up to a year of concentrated study away from their home institutions. Professors Banaszak and Schlessinger were among twenty-six Macy scholars chosen from approximately 130 candidates from the United States and Canada.

We are fortunate to have twenty-five endowed named professorships in the School of Medicine, including two created this year in honor of two of our most respected faculty members: the Fred C. Reynolds Professorship of Orthopedic Surgery and the Bernard Becker Research Professorship in Ophthalmology. In 1977, the Alumni Endowed Professorship Program was established to secure, through donations from alumni, the funds necessary to endow a professorship at the School. The goal of the AEP Program is that every department in the School of Medicine have an alumni professorship.

The highest priority of the School during the past year has been planning and raising funds for a new Clinical Sciences Building to be located on the property just north of Audubon Avenue on the site formerly occupied by the St. John’s Hospital. This building is urgently needed to provide more research space for some of the clinical departments.

After the Clinical Sciences Building, a major unrealized goal of the School of Medicine is a new library building, as I pointed out last year. The present collection is housed mostly within a building that was constructed more than sixty-five years ago.

A very significant event during the past year has been the efforts of the Commission on the Future of Washington University. The Task Force for the School of Medicine, chaired so very effectively by John W. Hanley, chairman and chief executive officer of Monsanto Company, held six meetings during the year, before finishing in May. The members of this Task Force, both local and national, have been very helpful to Dr. Guze and me over the past several years.
months, and we are looking forward to their final report.

In May the School of Medicine received yet another tremendous gift from one of its greatest benefactors. Mr. James S. McDonnell, chairman of the McDonnell Foundation, announced a gift of $5.5 million to Washington University to establish the McDonnell Center for Studies of Higher Brain Function. Mr. McDonnell said, "We stand at an historic point in mankind's development, where science and technology have made possible instrumentation which can be applied to the measurement of local brain activity in human beings as thought processes take place. Purposefully pursued, this line of neurosciences research may point up the possible interface between the human mind and the human brain..." Mr. McDonnell consistently supported research in areas of science at the forefront of human knowledge.

With his death on August 22, we lost a great friend and the scientific community lost a man of vision and energy. The new Center will be headed by Dr. Sidney Goldring, Professor and Head of Neurosurgery and Co-Head of the Department of Neurology and Neurosurgery. Dr. Goldring has been a leading authority on the study of the human brain for many years.
School of Social Work

As in previous years, faculty productivity at the George Warren Brown School of Social Work remained high last year. In conference presentations, research publications, journal editing, preparation of book-length manuscripts, submission of grant proposals, and contributions to scholarly and professional societies, the faculty evinced the leadership and creativity that the field has come to expect of them. A recent research study published in the Journal of Social Work Education, the official publication of the Council on Social Work Education, ranked social work schools according to faculty productivity as indicated by publication of articles in selected social work journals. According to this study, our faculty ranked eighth in the country in total faculty productivity and second when productivity was adjusted for faculty size.

Thanks to the calibre and diligence of the faculty, we received funding for several new projects. The 1979-80 federal funding level at the School was the highest in the past ten years.

The School of Social Work was selected by the Children's Bureau, an agency of the Department of Health and Human Services, as the Region VII Child Welfare Training Center. Under the directorship of Assistant Professor Robert Pierce, the Center will survey and develop child welfare training in accredited social work training programs and child welfare agencies in a four-state region comprising Missouri, Iowa, Kansas, and Nebraska. The selection of the George Warren Brown School of Social Work as the location of this important new Center recognizes and reinforces the School's scholarly and teaching strengths in child welfare. It also attests to the close ties the faculty has with practicing social workers in this region.

The entire George Warren Brown community was saddened at the death of Professor Emeritus Peggy Wood this spring. Associated with the University since 1946, Professor Wood was a staunch and dedicated supporter of the School.

After serving the School for a quarter century, Professor Dorrieece Pirtle retired from the University this summer. Under her inspiration and leadership, the George Warren Brown School became one of the first schools of social work in the country to offer courses dealing with women and welfare.

The success of the Social Work Continuing Education Program, established last year, exceeded our most optimistic expectations. The only comprehensive program of its kind in the St. Louis Metropolitan area, it was organized into three components: a Distinguished Lecture Series, a Clinical Training Program, and a Management Training Series. Offered during the fall and spring semesters, as well as during the summer, the thirty-two continuing education workshops and institutes attracted nearly 1,000 participants from a variety of human service organizations. It is clear that the continuing education program has responded to a long-existing need for lifelong learning opportunities to serve social welfare personnel in St. Louis and surrounding communities.

Considerable prior social work experience and an informed, serious attitude toward educational planning, school affairs, and career goals characterized the 167 students from thirty states and several foreign countries who enrolled in the Master of Social Work program in fall 1979. Eight students enrolled in the Ph.D. program. Last year's doctoral class included four minority students, a significant increase over previous years.

The continuing decline in applications for admission to M.S.W. programs nationwide has affected our enrollment. Despite the School's success in obtaining training grants and despite a sizable amount of financial aid being offered through the School's own funds, it is becoming patent that the amount of aid currently available is not sufficient to recruit a student body of requisite size, diversity, and quality to maintain a first-rate program. A Task Force on Admissions and Recruitment has studied the matter of student recruitment extensively and has prepared a number of recommendations, many of which are already being implemented.

In the past several years the School has attempted to provide financial assistance to a large number of students who, on their own resources, were unable to meet the increasing costs of attending a high-quality program of advanced education at an independent university. These efforts will continue and expand in the years to come. In addition, the School took an important step last year to ensure financial aid for a select number of exceptionally talented incoming students in recogni-
tion of their academic attainments and potential for leadership in the social work profession. Under a program of new fellowships, up to ten outstanding students will receive full tuition remission along with an annual stipend of $1000 for two years of graduate study in the M.S.W. program. This is the only financial aid program of the School which does not consider financial need as an award criterion. The highly successful history of merit scholarship programs at Washington University encourages the expectation that this substantial commitment to merit scholarship will bring us many excellent students.

Alumni support to the School is growing steadily. Twenty-three percent of the alumni participated in the annual giving program last year. The Century Club, founded in 1976-77, now has sixty members. Many alumni, as agency supervisors, provide valuable practicum experience to the M.S.W. students. Alumni are also helping us in recruiting students. One of every three out-of-town applicants to the School has had personal contact with an alumnus sometime during the applicant's decision-making process. This aid to the School and to the applicant has been made possible by more than 230 alumni across the country, who actively participate in our recruitment efforts.

An important event for the School of Social Work commenced on January 10, 1980, when, under the vigorous chairmanship of University Trustee James Lee Johnson, Jr., the Social Work Task Force met for the first time. This Task Force, working as part of the Commission on the Future of Washington University, includes university trustees, alumni, business and community leaders, and representatives of national social service constituencies. The Task Force has held three full-day meetings and will complete its assignment in January 1981. In the meetings so far it has heard detailed reports about the School's educational program from the dean, faculty, students, alumni representatives, and leading social work agency executives in the St. Louis community. In its fall 1980 meeting, the Task Force will review the financial resources of the School. Its advice and recommendations are likely to play a significant role in helping to test and evaluate the realism of goals and objectives for the School, and to fashion appropriate strategies to accomplish these goals.

As we move into the uncertain 1980s, some old problems and challenges will acquire new urgency. We will have to be imaginative in augmenting our resources, judicious in their allocation, and prudent in managing them. We have a foundation of rather impressive assets. The School's faculty is recognized as one of the best in the nation. We are able to recruit idealistic and talented students from all parts of the country and the world. The support of loyal alumni is increasing every year. Social welfare agencies continue to look to our students for practicum and placement opportunities. The reputation of the School, built by the contributions and accomplishments of its faculty and alumni, is solid and is becoming stronger. The faculty's ability to generate external funding through research and training proposals is well demonstrated. The innovations in our educational program have attracted widespread attention. The climate of close interprofessional and interdisciplinary collaboration at the University is the envy of many other institutions. The simultaneous presence of these assets strengthens my conviction that the George Warren Brown School of Social Work will remain in the forefront of social work education in the decade ahead.
Financial Condition of the University

The fiscal year 1980 ended with income in excess of expenditures, resulting in an increase in reserves of the total University, in spite of the adverse effect of double digit inflation. Many factors contributed to the 17 percent increase in revenues in the past year, with the largest increases being from patient and laboratory fees, organized patient-care activities, government grants and contracts, and investment income.

Below is a brief analysis of total income and expenditures, operations of separate fiscal units, University assets and investments.

TOTAL INCOME AND EXPENDITURES

Income
The University has four major sources of support for activities represented by its expenditures. These are:

Operating Revenue
Total operating income, primarily from payments by those who benefited directly from the University’s operation, amounted to $119,967,000. Student tuition and fees accounted for $37,534,000. Patient and laboratory fees for medical services provided by faculty and staff amounted to $28,579,000. Income from organized patient-care activities, such as the Edward Mallinckrodt Institute of Radiology, was $22,288,000. The auxiliary enterprises, including residence halls, food service, and bookstores, had income of $10,625,000. Current funds investment income was $5,789,000, while other miscellaneous operating revenues totaled $15,152,000.

Government Grants and Contracts
A large portion of the research done by the University is sponsored by grants and contracts from governmental agencies, mostly federal, for specific sponsored projects. Total income from governmental sources expended in fiscal year 1980 was $58,036,000, an increase of $8,581,000 over the previous year. Included in this total is $3,958,000 for scholarships and traineeships, an increase of $503,000 over the previous year. In addition, 90 percent of the total $2,372,000 student loan funds issued under the National Direct and Health Professions Loan Programs was funded by the federal government.

Private Gifts, Grants, and Contracts
Washington University received a total of $22,398,000 in gifts (including bequests) and grants from private sources for various purposes. In addition, $1,373,000 in private contracts was received during fiscal year 1980.

Support from private, non-governmental sources for operating purposes amounted to $13,490,000. Recognized as current income was $11,397,000 which includes $1,782,000 in unrestricted gifts and $9,615,000 expended for sponsored research and other sponsored programs in fiscal year 1980. The balance of $2,093,000 received for operating purposes is being held for future expenditures on sponsored programs. The ten-year chart reflects large unrestricted grant support from the Danforth Foundation for the 1973-77 years.

In addition to gifts for operating purposes, $6,170,000 was received for endowment, $4,091,000 for plant, and $20,000 for student loans. Major sources include alumni, individuals, business corporations, and foundations. A separate table presents a breakdown of the total by source and purpose.

Endowment
The investment of endowed funds resulted in $15,220,000 of income used to support operating expenditures. In addition, $1,152,000 of term endowment was utilized to meet operating expenditures which represents a transfer from the Danforth Foundation Challenge Grant in accordance with a formula adopted by the Board of Trustees.

Expenditures
The total operating expenditures of Washington University in fiscal year 1980 amounted to $181,736,000. In 1979 this figure was $163,791,000. Approximately 42 percent of the increased expenditures was attributed to instruction and student aid.

Purpose

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Aid</td>
<td>6%</td>
</tr>
<tr>
<td>Current Operations</td>
<td>18%</td>
</tr>
<tr>
<td>Endowment</td>
<td>28%</td>
</tr>
<tr>
<td>Sponsored Research and Other</td>
<td>44%</td>
</tr>
</tbody>
</table>

Total Private Gifts, Grants and Bequests—$22,398,000

---

Private Gifts, Grants and Bequests Received

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agencies and Groups</td>
<td>16%</td>
</tr>
<tr>
<td>Alumni</td>
<td>22%</td>
</tr>
<tr>
<td>Business Corporations</td>
<td>21%</td>
</tr>
<tr>
<td>Trusts and Foundations</td>
<td>20%</td>
</tr>
<tr>
<td>Individuals</td>
<td>21%</td>
</tr>
</tbody>
</table>

Total Private Gifts, Grants and Bequests—$22,398,000
Ten Year Comparison of Income by Source
(in millions of dollars)

Revenue from Tuition and Services

Income Expended from
Government Grants and Contracts

Private Gifts, Grants, Contracts and Bequests
Recognized as Operating Income
- Restricted (Amount Expended)
- Unrestricted

Endowment Resources Appropriated
for Operating Purposes
- Term and Temporary Endowment Utilized
- Income
SUMMARY OF UNDERGRADUATE FINANCIAL AID (Excluding Loan Funds)
Thousands of Dollars

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Tuition Remission</th>
<th>Restricted Scholarships</th>
<th>College Work Study</th>
<th>Basic Educational Opportunity Grants</th>
<th>State of Missouri Grants</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>$3,683</td>
<td>$953</td>
<td>$282</td>
<td>$508</td>
<td>$513</td>
<td>$55,939</td>
</tr>
<tr>
<td>1979</td>
<td>3,999</td>
<td>1,300</td>
<td>372</td>
<td>524</td>
<td>536</td>
<td>6,731</td>
</tr>
<tr>
<td>1980</td>
<td>3,805</td>
<td>1,501</td>
<td>1,184</td>
<td>1,057</td>
<td>559</td>
<td>8,106</td>
</tr>
</tbody>
</table>

Research, primarily supported by outside agencies, accounted for another 29 percent of the increase, and 10 percent of the increase was in organized patient-care activities, such as the Edward Mallinckrodt Institute of Radiology. The remainder of the increase was divided between operation and maintenance of plant, auxiliary enterprises, academic support, institutional support, and student services.

Capital expenditures for buildings were $10,937,000. Investments in all physical facilities, including buildings, land, equipment and library acquisitions, increased $42,248,000, of which $26,054,000 represents a revaluation of fixed assets undertaken this year.

Included in operating expenses is student aid (scholarships, fellowships, and stipends) amounting to $12,886,000 from University income and from governmental and private sources, but excluding College Work Study, Basic Educational Opportunity Grants, and the State of Missouri Student Grant Program. The accompanying summary reflects undergraduate financial aid for the past three years. Student loans are not expended from current funds—their source is a separate fund category. Student loans issued during fiscal year 1980 totaled $2,949,000, compared with $3,113,000 in the prior year.

OPERATION OF SEPARATE FISCAL UNITS
The University follows a policy of encouraging its schools to operate as independent fiscal units wherever possible. Each of the independent units is responsible for supporting its operating expenditures with its income, and each maintains an individual reserve of funds.

The Schools of Dental Medicine, Engineering, Law, Medicine, and Social Work have been independent units for a number of years, and this fiscal year the School of Business Administration became an independent fiscal unit also. The Schools of Architecture, Arts and Sciences, Continuing Education, and Fine Arts, plus general University services and activities such as Olin Library, are grouped in one fiscal entity presently referred to as the central fiscal unit. The central fiscal unit is reimbursed for services rendered to the independent units.

All of the fiscal units of the University completed the year with income in excess of expenditures and reserve transfers with the exception of the School of Dental Medicine, which ended the year with a small deficit.

A Summary of Current Funds Revenues, Expenditures, and Transfers from General Reserves follows.

UNIVERSITY ASSETS
Institutions of higher education and other not-for-profit organizations keep their financial resources in the form of funds to comply with the wishes of donors and to account properly for government grants and contracts. A separate fund is established for each project or purpose. The thousands of funds for which Washington University is accountable are handled in

Ten Year Comparison of Annual Expenditures
(in millions of dollars)
Summary of Current Funds Revenues, Expenditures, and Transfers From Reserves
For Separate Fiscal Units of the University
For Fiscal Year 1980
Thousands of Dollars

<table>
<thead>
<tr>
<th>Revenues:</th>
<th>Central Fiscal Unit</th>
<th>School of Business</th>
<th>School of Engineering</th>
<th>School of Law</th>
<th>School of Social Work</th>
<th>School of Dental Medicine</th>
<th>School of Medicine and Related Activities</th>
<th>Computer Systems Laboratory</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuition and fees</td>
<td>$ 19,378</td>
<td>$ 5,050</td>
<td>$ 5,211</td>
<td>$ 2,835</td>
<td>$ 1,225</td>
<td>$ 1,971</td>
<td>$ 3,864</td>
<td></td>
<td>$ 37,534</td>
</tr>
<tr>
<td>Government grants and contracts, including all overhead</td>
<td>8,998</td>
<td>63</td>
<td>3,847</td>
<td>39</td>
<td>616</td>
<td>635</td>
<td>42,953</td>
<td></td>
<td>$ 885</td>
</tr>
<tr>
<td>Private gifts</td>
<td>4,201</td>
<td>337</td>
<td>920</td>
<td>231</td>
<td>46</td>
<td>227</td>
<td>5,402</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>Endowment income (a)</td>
<td>6,806</td>
<td>87</td>
<td>612</td>
<td>366</td>
<td>343</td>
<td>24</td>
<td>6,982</td>
<td></td>
<td>15,220</td>
</tr>
<tr>
<td>Expired term endowment</td>
<td>1,152</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,152</td>
</tr>
<tr>
<td>Current funds investment income</td>
<td>768</td>
<td>69</td>
<td>275</td>
<td>96</td>
<td>62</td>
<td>127</td>
<td>4,351</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>Sales and services—educational activities</td>
<td>1,582</td>
<td>47</td>
<td>257</td>
<td>14</td>
<td>49</td>
<td>42</td>
<td>5,463</td>
<td></td>
<td>195</td>
</tr>
<tr>
<td>Sales and services—auxiliary enterprises</td>
<td>8,882</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,743</td>
<td></td>
<td>10,625</td>
</tr>
<tr>
<td>Patient and laboratory fees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>914</td>
<td>27,663</td>
<td>28,579</td>
</tr>
<tr>
<td>Organized patient-care activities—sales and services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other income and additions</td>
<td>1,053</td>
<td>65</td>
<td>59</td>
<td>37</td>
<td>37</td>
<td>59</td>
<td>6,186</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Total revenues</td>
<td>52,820</td>
<td>3,718</td>
<td>11,181</td>
<td>3,618</td>
<td>2,378</td>
<td>3,999</td>
<td>126,897</td>
<td></td>
<td>205,772</td>
</tr>
</tbody>
</table>

Expenditures and mandatory transfers:

| Instruction | 17,295 | 1,822 | 4,268 | 1,327 | 1,129 | 2,172 | 39,108 | | 67,121 |
| Research | 5,192 | 2,691 | 51 | 103 | 29,010 | 576 | 37,623 |
| Academic support | 4,324 | 619 | 1,033 | 1,209 | 586 | 735 | 4,918 | | 235 |
| Student services | 2,461 | 225 | 544 | 188 | 126 | 136 | 909 | | 4,589 |
| Institutional support | 2,690 | 184 | 376 | 159 | 115 | 138 | 2,570 | | 6,232 |
| Operation and maintenance of physical plant | 3,786 | 246 | 745 | 412 | 203 | 521 | 6,243 | | 12,156 |
| Scholarships and fellowships | 6,074 | 449 | 1,079 | 320 | 109 | 52 | 793 | | 8,876 |
| Organized patient-care activities | 20,339 | | | | | | 10,032 |
| Auxiliary enterprises | 8,320 | 1,712 | 131 | 189 |
| Miscellaneous services | 51 | 7 | | |
| Mandatory transfers | 846 | | | | | | 920 |
| Total expenditures and mandatory transfers | 51,039 | 3,545 | 10,743 | 3,615 | 2,319 | 3,990 | 105,674 | | 181,736 |

Transfers to committed reserves, plant, and other funds from revenues and prior years' accumulated reserves:

| Total expenditures and transfers | 52,802 | 3,403 | 10,786 | 3,609 | 2,377 | 4,011 | 120,850 | | 198,639 |

Net effect of revenues, expenditures, and transfers on general reserves:

<table>
<thead>
<tr>
<th></th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ 18</td>
<td>315</td>
<td>395</td>
<td>9</td>
<td>1</td>
<td>(12)</td>
<td>6,047</td>
<td>360</td>
<td>7,133</td>
<td></td>
</tr>
</tbody>
</table>

(a) Endowment at market value with income for:

| Support of current operations | $108,146 | $1,018 | $ 9,272 | $6,395 | $5,512 | $1,328 | $100,105 | | $231,776 |
| Other purposes | 6,939 | 96 | 2,063 | 27 | | 36 | 4,631 | | 13,792 |
| Total endowment | $115,085 | 1,114 | 11,335 | 56,422 | 55,512 | 1,364 | 104,736 | | 245,568 |

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four major groupings: current funds, student loan funds, endowment funds, and plant funds. With the exception of income from the investment of endowment funds, the ongoing operating expenditures of current funds may not be offset by resources of the other three fund groupings. The Summary of Assets, Liabilities, and Fund Balances as of June 30, 1980, presents the assets and any claims against them for the four fund groupings.

Current funds must be separated between unrestricted and restricted funds. The unrestricted current funds consist of revenues from the various income-producing operations of the University, plus unrestricted gifts and unrestricted earnings from endowment. Expenditure of these unrestricted funds is left to the discretion of the University. Other funds available for current operations restrict expenditures to a given department or school, or for special, designated purposes such as research in a specified field or by a specified person. Unrestricted and restricted funds are combined in the overview of current operations of the separate fiscal units presented previously. They are kept distinct in the accompanying Summary of Assets, Liabilities, and Fund Balances.

As of June 30, 1980, the total assets of the current funds were $590,478,000, including restricted current funds of $18,546,000 and unrestricted current funds of $71,532,000. Accounts payable and other such liabilities against unrestricted current funds amounted to $20,810,000. Another $29,576,000 of the unrestricted current fund assets was encumbered or otherwise administratively committed for specific future purposes. The net uncommitted general reserves was $21,146,000.

Student loan funds totaled $22,114,000. The total student-loan-fund receivables was $18,708,000, of which notes receivables from current and former students amounted to $18,363,000. Outstanding loans to students included $15,341,000 under the National Direct and Health Professions Loan Programs, which were 90 percent funded by the federal government.

The book value of the endowment fund was $245,007,000 (not including cash or other assets: of this amount, $221,985,000 is in long-term investments), up $19,698,000 from the year before. The market value was $245,568,000 up $19,100,000 from the prior year. The market value associated with each of the separate fiscal units is presented along with the summary of expenditures and income for each unit.

Plant funds totaled $264,170,000. Of that amount, $240,038,000 was invested in land, buildings, books, and equipment. Total borrowing for physical plant facilities as of June 30, 1980, was $21,203,000, of which $9,537,000 represents Housing and Urban Development bonds for student housing and dining facilities.

Summary of Assets, Liabilities, and Fund Balances as of June 30, 1980

Thousands of Dollars

<table>
<thead>
<tr>
<th>Assets:</th>
<th>Current Funds</th>
<th>Student Loan Funds</th>
<th>Endowment Funds</th>
<th>Plant Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unrestricted</td>
<td>Restricted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash and securities maturing within thirty days...</td>
<td>$6,323</td>
<td>$2,480</td>
<td>$894</td>
<td>$10,058</td>
</tr>
<tr>
<td>Investments.</td>
<td>30,600</td>
<td>12,001</td>
<td>2,051</td>
<td>230,361</td>
</tr>
<tr>
<td>Receivables.</td>
<td>27,852</td>
<td>3,454</td>
<td>18,708</td>
<td>4,589</td>
</tr>
<tr>
<td>Plant facilities.</td>
<td></td>
<td></td>
<td>461</td>
<td>22,711</td>
</tr>
<tr>
<td>Other.</td>
<td>6,757</td>
<td>611</td>
<td>21,146</td>
<td></td>
</tr>
<tr>
<td>Total assets.</td>
<td>$71,532</td>
<td>$18,546</td>
<td>$22,114</td>
<td>$267,719</td>
</tr>
<tr>
<td>Liabilities and fund balances:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liabilities.</td>
<td>$20,810</td>
<td>$666</td>
<td>$1,114</td>
<td>$23,892</td>
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<tr>
<td>Deferred undistributed investment income.</td>
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<td></td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>Encumbered and committed reserves.</td>
<td>29,576</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General reserves.</td>
<td>21,146</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Balance of funds.</td>
<td></td>
<td>17,784</td>
<td>21,000</td>
<td>243,827</td>
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<tr>
<td>Total liabilities and fund balances.</td>
<td>$71,532</td>
<td>$18,546</td>
<td>$22,114</td>
<td>$267,719</td>
</tr>
</tbody>
</table>
INVESTMENTS

Income (interest, dividends, rents, etc.) from all investments for the year ended June 30, 1980, totaled $28,176,000, an increase of 29.2 percent over the $21,808,000 reported for last year. Endowment income for the same period was $19,407,000, an increase of 20.6 percent over the $16,089,000 for last year.

The market value of all investments (endowment, current, plant, student loans, etc.) including interfund advances (loans) and those securities maturing within thirty days, totaled $332,197,000, compared with $294,839,000 for the preceding year.

The market value of endowment investments was $245,568,000 at June 30, compared with $226,468,000 the preceding year. A comparison of endowment investments over the past ten years is presented in the accompanying chart.

The increase in endowment investments for the year is the result of gifts, grants, and net transfers of $12,556,000 and appreciation of $6,544,000. This appreciation was achieved despite a decline of 11.9 percent in the price of bonds as measured by the Salomon Brothers Bond Index for the fiscal year.

At June 30, the total investment portfolio (including an additional block of common stock held in trust by others with a market value of $8,695,000) was diversified as follows:

- Cash and short-term securities: 20.2%
- Fixed income securities: 38.2%
- Equities: 39.1%
- Real estate net of liabilities: 2.3%
- Other: 0.2%
- Total: 100.0%

The net income from security lending reached an all-time high of $599,000 for the year, which was an increase of $149,000 over the preceding year. Record-high interest rates and higher average volume accounted for this increased income.
Recently there has been a good deal of discussion about relations between universities and the business community. Some of the talk is fueled by national concern about productivity and technological innovation. In addition many corporations have become increasingly aware of the important national resource which research universities represent.

Industry support of university research is welcomed by academic scientists hard pressed by rapidly rising costs. Moreover, the high cost of research equipment sometimes makes industry desirable of regional sharing arrangements.

Washington University's involvement with business goes back to our beginnings. The founding in 1853 was a combined effort of a well-educated, Boston-born Unitarian minister and practical St. Louis businessmen. Washington University's renewal in the building of the two campuses around the turn of the century was accomplished through the efforts of a St. Louis business leader of great vision and energy who valued the educational enterprises despite (or perhaps because of) the fact that he had never finished high school. Robert S. Brookings tapped into some of the best academic thinking of his era as well as into the pockets of his fellow businessmen.

Today this basic academic-business partnership remains. The Board of Trustees, the legal governing body of Washington University, is heavily weighted with business people who give dedicated service to the University because they believe in the value of our institution.

Business continues to support Washington University generously. This last year we received $4.6 million from corporations and their related charitable trusts and foundations; $1.3 million of this amount was unrestricted.

St. Louis firms have been especially helpful, providing $3.3 million of the total and most of the unrestricted support. Few business communities in the world support their hometown university with greater generosity and understanding. I believe that the amount of unrestricted giving is also unparalleled, indicating a wonderful confidence in the academic enterprise by St. Louis business leadership.

One of the factors that has changed since the early days is that private philanthropy is not our only patron or even our largest one. In the year just ended, income from the federal government totaled $58 million in grants and contracts compared with a total income of $37.6 million from the combination of gifts plus endowment. Most of the federal money is given for narrowly circumscribed purposes and subsequently is tightly audited. The private funds provide flexibility and the mortar that holds the university together financially.

Naturally, the way in which the partnership works has evolved over the years. New styles of interaction develop, for example:
- A professor or group of professors, usually but not always from a professional school, agrees to carry on a study for a corporation. In these cases careful attention must be paid so that commitments to the sponsoring corporation do not interfere with the academic responsibilities to teach, to study, to make information publicly available. Corporations, on their side, naturally worry about proprietary rights and the protection of confidential company information until such time as patents can be obtained.
- Sometimes an idea process may be licensed to business. Often such endeavors are rather complex since the interests of the faculty member, the university, and sometimes the federal government (which may have funded part of the research) need to be considered.
- Some university organizations make specialized information available to interested people through publications and/or seminars.
- Quite a few business corporations pay tuition, in whole or in part, for employees to attend the university.
- University faculty provide educational programs dealing with new ideas and processes of interest to business, or perhaps university people may coordinate the sharing of information, as is done in the Center for the Study of Data Processing.
- There are sometimes joint grant applications to federal agencies from a university and a corporation.
- Academics from a variety of disciplines consult with businesses. The School of Engineering recently has formalized this consulting in an innovative way by forming a for-profit corporation, called Washington University Technology Associates (WUTA), which is wholly owned by Washington University. WUTA contracts with businesses for complex applied engineering projects that our faculty and graduate students are well qualified to do. In the fiscal year just ended, WUTA had $440,000 in income from such projects.

Various arrangements can work as long as they are mutually beneficial and protect the interests of the parties involved. Key, of course, is the desire of faculty members with certain knowledge or skills to enter into such arrangements and to be responsible for them. The university is not like a business corporation. It does not direct faculty members to perform this or that service or research; rather, it sometimes serves as a coordinator or conduit for individuals who wish to become involved. What faculty members must evaluate is how the proposed endeavor fits their scholarly needs, how it enhances the academic experience.

Individuals within and without the university community ask me how this close relationship with business affects Washington University. They wonder whether
pressures from corporate donors or others may not impinge on academic freedoms either of individual professors or of the university in a larger sense. My answer is that, as far as I can tell, they do not. Our major donors and our Board of Trustees understand the role of an academic community in a free society. We may lose support from individuals from time to time because of strong disagreements with this or that professor or because of differences with university policies. I believe, however, that even in a financial sense these losses are trivial compared to what we gain by doing our job well, by protecting the academic freedoms of individuals, and by maintaining institutional integrity. Pressures from the federal and, increasingly, the state government to do or to refrain from doing this or that activity are greater by orders of magnitude than those that come from the private sector.

People also wonder how dependence on business giving determines the shape of the university. There is, of course, an effect, but it is much less than the effect of federal largess and not always what one might expect. The School of Business and Public Administration, for example, has one of the smallest endowments of any school of Washington University, while the George Warren Brown School of Social Work is in a relative sense much more generously endowed.

Some endeavors have benefited financially, and indeed exist, because of the interest of people in the business community. The Center for the Study of American Business has been supported because many business leaders feel that it fills a specific need and have confidence in the director. The McDonnell Center for the Space Sciences came into being because of the conviction of the late Mr. James S. McDonnell that it was timely for university research to be directed toward the space sciences, especially when support for governmental laboratories was declining. Research into cancer immunology is generously supported by the tobacco industry partly because of their confidence in the kind of work done and partly because of the desire to contribute to cancer research at the basic level. Currently corporate giving does not seem to me to be greatly altering the form of Washington University.

In the coming years there undoubtedly will be explorations of more ways to interact. As with any new effort, there are opportunities and dangers. I see as a great plus the promise that university people, especially those in scientific areas, may have more options for funding and for cooperative work. There is also a greater chance to see the influence of the faculty spread, to find more opportunities to perform new kinds of teaching, and to see ideas enter rapidly into the mainstream of American life. In a sense this interaction can be looked on as an expansion of the university's basic educational mission.

On the other hand, there are risks. Heavy engagement in federal research projects has changed the nature of universities. It is always critical that we remember who we are and what our function is. We are teachers, scholars, and researchers. In a free, democratic society we have a special mission to perform that is different from the mission of business. Our specialty is more in basic than in applied research. Our commitment is to objectivity, openness, to seeing the truth and to reporting it as we find it. We must give priority to our traditional educational mission and perform it wisely and well before breaking out into new endeavors. Our academic commitments must always take precedence over responsibilities to any patron — individual, corporate, or government. It is our integrity in maintaining standards that are uniquely ours that makes us valuable to the world in general and to other worthy institutions, such as business corporations, that make up the whole of American society.

I trust that we will handle our new opportunities wisely and well.

William H. Danforth
Chancellor

Washington University
August 20, 1980
Our Man at Argonne

Dr. Walter Massey usually runs the mile in about seven minutes. On the morning of June 16, he had every reason to try to hold that time for two miles. He was running in the first Director’s Run at Argonne National Laboratory and he is the director.

The morning was cold for June. Chicagoans had turned on their furnaces the evening before as the temperature dipped to forty-four and the wind off the lake added a damp chill. At 6:59 a.m., Massey pulled up to Building 214 on Argonne’s 1700-acre main site twenty-eight miles southwest of Chicago. Argonne’s white fallow deer capered in the thin morning sunshine, but the twenty persons gathered to run added arm-flapping warming motions to their stretching exercises.

The deer, which came with the site when Argonne was established by the Atomic Energy Commission as the country’s first national laboratory in 1946, survive in heraldry as well as in fact. The white deer is now the symbol of the Argonne Running Club, to which about 150 of some 4600 employees on the Chicago site belong. But Argonne runners, perhaps like runners everywhere, seem to be both individualistic and compulsive. Throughout the day—even as the Run’s runners strode to Building 212 for a shower—other runners loped across the scene. Seven a.m. was just not everyone’s time to run.

Marty Thomas (time 14:01), who had proposed the event, allowed that he himself generally runs at noon. “I like that time because it really breaks the day,” he said, and so saying seemed still quite undecided whether he would run again that day or could tolerate the break in his routine. Only the severely self-disciplined ever make the ranks of dedicated runner, as only the compulsively disciplined reach the upper ranks of academia. And Argonne surely has one of the highest densities of Ph.D.s in the nation.

Walter Massey’s Ph.D. was granted by the physics faculty of Washington University in 1966. If Walter Massey is compulsive, however (and he cheerfully acknowledges that accusation), he is so at home with that driving force that he seems to amble through his demanding life. He accepts the challenge of his position with a kind of intellectual noblesse oblige: he can, therefore he should. “Maybe it’s my Southern Baptist training,” he says.

Two years ago, he was comfortably established in the dean’s chair of the College of Brown University. He did research, wrote, taught, strode across the Providence, Rhode Island, campus, appreciating his encounters with artists, historians, political scientists, writers—free to attend any lecture, engage in any intellectual discussion and call it a part of the job. He delighted in being able to justify a sin of commission he had indulged in all of his life—reading widely.

“Ah, that’s why I liked being dean,” he says, stumbling onto the recollection long after the question was asked. “I’d forgotten. I had always wanted a job where you were required to read as widely as possible and to interact as broadly as possible.

“Physics is hard, you know, and it does require a commitment of time that precludes a lot of other things. I always envied graduate students who could read the New York Times and justify it as necessary to their intellectual development.”

Massey loved the deanship and seldom thought about the day he would give it up to go back to full-time teaching and research, although that was his long-range plan. Then one day he received a call from Hannah Gray, president of the University of Chicago. She asked if she could send someone out to talk to him about the directorship of Argonne. Argonne is operated under a tripartite contract among the Department of Energy, the University of Chicago, and the Argonne Universities Association (a consortium of thirty Midwestern universities, including Washington University).

“I thought she wanted me to recommend someone,” he recalls. That assumption was logical. Massey had long been active on the national science scene and in 1978 he was appointed by President Carter to the twenty-four member National Science Board, the policy-making arm of the National Science Foundation.

President Gray, however, sent Bill Cannon, vice president for finance and administration, to persuade Massey to take the job himself. Massey had spent a postdoctoral year at Argonne, and Cannon successfully lured him back to look around. Massey and his wife, Shirley, had met in Chicago and married on the campus of the University, but after nine years in Rhode Island, they were not anxious to abandon that life, nor their beloved house there.

In the end, however, Massey says the challenge was too much to resist. “We are at the center of the most important issue of our time: energy. That was just too big a thing not to do.” So on July 1, 1979, he arrived to direct Argonne’s $233 million annual research program, which is funded primarily by the Department of Energy. It has been a surprising year.

Seated in shirtsleeves in his sunny office, the New York Times on the couch to be carried home shortly after five with his take-home material, he muses: “It’s a very difficult job. Much more difficult than I thought it would be, but not in the sense I thought. I didn’t anticipate being in the center of the national scene so quickly. Energy suddenly is highly debated—as to what the country ought to do, what paths
Walter Massey, Ph.D. 66, is a theoretical physicist who has temporarily put his own research on the shelf to undertake the direction of Argonne National Laboratory near Chicago. At Argonne, research focuses on questions of energy resources and application.

Argonne is one of the oldest of the nation's eight major multidisciplinary national laboratories; its history coincides with that of organized atomic energy research in the United States. Its forerunner was the Metallurgical Laboratory founded in 1942 at the University of Chicago as a part of the Manhattan Project. There on December 2,
Although nuclear energy research remains the largest program at Argonne, consuming more than forty percent of its annual budget, Argonne's investigations have expanded to pursue basic questions in the application of additional energy sources. Dr. Roland Winston, a University of Chicago physicist working at Argonne, for instance, designed an optic device (known as the Compound Parabolic Concentrator) which is now used in two solar collectors being marketed and tested for home heating and air conditioning. And Argonne physicists developed the basic concept being used today to pursue heavy-ion research for possible future fusion reactors to generate commercial electricity. Ron Martin, director of Argonne's HEARTHFIRE (High Energy Accelerator and Reactor for Thermonuclear Fusion with Ion Beams of Relativistic Energy) project, notes with obvious pride that fusion probably offers the most promising long-term method of power generation. "The level of its radioactivity is very low and its basic source—hydrogen—is inexhaustible," he says, "but we may be forty years from commercialization."

Within the energy spectrum, almost no question is beyond the pale of the nearly 2000 Argonne scientists and engineers. On the bucolic Illinois site, and at a small western site about thirty miles from Idaho Falls, these men and women and a larger number of support staff members pursue research on thousands of scientific fronts.

To support Argonne's energy research and development, the laboratory engages in fundamental programs in the physical, environmental, and biological sciences. Much of its reactor development work is carried out in Idaho by some 740 employees. Diversity is the byword at the Chicago site. Research there includes fundamental studies in physics, chemistry, mathematics, materials science, and solid-state science. Biomedical and environmental research, although focusing on how new energy technologies affect living organisms and their environments, influences hundreds of basic questions in biology and biomedicine. For instance, a new technique in Argonne's molecular anatomy program has made it possible to catalogue for the first time the 30,000 to 50,000 protein constituents of human cells.

"No one at this laboratory disagrees about what form of energy research should be pursued," says Massey with great sincerity. "People in every area are uniform in the belief that we have to develop every energy source, that we cannot afford not to.

"Within the sciences, we are very diverse, although we miss here the interchange of scientific and humanistic disciplines. The reactor people are different from the high-energy physics people, and they are both different from the people in environmental assessment. The sociology of the scientific disciplines makes the place fascinating."

To dip into any one of Argonne's major research programs is to look at a facet of the future. For instance, within the solar energy research group, a half dozen different projects are under way. Some have reached the application and evaluation stage, others are still on the drawing board, many are in between. Last summer the Argonne group that designed the Compound Parabolic Concentrator took part in the large-scale installation of a collector based on this device (which eliminates the need for sun tracking by capturing and concentrating the sun's rays over a very wide angle) at a Holiday Inn in the Virgin Islands. The collector is using solar energy to air condition the public areas of the inn. Meanwhile the CPC group is analyzing other collector designs and materials.

Argonne scientists are also leading an effort to develop a passive system to cool a home in summer with ice frozen in the winter and stored in a subterranean tank. Preliminary studies completed last year suggest a system capable of cooling an average house in a climate such as Chicago's could be built for about $5000.

Argonne is deeply involved in two phases of study of ocean thermal energy conversion (OTEC) for electrical power generation. OTEC plants, by using sophisticated heat exchangers, would produce power from energy generated by temperature gradi-
ents in tropical oceans. Argonne operates a facility to test and evaluate these advanced heat exchangers and is investigating all aspects of the environmental impacts. OTEC plants are likely to have.

Finally, Argonne's solar researchers are also heavily involved in testing suitable materials for all types of photovoltaic cells. Such cells promise to be used in many of the energy systems of the future.

Such diversity is common to Argonne's twenty scientific divisions and dozens of additional projects and facilities. Its fusion reactor research basically supports two programs. One aims at determining the engineering requirements of tokomak fusion reactors and at developing materials for their construction. A second, of which the HEARTFIRE program is a part, is working on ion-beam fusion.

Argonne's researchers may also be among those who lead the U.S. into a new coal age. Its studies—particularly of high-sulfur coal—range from fundamental investigations into the nature of coal itself to applied work to develop materials, instrumentation, and new processes for converting and using coal as a synthetic liquid or gaseous fuel.

One promising Argonne program is a fluidized-bed combustion process which reduces stack-gas pollutants by more than ninety percent by burning pulverized coal in the presence of crushed limestone. The sulfur in the coal reacts with the calcium oxide in the limestone to form calcium sulfate, a harmless white precipitate.

Another improved fossil fuel program which Argonne leads focuses on the technology of magnetohydrodynamics. Magnetohydrodynamic (MHD) generators convert heat directly into electricity by passing a hot ionized gas or liquid metal through a magnetic field. Not only are today's conventional power plants expected to be converted to MHD generators, but many nuclear power plants may also use these new generators as supplements to reduce pollution and increase plant efficiency. As part of a joint U.S.-U.S.S.R. research project, Argonne recently shipped a superconducting magnet it had designed and built to Moscow for installation in a power plant there.

Argonne's efforts to find new and more efficient ways to use conventional energy sources have been accelerated in recent years by this country's push toward finding an alternative to the internal combustion engine. An example of this kind of effort is the new National Battery Test Laboratory established to advance electric vehicle technology. The laboratory itself is involved in basic battery research, but it also is a center of testing advanced batteries developed by industry. Three basic types—the improved lead-acid battery (today's standard), the nickel-iron battery, and the nickel-zinc battery—are under study. While Argonne's research is proving that each type could extend the range of electric vehicles, battery weight, costs and life-cycles remain problems.

Meanwhile Argonne continues its original commission to develop nuclear energy. Most of its reactor research is devoted to breeder reactors, but as the nation demands, more attention is now also focused on increasing the safety of lightwater reactors and on the problems of the storage of spent fuel and nuclear wastes.

The nuclear reactor of the future—the breeder reactor—creates more fuel than it consumes, so it offers a potential unlimited source of energy. Argonne has always been on the leading edge of this development program. Today, at its Idaho facility, some workers concentrate on breeder reactor safety, but others continue to develop breeder reactor technology.

An exciting contribution to basic physical science research is being made by Argonne's work in nuclear physics. For the past two years, Argonne has been operating and improving a superconducting linear accelerator (linac), which is based upon new accelerator technology developed at the laboratory. By providing energies higher than the Van de Graaff accelerators (used in most nuclear research programs) can deliver at a reasonable cost, the Argonne Tandem Linac Accelerator System promises to open new doors to nuclear research. When its linac system is completed and coupled with existing Van de Graffs, heavy-ion experiments will move into a range never before examined. What will follow may accelerate some areas of theoretical physics out of that orbit.

No one is more excited about that prospect than Walter Massey, a theoretical physicist who holds an appointment as professor of physics at the University of Chicago (but hasn't had time for teaching or research for the past year). But for Massey, coming to Argonne as its director has been like finding one of the golden tickets to Willy Wonka's chocolate factory.

"The most exciting part of the job is that you learn so much so fast. One day you're reading about and looking at electric batteries and the next at neutron scattering. And one of the privileges of the director is to command a seminar right here, right now, on anything he needs to understand."
Our Man at Argonne

Argonne's energy research programs and their support systems employ nearly 2000 scientists and engineers. Massey discusses Argonne's central computing facilities with Richard Royston, director of the division of Applied Mathematics.

Ron Martin of the Accelerator Research Facilities division stands before an experimental high-energy accelerator and reactor used for thermonuclear fusion research.

Ken Shepard displays a new splitting resonator developed by California Institute of Technology and Argonne for the laboratory's proposed Tandem-Linac Accelerator System, which promises to open new horizons for heavy-ion research in physics.

He smiles at that idea with the glimmer of a child, adding, "It's hard to think of anything that could come up having to do with science that someone on this site couldn't handle." Then he adds with a director's modesty, "Well, maybe there are one or two fields we don't do, but not many."

After a year on the job, Massey still spends a major part of his day getting to know Argonne. He brownbags lunch regularly with four or five representatives of varying divisions and programs to learn both about them and from them, saying in introduction, "I don't get a chance to get around as much as I would like to. Tell me about what you're doing. Any problems you're encountering or foresee?"

Thomas Kassner of the Materials Science Division tells him about the work of a corrosion group, saying, "We've had to diversify since funding of the breeder group has been going down. The real problem is that we can't get enough money to support generic research." He mentions several projects, saying that they work presently with the solar group, chemical engineering, and OTEC people. "We've become quite ingenious at funding," he says, "Right now, there are five professional staff members and we're working on maybe twenty budget numbers."

Massey laughs, agrees, asks some questions, then turns to another guest.

"We're all becoming diversified," says Paul Frenzen of the Radiological and Environmental Research Division. "But I shudder to think of [Sen. William] Proxmire seeing us yesterday. We were
out on the lake flying kites.” He explains that their work supports a turbulence study of the marine boundary layer needed for studies by the Nuclear Regulatory Commission. Paradoxically, he notes, it renews interest in a study he began years before for the AEC. “The kites we bought are supposed to be extremely stable. They were developed by the French for aerial photography in World War I, but we had them doing loops.”

“Did you anchor the boat?” Massey asks.

“At first, then we flew them upwind at top speed,” Frenzen answers. “You are supposed to be able to fly two of these kites at a time and never get them tangled, so we tried that finally. They’re right: those kites stay apart.”

“Air spilling off each sets up a barrier,” offers Massey.

“Exactly,” answers Frenzen. The meeting goes on. Anthony Thomas of the Energy and Environmental Systems Division talks about the environmental assessment work he and his colleagues are doing in support of the ocean thermal energy conversion project. Massey listens and nods, as he munches on cheese and crackers.

At forty-two, he is slim and agile, playing tennis and squash, often running in the morning on the untriflicted roads that wind between Argonne’s utilitarian-looking buildings, all set in groups isolated from one another by woods and meadows.

Much of any day in his office is filled with meetings. His calendar is ably guarded by Marie Carroll, a native of rural South Dakota who has been secretary to the director of Argonne for seven years. But despite her efficiency and surveillance, his schedule is hectic. In a day of electronic communication, he still frequently calls to her through the open door.

“Marie, would you see if you can find that material of mine on . . . .” She does.

“In the summer Argonne teams with families accompanying faculty members who have come to study and consult. Annually over 5000 visitors come to Argonne. Many live on the grounds while they work under DOE educational grants. Many come as users of Argonne’s large experimental facilities.”

“Generally, we undertake three kinds of work: research that is too costly or too complex for any one university or industry; operation of very large facilities, such as our big accelerators or a new facility we are developing for neutron scattering; or work that directly supports some national program.”

“A large part of the responsibility of the director is involved in funding. You have to build a strong case for a certain kind of research to convince Congress that it is necessary. But you not only have to build that case, you have to work with Midwestern universities to prove that this sort of facility or project needs to be available in the Midwest, then convince DOE and Congress that this particular place is the appropriate location.”

Much of the day in his mind and demeanor seem always to be in automatic transmission and he slips from one role to another dozens of times a day. He receives a group of women concerned with affirmative action, admitting that things do not seem to go as smoothly or as quickly as they should, promising to try to meet their reasonable expectations. He takes the matter up with the all-male group of associate and deputy directors at a regular 3:30 p.m. Monday meeting: “I was visited this morning by the Ad Hoc Committee on Women. They raised some valid issues which need our attention . . . .”

“Look,” he says on another matter. “I would like for us to have a good idea of what we see as the long-range future of the laboratory.” They go on to pursue annual budget making and planning. “Remember, this is my first time through this,” Massey cautions, then as he looks around at his colleagues, most of whom he appointed or promoted, he revamps that statement: “Our first time through this, I mean.” They deal with appointments, memos, budget and personnel evaluations. He asks them to look at each case individually to ask what makes sense. He requests that each help Marie schedule an hour with him individually so that they can discuss their programs and suggest how their own performance can be evaluated. The meeting is relaxed, and to the point. It ends just after five.

Walter Massey does not spend long days in the office. Although he takes the lab home with him, he is careful to reserve time for his own life, his wife, and their two sons. Since he frequently bounces between Idaho Falls and Chicago, Washington and Chicago, days at home and office are carefully sheltered. If there is too much to do, which obviously there is, Massey takes things as they come, ordering his priorities as he has done all his life.

He was born in Hattiesburg, Mississippi. His mother was a school teacher; his father a steel worker. “My mother had one primary goal for us [him and his brother],” he says. “She wanted us to get out of
Mississippi.” It was obvious from his childhood that Walter Massey would do that through education. He always did well in school; he was an avid reader.

In high school, he was selected as one of about twenty bright young men to be experimented with. He was plucked by a Ford Foundation program from his sophomore year in high school to an early admissions program at Morehouse College in Atlanta. Although the experience was gratifying, it was also frightening. At fifteen, he had to make life-determining choices.

“I remember that we had to take all kinds of placement tests, but before those results were in, some teacher asked a class how many of us had been valedictorians of our classes. All sorts of hands shot up. I called my mother that night and said I wanted to come home, but she wouldn’t let me. Then, when the test results came back I found that out of 150 freshmen I had the fifth highest score. I decided then that I was sufficiently bright to do something with my life.”

He took the hardest courses he could find at Morehouse. His first biology course determined that he would not be a physician, which had been everyone’s obvious goal for a bright young man. “I got sick at the sight of blood,” he says. Since he had not finished high school, he had taken little science or math; he taught himself trigonometry while he took chemistry. Then someone told him that practically nobody at Morehouse ever majored in physics. So Massey did.

That fortuitous choice was enhanced by the personage of Sabinus Hobart Christensen, then head of Morehouse’s physics faculty of two, and now a professor at Lincoln University in Pennsylvania. “I think that he alone turned out about five Ph.D.’s in physics and chemistry,” says Massey, who in his junior and senior year was Christensen’s only advanced student. “He insisted that studying physics could be something significant. He would not settle for less. And he sent me to Washington University.”

In 1960, Massey found St. Louis shockingly segregated: a Southern city. But on campus, though he was the only black graduate student in physics during his first year, his race was not an issue. “And all of my fellow students were very good. I remember we used to spend hours on Sunday looking for a place we could all eat. But they did it. Eventually things in the community began to change and changed very quickly.”

Massey studied from 1960 to 1966 at Washington University under the late Eugene Feenberg, doing Ph.D. research on the development of a theory and the calculations of the ground state properties of liquid helium². After a postdoctoral year at Argonne, he accepted an assistant professorship at the University of Illinois; he joined Brown University in 1970. In 1974 he spent a trial year in university administration as assistant to the chancellor of the University of California at Santa Cruz and then returned to Brown in 1975 as dean.

Woven through Walter Massey’s conversations like warp and woof are the words “citizenship” and “responsibility.” They are a part of his life. Seeds were sown by an energetic and ambitious mother, cultivated by men like Christensen and Benjamin Mays (former president of Morehouse), and nurtured by the traditions of the black colleges of the South in daily chapel sessions on ethics and responsibility.

Walter Massey believes in moral choices. He told the graduating class of Northern Illinois University in a commencement address last spring. “You embark upon or expand your careers at a time when most of the issues of major importance to society require a kind of education, a mode of public participation and responsibility in leadership, which has not been noticeably present in recent times.” He asked them to accept the responsibility of both scientist and non-scientist to see that the technological applications of scientific research redound to our benefit rather than detriment. To do so, he said, would require a new synthesis of the sciences and the humanities, a new approach to the education of practitioners of both.

“Scientific illiteracy among non-scientists surely is a serious failure of our education system, but equally important is the paucity of ethical, moral, and value considerations which enter the education of the professional scientist.

“On what basis should the public make decisions, and what should be the role of the scientist and the humanist in helping to create a situation in which the public can make reasonable choices? The responsibility for the resolution of these kinds of issues cannot be left to the scientist and engineer alone, but must involve the humanist. For one can argue, I believe, that the ethical, moral, and value dilemmas presented may be, in fact, more important than the scientific and technical consequences.

“Not that sciences and the humanities ought to be viewed as antagonistic or so disconnected that their concerns have no overlap or their practitioners no common interests. I would submit that the practice of science can be a liberalizing, humanizing experience, which broadens the spirit as well as the intellect, and that there is a commonality of purpose and unity of view in all human endeavors. Science and humanities are simply two sides of one universal coin.”

In leisure, Walter Massey has been reading a great deal about this dilemma. He is director of one of the nation’s largest scientific endeavors because he believes in the challenge of that position. Moral and ethical decisions, as well as scientific decisions, need to be made and articulated, he says. That is, finally, what the director does.
Clearing the Air

When soft coal was almost exclusively used for fuel for both domestic and manufacturing purposes, the air was ordinarily filled with smoke and soot, and many dark days were the result.

Downtown at the going-to-work hour, visibility was almost zero, and automobiles and streetcars crept along at a snail's pace with headlights burning, although they were only dimly visible at short distances.... One motorist got lost and suddenly found his car snailed, pacing with headlights streetcar reptile alan?, at a eastern horizon. Only dimly visible at short distances. on the sidewalk on the wrong coming from the suburbs saw a black curtain blocking out the eastern horizon.

These accounts are not portents from some ominous scenario of the future. The first was written by a Pittsburgh weather official in 1914, and the second by a St. Louis Post-Dispatch reporter in 1939 on a day later remembered as “Black Tuesday.” St. Louis was one of the dirtiest cities in the nation before Raymond Tucker, Washington University alumnus, professor, and three-term mayor of the city, introduced the first strong anti-smoke ordinance more than forty years ago.

“Pollution is not a new thing,” points out Rudolf Husar, the director of Washington University’s new Center for Air Pollution Impact and Trend Analysis, also known as CAPITA.

“Cities were dirty a long, long time ago. Each era had its own specific problems and its own means of coping.

“In the early 1900s, smoke and soot were considered the price citizens had to pay for living and working. Now, people have restated their priorities. They are more aware of the long-term, widespread effects of pollution, and they are willing to pay a higher price for clean air.”

There’s no doubt that clean air has become a much talked-of commodity. But it’s a complex problem—interwoven with the fabric of modern society—and the facts are hard to come by. What does it mean when a federal bulletin states that sulfur dioxide concentrations, produced by fossil fuel combustion, are down nationally seventeen percent since 1972, while a science magazine warns that sulfur emissions have increased in the last twenty-five years and may jump another ten percent during the coming decades? How do we interpret the phenomenon of acid rain? Is our climate turning warmer or colder due to pollution?

Beyond the doomsday reports and clashes of industry and environmental groups, CAPITA members are working towards a better understanding of the nature of air pollution.

Although the Center was officially recognized in January, its work has been in process for the past five years. Headquartered in Bryan Hall, CAPITA combines a clearinghouse for air pollution literature, an extensive computerized data bank of pollution-related statistics, and an assemblage of interdisciplinary research projects. The Environmental Protection Agency (EPA) funds the bulk of its $600,000 annual budget. The permanent staff numbers about a dozen, including four full-time professors whose backgrounds range from nuclear chemistry and mathematics to bioengineering and mechanical engineering.

This high-level teamwork makes the Center’s staff very special, says Husar. “There are few groups in this field with the intellectual capital that we have.

“If you are doing things right, you are steering things. You are at the front of the crowd. Well, we have never been on the catching-up side.”

The Center has, in fact, been consistently ahead of the crowd. Years before the long-range transport of pollutants was of major concern. Washington University researchers were tracking urban and power plant plumes and quantifying aircraft emission data. Recalls Noor Gillani, an associate professor of mechanical engineering, “Back in 1974, when our air pollution lab got going, we thought in terms of a thirty-mile impact range. We soon found out that St. Louis emissions could have significant impact at downwind distances ten times that far, and possibly much farther.”

WU researchers also were among the first to document the occurrence and behavior of large-scale (multi-state) haziness as an indicator of the pollution picture. In one of their newest ventures, CAPITA members are probing the link between energy use and environmental changes, looking back in history as well as toward developing trends. Husar already has collected an array of old weather bureau reports and general observations, some dating from the mid-1800s. “I have a hunch this is something that will be done a lot in the future, building much on the work we’re beginning here,” he predicts.

CAPITA has a reputation as an organizer of scientific symposia of world scope. In 1977, the Husars (Rudolf and his wife, Janjali) organized in Dubrovnik, Yugoslavia, a highly successful international symposium on sulfur in the atmosphere. And the Center’s newest recruit, Warren White,
a professor of mechanical engineering, is currently completing arrangements for a symposium on plumes and visibility scheduled for November at Grand Canyon National Park. The conference, which is expected to draw more than 200 scientists, will be the most important meeting of the year in these two areas. Collectively, White, Husar, Gillani, and Edward Macias, CAPITA’s associate director, will present six papers. The scope of these presentations entails a view at once microscopic and universal. “We are looking at the nitty-gritty physics and chemistry of pollution particles,” says Gillani, “often on a regional or sub-continental scale.”

Born in Tanzania, Gillani studied in England and at Harvard University before completing doctoral work on the fluid mechanics of a heart valve at Washington University. His introduction to pollution studies came when he began to do computer modeling for Husar on a part-time basis.

“Today we have a fairly good working picture. Prior to 1976, we were groping in the dark,” he observes. He notes that the way primary gaseous pollutants such as sulfur dioxide and nitrogen oxides change in the atmosphere to the more noxious particulate forms is now much less of a mystery.

“The question used to arouse quite a controversy. Now we know that sunlight is a driving force—the greater the amount of sunlight, the faster the conversion rate. Almost equally important, however, is the background air.” He explains that the pollution apparently feeds upon itself. Pollutants released over the industrial eastern United States, for instance, will become more noxious more rapidly than the same pollutants released at the Arctic Circle. When a power plant plume rich in sulfur and nitrogen oxide mixes with an urban plume containing hydrocarbons from auto emissions, the effect is a double whammy.

Growing knowledge of the chemistry of pollutant particles has cast an ironical light on some earlier well-intended regulations. For instance, the switch from short to tall smokestacks may exacerbate rather than alleviate pollution problems. By spewing relatively short-lived primary pollutants higher into the air, the taller stacks actually may aid the formation of more harmful secondary pollutants and increase the distances they will travel. On balance, it is still not resolved whether the switch has been beneficial or detrimental.

“It’s becoming clear that we can’t just attack one part of the problem.” reflects Gillani. “The thing is all tied up.”

Both Husar and Gillani helped design a project this summer in which more than a dozen universities, commercial firms, and governmental agencies took part. Stationed in the Ohio River Valley, ten CAPITA members and WU students spent six weeks studying persistent elevated pollution episodes—large, hazy air masses of pollution frequently blanketing multi-state regions. Gillani, who has participated in five smaller but similar projects, explains the variety of methods used to collect information include airplanes and helicopters, tetrons (constant-altitude balloons), instrumented towers, and mobile ground vehicles. In the recent project, CAPITA contributed to the design of the experiment, did the on-site processing of chemical aircraft data, and has become the central data bank for all field information.

Many of CAPITA’S accomplishments can be attributed to its important state-of-the-art instrumentation. Its staff consistently modifies and improves stock analytical instruments and processing techniques. In a penthouse atop Louderman Hall, where a local air monitoring station runs continuously, not one piece of equipment is standard. Senior research associate Janja Husar, who holds the Ph.D. in chemistry, and Geoff Cobourn, who recently earned the Ph.D. in mechanical engineering here, are responsible for many of the devices. Theirs is a constant push to develop new and better ways of sampling the air. Related work on new methods of analyzing carbon and trace elements has been carried out by Macias and Lih-Ching Chu, a fourth-year graduate student in chemistry.

Macias, an associate professor of chemistry, has applied his background in nuclear and atomic spectroscopy to a number of special techniques. One method, worked out over four years, uses the cyclotron to analyze pollutants. By mounting air filters onto slides and bombarding them with protons, he examines the gamma rays given off by the pollutant particles to identify their chemical signatures.

Dubbed GRALE (gamma ray analysis of light elements), this method, which he admits has something of a Rube Goldberg appearance, has been successfully applied to identifying carbon-containing pollutants collected in both Eastern urban areas and the arid Southwest near the four-corners region of Colorado, Utah, Arizona, and New Mexico. Though this area remains one of the most pris-
tine spots in the nation, visibility there has decreased markedly in recent years due to millions of tiny man-made air particles which scatter the sunlight.

According to Macias, the most abundant particles in polluted air contain sulfur and carbon. “We know a lot about sulfur in the atmosphere; we know less about carbon,” he says. “The techniques for measuring carbon in particles are relatively less developed, even though hundreds of different carbon-compounds have been identified, some of which are known carcinogens.”

Aesthetics as well as health are reasons for investigating these pollutant particles. “Visibility loss really makes a big difference in this part of the country,” Macias says of the Southwest, “especially if you’re sitting on the rim of the Grand Canyon. In determining what causes the haziness, we’re finding that emissions from as far away as Southern California can have an effect.”

Until recently, Southern California was the home of White, who began his career in theoretical mathematics before switching later to mathematical applications. He worked on numerous projects including analysis of weekday vs. weekend differences in pollutant levels, the anatomy of Los Angeles smog episodes, and the optics of aerosols or fine, suspended air particles. A

Around-the-clock data is recorded at the monitoring lab on strip charts, checked here by Janja Husar.
Clearing the Air

Ed Macias examines an on-line printout of local pollution data collected by equipment he helped design.

favorite paper of his, later described in the amateur science column of Scientific American, told how to use a pair of polarizing sunglasses to estimate the size of smog particles.

In Los Angeles, White analyzed the practice of episode control strategy. Because some fuels, such as gas, are cleaner than other fuels, such as oil, the power plants proposed to switch to cleaner but costlier fuels when meteorologists forecast smog. After examining the possibility of changing fuels during the months of poorest air quality (May to October), he concluded that the change would have a nearly undetectable effect on airborne sulfate emissions.

"Just altering the rate at which you put sulfur in the air doesn't have a straightforward effect on the air quality," White emphasizes. "Although it seemed obvious that cutting emissions would directly cut back effects, there isn't always a simple, obvious relationship."

As a scientist studying the problem, White's work quantified for him a perception which is common among all citizens of Los Angeles County: part of the reason he left California was to move his family to cleaner air. Pollution in the Los Angeles Basin has befouled what was once air of pristine quality. As recently as 1917, when the world's then-largest telescope was built atop Mt. Wilson, an English visitor described the basin: "Objects on the plain below us dwindled till it began to look like an airman's map: but though the bungalows became white specks among their tufted orchards, they seemed to retain their sharpness of outline and one began to realize what the lucid air of California might mean to the astronomer."

By the early 1950s, the U.S. Forest Service was closing down its fire lookout towers in this area because the thick smog made it impossible to see.

Husar, a professor of mechanical engineering, is particularly interested in accounts such as these chronicling the history of changes in air quality. He has put together a database which is among the most extensive to be found at any university. In addition to central data for several EPA studies, CAPITA's computer facilities store National Weather Service data compiled since 1948, energy consumption and pollution emission rates for electrical utility companies, hourly data on local and regional air quality, and even international pollution data for North America and Europe.

Jan Holloway and David Patterson are two key staff members who work with the computerized data. As data manager, Holloway organizes, packages, and delivers the data needed by CAPITA researchers. Patterson, a research associate, does much of the technical computer work on various projects. He devised one of the Center's current computer tools—an interpretative diagnostic model for the long-range transport of pollutants.

The CAPITA staff keeps abreast of new developments by maintaining a wide range of contacts. Husar has served on numerous advisory committees for the EPA, the National Aeronautics and Space Administration, the National Academy of Sciences, and the National Commission on Air Quality. He and his wife, both of whom are Yugoslavian, are particularly interested in the international pollution picture and the global transport of air particles. In addition, regular visits from active researchers overseas are routine. In the past year, scientists from Norway, Sweden, and Australia carried out investigations here.

In examining this larger picture of pollution, Husar believes that man has been altering his environment since the industrial revolution. The nation's total coal consumption in the 1910-1920 period, for instance, was close to that in the mid-1970s. "It's entirely possible," says Husar, "that the visual range in the northeastern U.S. once was similar to the current visual range in the scenic southwestern part of the country."

His research also is uncovering provocative questions
about acid rain. "All my information indicates that there should have been acid rain of comparable intensity sixty or seventy years ago. We need to look at the rate of acidification of our lakes to find out how long this has been going on before jumping to conclusions."

Macias perhaps echoes the thoughts of the entire CAPITA group when he cautions against a knee-jerk reaction to the complexities of pollution. "There's a certain current fear of any amount of pollution," he observes. Gillani adds, "The environment has a tremendous capacity to maintain itself. It's one of our greatest treasures, but this doesn't mean we should give up all our activities in the quest for purity."

Their comments are contrasted by a poster on the wall of Macias's office which bills a movie titled, "Godzilla vs. the Smog Monster." The poster foretells how the smog monster, "with deadly breath and venomed blood, slithers across the land—a poisoned slime in its wake...a trembling world in its path!" During one pronounced smog episode, Los Angeles headlines seemed to describe a dreadful battle. "Seventh Day of Siege," they proclaimed. "Scores Hospitalized." "Smog Fight: Optimism Fades."

If this battle analogy is appropriate, the battle surely is to understand exactly how we are changing the environment and what these changes may cost us. Sums up Husar, "Our job as environmental scientists is to come up with the specific consequences of pollution by quantifying the relationship between its causes and effects. We want to be able to say that one hour of air conditioning or one tank of gasoline will take 'X' amount of toll on air or water quality."

For centuries man regarded air, earth, fire, and water as the primal elements, each distinct and unchangeable. We now are painfully aware of the changing qualities of three of the four and of the elemental balance and interrelatedness of all.

"The question remains, what are our priorities?" asks Husar. "This is not a situation where we can outlaw all activities which produce pollutants. I don't believe that energy and the environment are necessarily on a collision course. It used to be said that everything in America has to be done on a big scale because the country is so big. That's absolutely not true. We could follow many of the European countries in methods of trimming back.

"The sky is not falling," he continues. "We are making some progress. But there are so many ways we can do better if we just think about it." He pauses for a moment at his last observation. "It is one of those things," he says slowly, "that will take a long, long time."
AFGHANISTAN

By Robert Canfield
Associate Professor of Anthropology

Professor Canfield, who joined the University faculty in 1969, has been a student of Afghanistan and its peoples for three decades. He lived in that country for a total of ten years during the 1950s and 1960s.

In Badakhshan, a remote province of Afghanistan, a pregnant woman strapped explosives to her body, threw herself under a Soviet tank, and blew it up. In Kabul, the capital city, unarmed men stood before machine-gun emplacements, daring the gunners to shoot them; when they were shot down other men took their places and were also killed; they did this, according to the Christian Science Monitor, "until the soldiers were so ashamed they ran away." Also in Kabul, women and children threw blankets soaked in kerosene over tanks and tried to set them on fire with Molotov cocktails. In Paktia, an eastern province, villagers attacked a group of Soviet-led Afghan soldiers with swords, knives, antiquated rifles, handguns, even shovels. In the western city of Herat, rioting crowds decapitated thirty-five Soviet "advisors" and paraded the heads on poles in the streets. In other places children plastered mud on the gun sights and peepholes of Soviet tanks so that snipers could pick off the tank crew as they emerged to clean off the mud.

These reports appeared last spring in such diverse sources as the Afghanistan Times, the Omaha World-Herald, the National Review, and the New York Times. They tell of the acts of violence and courage by which the peoples of Afghanistan resist the Soviet occupation. To most Americans, Afghanistan is one of the remotest countries on earth. The Soviet invasion there appears no more than a distant, isolated tragedy. The Europeans, generally more interested in international events, feel likewise. A prominent European political analyst quoted in U.S. News and World Report said, "Many in Europe want to close their eyes to the change that has occurred...."

If indeed a change has occurred as a result of the Soviet invasion, we need to be aware of it. That requires that we understand more than the obvious reasons for the Soviet invasion. The moves of a chess master must be understood as part of a plan. To interpret his moves it is necessary to note the moves he does not make, to know that no move stands alone; every one is made with the plan in mind. Unfortunately, some of our most respected authorities have told us that the Soviet invasion is only an isolated event, a local act, merely an attempt by the Soviets to control a local irritation on their southern flank.

The truth is otherwise. This invasion will affect political relations all over the world. I want to discuss the Soviets' reasons for the invasion, showing first the general contexts of their long-range interest in Afghanistan, and then the specific situation that precipitated the invasion. By explaining Soviet intentions in this invasion I hope to show that the Afghan people's struggle, far away as it is, does relate closely to our affairs: that its outcome will affect our future.

First, certain geophysical conditions have obliged the Soviet Union to have a vital interest in Afghanistan for over a century. One of these conditions is that Russia, despite many material advantages—rich agricultural lands and diverse and abundant mineral resources—has one major problem created by its geographic location. Except for the ports on the Pacific, Russia has no year-round port on the open sea. The northern ports are frozen in winter and the Black Sea ports are controlled by the Turks at the Dardanelles and Bosporus Straits. This condition contributed to the "Great Game" in the nineteenth century between the British, who controlled India and had close ties with Persia, and the Russians, who considered it a kind of "manifest destiny" that they should expand into neighboring territories and obtain direct access to the sea, either the Mediterranean or the Indian Ocean. This problem is not now defunct, as some people suppose: early in the Iranian crisis, Turkish officials stopped all traffic through the straits for a few days, thus immobilizing Soviet ships in the Black Sea.

The other geophysical feature influencing political affairs in Central Asia is this: Afghanistan sits astride the historic corridors of trade and conquest between the great population centers of Eurasia. Through this region have passed the caravans that linked India, China, Europe, and the Middle East. Also through this region have passed the great
Afghanistan

conquerors of Asia: Alexander, Mahmood of Ghazni, Genghis Khan, Tamerlane, Babur, Nadir Shah, and many others. Formerly, the importance of this region lay in its position on the way to India to the southeast and to Persia and Mesopotamia to the southwest—the flow of conquest normally moving from north to south. In the present time its importance lies in its control of the corridors between the Soviet Union to the north and Baluchistan and Pakistan to the south, which have shores on the Indian Ocean, and its control of certain corridors into Iran. That makes Afghanistan, along with Baluchistan, a piece of real estate precious to the Soviet Union. The U.S. Naval College Review noted several months before the invasion: “Soviet access through Pakhtoonistan and Baluchistan to the Indian Ocean, a distance of only 300 miles, would enable the Soviet navy to operate for extended periods at a great distance from Russian shores, to service Soviet ships that increasingly patrol the area, and permit a Soviet naval presence in areas close to important oil tanker routes to Western Europe, the United States, and Japan.”

The importance of an Indian Ocean seaport to the Soviet Union should be evident in this: in the last ten years it has constructed the largest and most modern navy in the world.

Context two involves the locations of vital resources. The most prominent resource in or near the Central Asian region is, of course, oil. Most of that lies on the Persian Gulf. The United States imports about half the oil it uses, Europe 85 percent, and Japan 100 percent. Most of that oil—about two thirds of the non-Communist industrial world’s oil supply—comes from the Persian Gulf.

Another major source of oil in this Central Asian region lies in the opposite direction: within the Soviet Union. The Soviet Union is the world’s largest oil producer—12.1 million barrels a day—and it is the second largest oil exporter. About 3.3 million barrels a day. Most of its exported oil goes, of course, to satellite countries, but about a third of it is sold to Western Europe and Japan. So the Soviet Union, unlike the other major powers, has more than enough oil for its own needs. And this is true despite its poor petroleum technology; depths that Western technology can drill in six months take Soviet technology five years. However, because of rising domestic consumption, the Soviet Union may have to import oil within five or six years. How long it will be before Soviet petroleum needs outstrip production is unclear, and how the Soviets will deal with the problem is likewise unclear. They could improve technology, limit export, or acquire oil from the Middle East, most likely from the Persian Gulf region.

Besides the oil of the Persian Gulf there is another set of valuable resources that could be reached easily by the Soviet Union through Afghanistan and Baluchistan. This is in southern Africa, where there are some of the richest mineral deposits in the world. Over 90 percent of the world’s supply of chromium, vital to the aircraft industry, is found in two countries, South Africa and Zimbabwe. Besides chromium, there are large deposits of other industrially important minerals: copper, uranium, platinum, manganese; not to mention the commercially valuable deposits of diamonds, gold, and silver.

The third context to be considered is political—the policies of the great powers. The political policies of the major powers have always been an important factor in Central Asian affairs. For the British in the nineteenth century and for the United States since World War II, the policy has basically been the same: to contain the Russians on their southern flank. American policy, further, included the idea of developing a “northern tier”—Turkey, Iran, Afghanistan, and Pakistan—as the barrier against Soviet expansion to the south. Iran in recent years became a main bulwark of that tier. In 1953, fearing that the duly elected Premier Musaddiq would not respond well to Western pressures, the CIA...
Thus, when Afghan Prime Minister Daood requested military aid from Vice President Nixon in 1954, Nixon turned him down. The United States would offer some forms of domestic aid, he said, but no military assistance.

Daood eventually took his military needs to the Soviet Union, and Afghanistan thus became the first nation to receive aid from both the United States and the Soviet Union. The desire to win Afghan friendship was the aim of both sides, and the Afghans were the beneficiaries. This suited United States policy, since the Shah still guarded the real prize, Iran and the Persian Gulf. As long as the Shah was strong, Afghanistan's importance lay only in its remaining friendly and neutral. This was presumably acceptable, if not ideal, to the Soviet Union as well.

As far as the Soviets were concerned, the real worry was China. Mao had long since pulled out of Soviet control. The border between China and the U.S.S.R., the longest in the world, had been the site of many skirmishes. And after 1972, relations between China and the United States dramatically warmed up. A coalition of the United States and China along with the European nations and Japan promised to be a formidable bloc indeed.

These conditions set limits on viable political activity for the Soviet Union in Central Asia. The conditions placed a high value on any development in the nations of the "northern tier" that would favor the Soviet Union. A weakening of the barricade would provide an opening for the Soviet Union to make moves that could outflank this China-Western world coalition and strengthen the Soviet position in relation to the Persian Gulf and eastern Africa.

Two developments in Central Asia made such a move possible and those were the specific circumstances that precipitated the invasion. One was the collapse of the Shah. When the Shah fell, the "northern tier" policy fell with him. If the Shah had stayed in power, he would have had the ability to undermine any serious Soviet activity in Afghanistan, Pakistan, or Baluchistan. Prince Daood, who took over Afghanistan in the coup of 1973, had been sensitive to that. Eventually losing confidence in the Soviet Union, he eased closer to the Shah. When he began to remove the Marxists in his own cadre, they overturned him in April 1978. That was the second critical development. It was a break for the Soviet Union that the Shah began to have troubles of his own after the Afghan coup. These developments in Iran and Afghanistan tipped the balance of power along the "northern tier" and made it possible for the Soviet Union to make more decisive moves in Central Asia.

The leader of the coup that overturned Daood in April 1978 was Nur Muhammad Taraki: the group that he led was known as the Khalq ("masses") party. The name is misleading because not one of the key figures in this party identified with the traditional Islamic culture of the masses. All of them had been trained abroad, all spoke and wrote at least one Western language well. It was as Western, as urban, and as middle class a group as you could find in Afghanistan. They were, however, ideological Marxists of an extreme sort, having split away from another more moderate Marxist party, the Parcham ("banner") party.

Even though the new regime was well received at first, the attitude of the masses soon became quite negative. By the summer of 1978 repressive measures were required in order to get the people to cooperate. Popular resentment gathered quickly. This took shape, at first, as com-
plaints against Hafizullah Amin. Taraki's second in command. But it soon also took form as localized rebellions. By the end of the year there was trouble in every rural area of the country. Popular resentment was also evident in the growing number of desertions from the Afghan army—which of course Amin used to enforce his policies.

By March 1979, less than a year after Taraki's coup, separate rebellions were exploding all over the country. Without coordination, without even trusting each other, rebel groups were attacking convoys and military bases, blowing up bridges, and assassinating government officials. Members of the Khalq party were captured, and if not killed, deprived of their mustaches and, sometimes, of their upper lips—the mustache having become an informal mark of party membership.

In spring 1979 Soviet advisors took command of the Afghan air force and began to supervise the army more closely. They tried to intimidate the Afghan people. In March, retaliating for an uprising in Herat, helicopter gunships attacked people as they were coming home from Friday prayers. These “flying tanks” can fire 6000 rounds a minute: they can level a forest or village in a few minutes. On that day in March several thousand people died in the attack. In the northern part of the country Afghan security forces, advised by twelve Soviet officers, drowned 1500 Hazara young men.

But the more the Soviets became involved, the more fiercely and sacrificially the Afghan people resisted. Herat, decimated as it was, rose up again in a general strike and public rioting. In the north, one million Tajiks were in open revolt. The rebels claimed full control of twelve provinces. At least one of these areas, the Kunar valley, set up its own adjudicative and administrative structure to serve the needs of its populations.

Soviet officials, plainly mystified by the intensity and breadth of the resistance, sent in three study groups to look at the situation. The first came in spring 1979. Another group arrived in the early summer. Finally, in mid-August a delegation of 118 people, including twelve Soviet generals, was sent to blanket the whole country. They stayed for two months, trying to find out why the Khalq regime was collapsing. While this study group was in the field, one of the most obvious countermeasures was determined: Hafizullah Amin would have to be removed. The decision was apparently made while Taraki was at the conference of nonaligned nations in Cuba. Taraki stopped in Moscow on the way back and was informed of the plan. Amin was too, however, because Taraki's bodyguard was a personal friend of Amin's. On September 13, Amin was invited to the Palace (now called the People's House). A shootout took place and Taraki was killed, apparently by military personnel loyal to Amin. Amin assumed control of the government.

Amin acquired a bundle of problems. The grassfire had become an inferno. On the day after Taraki was killed a leading person in Kandahar was wounded in an assassination attempt: on the way to the hospital in a taxi he was killed by another rebel group. About the same time the Kabul chief of police was killed while travelling in Logar. Soon afterwards rebels stormed the Soviet embassy, killing six members of the embassy staff, and also, reportedly, the head of the military police in Kabul. Amin apparently controlled only Kabul. Roads were unsafe, and desertions from the army had hit an all-time high. The economy was in trouble. New conscription orders and a doubling of military salaries did not stanch the hemorrhage afflicting the military. The troops that remained showed no heart to fight. Even the “People's Defense Committees,” civilian militias set up by the Khalq regime, were disappearing and their weapons were falling into rebel hands. For that reason, Amin withdrew support from them. He attempted to secure his position by surrounding himself with trusted associates—most of whom, in traditional Afghan custom, were relatives. One of those was soon assassinated.

This was the condition of Amin’s government in November 1979. Soviet officials had been spending a few weeks reviewing their research on the rebellion. Trying to decide what to do about it. The following must have been weighed in their deliberations: 1) The Soviets knew that the rebels had nothing more than ordinary small arms. Despite their accusations of CIA or Pakistani or Chinese complicity, the Soviets knew very well that there was little modern weaponry on the other side to oppose them. Never since World War II has the Soviet Union invaded a country where it expected to be met by fully armed opposition. 2) They knew that if they withdrew their already sizable support from the Afghanistan govern-
American hostages were taken. Soviet move into Afghanistan were pondering their options in Afghanistan. Conceivably, responding with an American States soon to attack Iran. A action in Iran, and might have blunted world reaction against have been calculated to cor­

ment, the regime would fall into militant Islamic hands. What that would mean was already becoming evident in Iran.

3) The Iranian revolution was of course by now boiling. The American move into Afghanistan in December or January might have been calculated to corre­

Correspond with an American action in Iran, and might have blunted world reaction against the Soviets.

They may also have considered the risk involved in invading Afghanistan, but probably not very seriously. Soviet leaders probably did not think there was much danger of a military setback. This is only worth mentioning now that the Afghans have done better than expected. A loss could undermine Soviet control of Central Asia, where the Russians are not popular any­

way. A decisive loss could weaken Soviet control of their own country, just as the defeat of Russia by the Japanese in 1905 eventually led to the collapse of the Czar. The Russian people have not forgotten the toll of World War II.

In any case, the decision was made to invade and to remove Amin. The immediate tasks were political and military. The political side of the invasion was to arrange for the legitimation of the invasion. That did not work out. A Soviet deputy minister for foreign affairs was sent to Kabul to persuade Amin to do two things: to request the Soviets formally to send troops into Afghanistan, and to step aside so that Babrak Karmal, of the more moderate Parchami wing of the Marxist group, could take over. Amin apparently refused to do either. There was more fighting in the "People’s House" and Amin and several other persons, including the Soviet deputy minister, were killed. This deprived the Soviets of the legitimation they wanted. They could only claim, as they did, that the man they had killed had been the one who invited them in. Also, the bitter resistance of the Afghan troops in Kabul in the first few days showed how welcome the Soviet troops were. Moreover, Babrak Karmal was not in place to take over the government immediately. The Manchester Guardian reported that after the invasion began, his voice was broadcast, as if on Kabul Radio, announcing his ascension to power. Actually, the broadcast came from Radio Tashkent in the U.S.S.R.: Kabul Radio carried on its usual programming all day long.

The military side of the invasion went well. On Christmas Day air transport planes began to land at Kabul airport. More than 150 flights in two days brought in as many as 10,000 troops. Convoys crossed the border in the north in two places. For a number of days troops poured in. Eventually nine or ten divisions were ensconced in the country and another four of five were poised at the border altogether, about 100,000 men.

Besides the military and political dimensions of the invasion, there was an administrative one. In January, after the military phase was well under way, the Soviets flew in 5000 bureaucrats to run the country. These were not advisors. They were native speakers of Tajik-Dari who knew how to read and write the Dari (Persian) language, capable of wading into, and making order out of, the bureaucratic mess left by dis­heartened and recalcitrant Afghan bureaucrats. One Afghan official who escaped the country said he was ordered "not to show my face in the office unless it is to collect my pay."

Now it is possible to sum­

marize the Soviets’ rea­

sons for invading: They were obviously concerned about putting out the grassfire resistance against the Khalq regime. This was a precipitating cause, but not the only one: the long-range goals were those set by the geopolitical context. They invaded in order to establish a better position from which to do the follow­ing: to establish a base on the Indian Ocean; to gain control over oil on the Persian Gulf; to strengthen their relationship with, and influence over, the nations of southern Africa; and to out-flank the China­

American coalition.

The Soviet invasion of Afghanistan has had its price. It has probably been more costly than Soviet officials forewarn. There is a chance they now see some risks in the operation they had not noticed before — like the risk of having the world’s strongest war machine embarrassed by a motley assemblage of tribesmen, merchants, civil servants, women and children. But even if the Soviets have not done as well as expected, their plan is by no means foiled. The Soviets have a firm grip on Afghanistan, and they have the military might to continue to hold it. To quell the resistance, now that the Moscow Olympics are over, they will likely send in additional troops. In April, H. N. Kaul reported in The Press Trust of India that the Russians had already moved ballistic missiles into the country, some of them possibly carrying nuclear warheads. They have 300 agents working among the Baluch, to soften the resistance which they should reasonably expect there. It may take time, but as long as they have the resources, time can be on their side. They need not complete the game at once to win it, and they have reason to believe at this point that they will win it.

The Soviets are committed to holding Afghanistan. They may have been drawn in too soon by the brushfire and under undesirable circumstances, and they may have botched their invasion politically; but having been drawn in, they are going to stay — even if the price is high, as it may be. That is why the resist­

ance of the Afghan pop­

eous is so important. The Afghans are now the immedi­

date, if not the ultimate, deter­

rent against a Soviet push to the Indian Ocean and/or the Persian Gulf.
Unlike law and business, science is a profession which is seldom a family affair. Yet...

There are thirteen Smiths, seven Joneses, and three Thaches listed in the 1980-81 Washington University School of Medicine Bulletin. The troika Thach share the unusual surname for an uncommon reason—they are brothers. In order of their appearance in the Thach family, they are: W. Thomas Thach, Jr., 43, professor of neurobiology and neurology; Robert Edwards Thach, 41, professor of biology and chairman of the department; and Bradley Terrill Thach, 38, associate professor of pediatrics. Brother Bob, a Ph.D., the only non-M.D., is also the only one with an appointment on the Hilltop campus as well as in the School of Medicine. The brothers Thach are all respected researchers and teachers. In addition, Bob is a busy administrator; Tom and Bradley are physicians who regularly treat patients.

The scions of Mary Elizabeth Edwards Thach and the late W. Thomas Thach of Oklahoma City, where they were born and reared in what was once a rustic part of that metropolis, the brothers Thach have one sister, Mary Chaille Thach Brown of Montreal, the only non-scientist of the four.

In the sophisticated milieu in which they work, they are not regarded as a phenomenon, nor have they been the focus of undue attention, although it is unusual to find a trio of brothers all dedicated to science and medicine on the faculty of a single institution. Still, their more candid colleagues admit to a curiosity about why all of the Thach brothers opted for the life of science at the same university.

The Thaches' consensus, expressed most eloquently by the two elder brothers, and underscored by their mother, is that heritage, or roots, is responsible, in large measure, for their career choices. For many reasons, including the fact that their mother is an enthusiastic member and former president of the Oklahoma chapter of the Colonial Dames, the Thaches are steeped in family history and can readily identify those forebears who have been influential in shaping their destinies.

W. Thomas Thach, Jr., observes, "We’ve had doctors and teachers on my father’s side of the family for generations." Among the most illustrious of these early physicians were William Thomas Thach, the great-grandfather after whom their father and Tom were named, and his son, Stephen Dunbar Thach. Perhaps the most noted Thach ancestral educator was James W. Terrill, another great-grandfather, from whom Bradley received his middle name. Grandpa Terrill, a captured Confederate spy who made good his escape, is suspected of having served as the paymaster for Quantrill’s Raiders. He is reported to have swum across the Mississippi River wearing strapped to his waist a bounty of gold which he distributed among these Midwestern freebooters. After the War, he helped to reorganize Winchester Normal School and founded Terrill College, both in Tennessee. His progeny continued this educational tradition by establishing other schools throughout the country.

Those exploits are hard to match, but Bob, an enthralling raconteur, tells of the deeds of yet another maverick, the notorious pirate Blackbeard (real name: Edward Teach), from whom the Thaches are also believed to be descended. A bold, brilliant, and romantic brigand, Blackbeard once blockaded the Charleston harbor for several weeks during the Colonial period and debonairly collected a king’s ransom for his temerity. This swashbuckler’s official surname is usually spelled “Teach,” and it is thought that the name Thach may be derived from the same word. Others suspect that it may have stemmed, with a slight spelling variation, from the word thatch, as in “thatch roof.” Precisely which Blackbeard characteristics were transmitted to his descendants besides a love of adventure is unclear, but his embodiment of that trait is sufficient to have endeared him to the contemporary Thaches.
That same spirit fired the Edwards clan from whom Mary Elizabeth Edwards Thach (mother Thach) is descended. Her sons speak with special affection of their maternal grandfather, Robert James Edwards, who early on seemed possessed by a compulsive wanderlust and ran away from his Maryville, Missouri, home on four occasions. Grandfather Edwards, who entered the law without having taken a single undergraduate course, liked to joke that “a college education kills your initiative.” He studied law in his father’s office in Maryville, was admitted to the Missouri Bar, and moved to Oklahoma City after the famous run of 1889. When the Cherokee Strip was opened in 1893, Edwards, then twenty-five, was appointed as probate judge at one of four places where settlers could register their land claims.

Eventually, he founded a bond business, R. J. Edwards, Inc., married, and sired six children. One of his two daughters, Mary Elizabeth, born on Oklahoma statehood day (November 16, 1907), grew up and married W. Thomas Thach, an insurance salesman dispatched to Oklahoma City by his New Jersey firm. They took up residence on the acreage which her father had purchased as a pioneer, and begat the brothers Thach and their sister.

At least one of the brothers, Tom, sees an interesting parallel between grandfather Edwards’s penchant for exploration of new frontiers, and the spirit that motivated him and his brothers to concentrate on science and medicine. “I think our professional interests are derived in large measure from the fact that at an early age we perceived that these disciplines are the center of action today. We were attracted to science and medicine because we felt that they offered opportunities to pioneer in new areas just as our grandfather had done when he helped open up the West.”

Dostoevski made The Brothers Karamazov famous, but in the world of science and medicine, the brothers Thach of Washington University have made their own mark. Although all are faculty members at this University, their specialties are as disparate as their personalities. Left to right, the beaming siblings are: Bradley Terrill Thach, M.D., associate professor of pediatrics; Robert Edward Thach, Ph.D., professor of biology and chairman of the department; and W. Thomas Thach, Jr., M.D., professor of neurobiology and neurology.

Fortuitous genealogy has been a powerful influence on the Thaches’ career decisions, but the intellectual gifts and strong character traits they share could not have developed in a sterile environment. The fun of growing up on newly settled land which they shared with wildlife as well as typical farm animals was also of significance in shaping their lives.

Nurtured by wise parents who encouraged their love of the wilderness, the Thaches were raised in a large, rambling house overflowing with books, myriad collections of nature’s handiwork, and arrowheads. Theirs was an extraordinary family, headed by a father who could converse in seventy-eight languages, most of which he learned by listening to Berlitz courses on recordings and memorizing phrase-books which complemented them. “He could address people in Tagalog, a language spoken in the Philippines, in the tongue of the Eskimo, several Chinese dialects, and even Swahili, although he never attended a formal Berlitz class,” Bob Thach recalls. The linguist Thach built on a sound foundation—he had majored in languages and mathematics at Princeton University.

The Thaches’ mother is also well-educated. On the recent occasion of her fiftieth Bryn Mawr College class reunion, she wrote: “My ‘career’ has been my family, and it has taken everything my inheritance and education could bring.” She was not joking—her children, a lively, imaginative brood, somehow managed to become embroiled in strange and wonderful adventures. Not infrequently, Bradley, the family naturalist, was the instigator.

She remembers fondly the time that Bradley bought a “battery”—a type of tiered, wire cage—to protect the family’s hapless chickens from ravaging skunks and possums. The chickens nested comfortably until a wild beast penetrated their sanctuary and impaled one squawking, terrified bird on the wire. The boy was disconsolate; then his father suggested he try to save it by sewing up its wounds. Bradley, then 13, rejected this idea because he has no anesthesia. After his father persuaded the family doctor to arrange for a sympathetic druggist to supply the ether, a scene worthy of a Norman Rockwell Saturday Evening Post cover was enacted. While Mother Thach held the hysterical chicken and her husband administered the ether, Bradley stitched up the bedraggled beast with a darning needle.
The patient revived to reign as queen of the roost, much to the delight of its proud surgeon.

Encouraged by this success, Bradley contemplated becoming a veterinarian, but in the end decided to become a physician. Tom, according to his mother, also decided on a medical career at an early age. All three brothers worked at the Oklahoma City Medical Center as teenagers to gain firsthand knowledge of science, medicine, and its practitioners.

When it came time for college, each young man went East to earn the bachelor of arts degree from Princeton as their father had done. Tom and Bradley majored in biology: Robert chose chemistry. Tom, the first to complete his undergraduate studies, delayed entering Harvard Medical School for a year to take physiological studies at the University of Melbourne in Australia as a Fulbright scholar.

Upon his return, he settled down in Cambridge, Massachusetts, where his brother Bob soon joined him to pursue graduate studies in biochemistry. In 1964, Tom received the M.D., and Bob the Ph.D., while Bradley, having completed his studies at Princeton that year, on the advice of Tom, entered Washington University's School of Medicine.

The youngest Thach brother remained in St. Louis for six years while he earned the M.D. and completed his internship and residency at Barnes and St. Louis Children's hospitals. Coincidentally, in mid-1970 while Bradley prepared to leave St. Louis to become a clinical associate in the Oral and Pharyngeal Development Section of the National Institute of Dental Research (part of the National Institutes of Health at Bethesda, Maryland), his brother Bob joined the Washington University Medical School faculty as an associate professor of chemical biology. It was not his departing brother, but rather Dr. P. Roy Vagelos, then head of the Department of Biological Chemistry at this University (now president of Merck/Sharp and Dohme Research Laboratories), who persuaded Robert to leave the Harvard faculty where he had served for six years.

Tom came to St. Louis in 1975 from the Yale University School of Medicine to accept a position as associate professor of neurobiology and neurology, having been handpicked by Dr. W. Maxwell Cowan, then head of the Medical School's Department of Anatomy and Neurobiology, as well as director of the Division of Biology and Biomedical Sciences. (Cowan recently resigned from the faculty to join the Salk Institute for Biological Studies at La Jolla, California.) "I decided to come," Thomas explains, "because I knew that some of the best research in my specialty was going on here." Bradley returned to his alma mater as assistant professor of pediatrics in 1976, having taught at Harvard's medical school for a year. Previously, he had been a research fellow in neonatology, a subspecialty of pediatrics concerned with the newborn, at Montreal Children's Hospital and Boston Hospital for Women.

With his arrival, the brothers Thach were once again united. It is a fringe benefit which they mutually enjoy and value because there are strong bonds between them. Serving on the same faculty enables them to consult frequently with each other about problems related to their scientific investigations.

The specific research interests of the brothers Thach are as different as the temperaments of the men themselves. Thomas is doing fundamental research on the brain, studying the neural mechanisms underlying voluntary movement. For the last fifteen years, he has been working with monkeys to learn how individual nerve cells (neurons) in their brains relate to normal, working tasks they perform with their hands. He is trying to answer basic questions such as why nerve cells start and stop movement, how it is regulated, and whether the neurons generate the force of the movement or just specify its velocity and direction.

The techniques that he employs were originally developed by Dr. Edward V. Evarts, with whom Thomas worked from 1966 to 1969 at the National Institute of Mental Health. Evarts worked out a delicate and painless way of recording the activity of a single nerve cell in the monkey's brain while the animal is performing a learned task in a special "primate chair" of Evarts's own design. By implanting a microelectrode smaller than a hypodermic needle in the monkey's brain, he was able to monitor recordings from the individual nerve cells on an oscilloscope, just as an electrocardiograph registers heart signals.

"Much of the work that I do," Thomas explains, "is conducted in a darkened room where I spend hours on end looking at such an oscilloscope. There are millions of these nerve cells in the brain of the monkey, and about a hundred billion—give or take a factor of ten—in that of a human. They function like minute components in a computer. Each one, by virtue of its connection, is different from another. If you pull one out of a computer or a brain, you disturb one special aspect of the complex functioning of the whole system. The main feature of my work is that I don't disrupt the nervous system, but rather look at it as it functions normally." Using an audio amplifier, he can also monitor the popping sounds that these active nerve cells emit, and follow their discharges on paper or by recording them on magnetic tape which can be analyzed by a computer.

Evarts concentrated on motor movements which could be traced back to the activity of neurons in the cerebral cortex, the wrinkled sheet of gray matter on the surface of the brain. "I was able to show that the cells in the motor cortex are components in the circuit that initiates the motor response," he wrote some years ago in a Scientific American article. Thomas Thach has demonstrated more recently, via his own classic research, "that the cerebellum is the initiator of..."
James S. McDonnell, chairman of the McDonnell Foundation, has recently given $5.5 million to Washington University to establish the McDonnell Center for Studies of Higher Brain Function. The center is one of sixty-five in twelve different departments which are carrying out research on the nervous system. He expects that all of this work will benefit immeasurably from McDonnell's generosity.

The second Thach brother, Robert, in 1969 took special training in Geneva where a Guggenheim fellowship facilitated his research. There he learned to use an electron microscope, an important tool in his work, which is concerned with the regulation of protein synthesis in virus-infected cells. He focuses his attention on those cases in which viruses kill their host cells rapidly during the course of virus replication.

Unlike his brothers, who work at the University’s medical school, Robert does his scientific research in a spacious laboratory near his office in renovated Rebstock Hall, where he presides over the biology department. Currently, he is studying viruses that cause upper respiratory infections, a condition which is also of particular concern to his brother Bradley. “When a virus infects a cell,” Robert explains, “it subverts the cellular machinery to synthesize viral proteins rather than cellular proteins. Such a procedure is called the ‘shut off’ of host protein synthesis, and, in most cases, it leads to the destruction of once healthy cells. That’s what happens in a serious disease like polio.”

Last June in New Orleans he delivered a paper in which he contrasted two viruses which had hitherto been considered similar. They are the human poliovirus and encephalomyocarditis (or EMC virus), which is thought to affect mice in a manner analogous to polio. In searching the literature, Robert Thach and his researchers have found that EMC infects a broad number of hosts. In addition to mice, it attacks monkeys, rats, raccoons, and pigs. A few years ago, it wiped out an elephant herd in a Florida zoo as well as the lions which fed on the carcasses. Poliovirus, in sharp contrast, grows only in humans and primates. EMC can cause such illnesses as encephalitis and meningitis in humans, although the symptoms it produces are frequently much milder than the virulent forms of these diseases, and, often, they are diagnosed as a common cold.

“We have demonstrated in our laboratory,” Robert explains, “that although human poliovirus and EMC have certain similar features, they shut off host protein synthesis by entirely different mechanisms. This finding is most surprising, and we regard it as an evolutionary puzzle. Our data suggest that EMC is far different in important details from human poliovirus.”

Voluntary movement and that, presumably, it tells the motor cortex what to do.” The cerebellum is a small, three-lobed structure behind the occipital lobe at the back of the brain. He suspects that “it may be the overall function of the cerebellum to adjust different parameters of movement which enable athletic humans to make fast, smooth, coordinated automated swings such as a smashing tennis serve.”

He has also identified certain cells in the monkey’s brain which signal what kind of a movement it will make many minutes before the animal actually performs such action. “These cells enable us to predict movement. In a sense, we can read the monkey’s mind.”

This exacting experimental work is obviously tedious, frustrating, and time-consuming. Training the monkeys to perform can take months. “I had to wait some four years to get the final results of my last experiment,” he added. These inherent difficulties explain why Thomas Thach is one of only some two dozen scientists in the world engaged in this meticulous type of research.

Fortunately, Thomas has other responsibilities which, while no less demanding, provide contrasting outlets for his energy and skills. These include teaching and the treatment of patients, to whom he devotes about a third of his time as a neurologist. He is hopeful that his research will eventually enable him and other neurological specialists to make earlier and more accurate diagnoses and aid in the normal recovery processes of stroke victims.

His research is an extension of neurological studies he first observed at Harvard. There, two pioneers, Dr. David H. Hubel and Dr. Torsten N. Wiesel, were also using exquisitely small microelectrodes to explore the ways in which higher animals process visual information. “I was lucky to have been in the right place at the right time to work with them and later with Dr. Evarts. It has been a privilege to learn from such wonderful people,” he says.

Dr. Sidney Goldring, professor and head of neurological surgery and co-head of the Department of Neurology and Neurological Surgery at the medical school, asked Thomas Thach to make a special presentation of his research to the late James S. McDonnell, chairman of the McDonnell Foundation, which recently gave $5.5 million to Washington University to establish the McDonnell Center for Studies of Higher Brain Function. Thach’s laboratory is one of sixty-five in twelve different departments which are carrying out research on the nervous system. He expects that all of this work will benefit immeasurably from McDonnell’s generosity.

The second Thach brother, Robert, in 1969 took special training in Geneva where a Guggenheim fellowship facilitated
Bradley Terry Thach, a pediatrician, treats critically ill babies at St. Louis Children's Hospital, and devotes the rest of his time to research on a variety of subjects, including the "diving reflex."

His work has brought him international recognition. Last March, he was one of eleven scientists from the West who were invited to attend a symposium in Moscow honoring the fiftieth birthday of the Russian researcher V. Agol. Although not well-known outside his native country, Agol is highly regarded in Russia and was, therefore, permitted to invite those whom he most wanted to meet. "Agol himself is classified as a 'refusenik'; he is not allowed to travel outside Russia," Thach explains. He found the experience enormously exciting because he and his colleagues were able to move about Moscow freely, unencumbered by the Intourist guides routinely assigned to escort visitors from abroad. "I came away convinced that we must not close all the doors connecting us with Russia. It is essential that we continue to deal with the Russians at the scientific level," he says.

He does not have time for many such trips because of the numerous responsibilities he shoulders. Besides teaching and research, he must devote a large measure of his attention to administration as head of the biology department. He presides over a department of twenty-six faculty members who offer between fifty and sixty courses a year. Valuable executive experience acquired as director of this University's Center for Basic Cancer Research from 1972 to 1975, and, for a portion of this period, as director of its graduate program in molecular biology in the Division of Biology and Biomedical Sciences, helped prepare him for his present role. "As every administrator soon finds out, the key to balancing all of these activities is organization," he stressed.

David L. Kirk, who recently was acting dean of the University's Graduate School of Arts and Sciences for thirteen months and is an active biology researcher himself, understands the problems inherent in such a situation. He has high regard for Robert Thach's performance in all three areas. "I found it difficult being an administrator and scientific researcher," he reflects, "but to Bob it all comes naturally. He is the sort of person academia will need more and more of in the coming years." Kirk believes that much of Thach's success in these endeavors derives from his ability to delegate responsibility carefully and selectively. "Bob is very much a person of action. He reads widely, thinks a great deal, and is interested in finding a creative solution to a problem rather than musing about it. The ultimate virtue, in Bob's estimation, is to figure out what one can do well, and then to do the best possible job."

Bradley Thach, in contrast with his more formal brother, Robert, and his patient, reflective brother, Tom, seems almost freewheeling and puckish by nature. As a member of the Department of Pediatrics, he is on a rotating schedule which requires that he spend three months of every year on call around the clock as the attending physician of the intensive care neonatal unit at St. Louis Children's Hospital. The rest of the time, he teaches, consults with colleagues about problems of the newborn, and concentrates in his laboratory on his major research interest, neonatal apnea—transient suspension of breathing in the newborn.

The pediatric subspecialty of neonatology is only about eight years old. "Newborn infants," he explains, "have a tremendous number of problems all boxed into about the first two weeks after birth. Incidentally, the most dangerous time of life is that thirty-minute period when you are getting born," he adds. Bradley Thach has a way of interjecting all kinds of offhand information into his conversation. He has eclectic tastes, an awesome memory, and a penchant for making extraordinary and unexpected pronouncements. "He has a dry sense of humor," volunteered a nurse who knows him well.

Dr. Richard E. Marshall, professor of pediatrics, agrees: "He loves to say outrageous things with a straight face. I can't think of any examples, but I start smiling when I begin to think of Bradley."

In his concern about neonatal apnea, Bradley focuses attention and study on the structure and operation of the respiratory tract. More specifically, he concentrates on upper airway problems involving the pharynx, the nose, and the larynx. "I'm interested in the regulation of the muscles that control the patency of the upper airway," he says, explaining that "patency, in this context, refers to the wide-open condition of.
"There are twenty-two known pairs of muscles in the neck which support the airway. A twenty-third and twenty-fourth are the subject of anatomical debate because there is uncertainty that they actually exist. For inexplicable reasons, this area of human anatomy has been even less explored than the eye or the brain."

He and his researchers wonder if apnea may occur because these neck muscles become too relaxed during sleep and thereby permit the airway to collapse, just as a faulty soda straw sometimes becomes floppy while one sips a milkshake. If this theory is correct, it may also explain apnea which occurs in older babies, children with various diseases and abnormalities of the jaw, those with enlarged tonsils, and even some adults, especially those who are obese. There is precedent for such an idea because anesthesiologists have long been familiar with the problems of airway obstruction in people whose muscles are relaxed during anesthesia.

It is also possible that there may be an inherent weakness in these muscles which has not been detected. In addition, there is speculation that the airway may sometimes become obstructed abruptly because of a condition known as laryngospasm in which these muscles suddenly close off the airway.

Researchers in Bradley Thach's laboratory discovered last year that the position of an infant's head may affect his or her ability to maintain an open airway. They demonstrated that additional muscle strength is needed to hold the airway walls apart when the neck is flexed or bent. Once closed, the airway walls tend to stick together so that extra muscle action is needed to force them apart before breathing can resume. If this condition is not corrected, obstructive apnea (cessation of breathing) may result in sudden death syndrome—the condition which causes babies to die in their cribs for unknown reasons.

Another subject of absorbing interest to Bradley Thach is the so-called diving reflexes. Many mammals, a little-known group of women divers off the Japanese coast, and even a southern Missouri swamp rabbit are able to stay under water for long periods without duress. Thanks to the diving reflexes, they experience certain physiological changes which serve as oxygen-conserving mechanisms. It has been demonstrated that the energy expended by the heart is reduced. Presumably to compensate for this effect, the blood is diverted from the muscles, the kidneys, and the digestive system and directed to the heart and brain, thus preventing serious damage to these vital organs.

This pattern of protective change in vascular resistance, triggered by the diving reflexes, can occur for example in babies who at birth become entangled in the umbilical cord, with consequent loss of their oxygen supply. As an additional safety device, the discharge of neurons in the brain suddenly stops, causing a "silent" EEG (electroencephalograph or brain wave tracing) as the blood pressure and oxygen begin to drop. These changes also reduce the brain's need for oxygen and afford it still more protection from damage. Such babies can usually be resuscitated without suffering any permanent ill effects.

In his effort to learn more about the diving reflexes, Thach has been making a variety of tests on young rabbits. Curiously enough, the diving reflexes appear to work least efficiently midway in the growth of these animals from bunnies to adults. Thach speculates that this also may be true of other young mammals. For unknown reasons, they, too, may be most susceptible to a fatal apnea spell at about the same period in their maturation process. If this theory is confirmed by subsequent research, it may explain why the peak incidence of death from neonatal apnea, which is suspected of being the cause of death in sudden death syndrome, occurs when human babies are about three months old.

The engrossing research of the brothers Thach has earned them the respect and commendation of their peers. They find it difficult to respond to such enthusiastic praise because they are innately modest and not given to introspection. Perhaps the raison d'être for their devotion to their professions is best summed up in the words of Horace Freeland Judson, who wrote in his recent book, The Search for Solutions: "Science has several rewards, but the greatest is that it is the most interesting, difficult, pitiless, exciting, and beautiful pursuit that we have yet found. Science is this century's art."
Three Mile Island As History

By Robert C. Williams
Professor of History

Robert C. Williams is co-author, with Philip L. Cantelon, of the official history of the Department of Energy's response to the Three Mile Island accident. This essay is adapted from the annual Phi Beta Kappa—Sigma Xi lecture delivered by Professor Williams in Graham Chapel on April 23.

One year after America's worst nuclear power accident it is clear that Three Mile Island was not so much a technological event as a human and historical one. It was a failure not of technology but of technocracy, the rule by experts based on criteria of rationality, efficiency, productivity, and profit. It was not a mechanical breakdown but a series of human choices that crippled a nuclear reactor and threatened injury and death to the public. What went out the window at Three Mile Island was not only radiation but public confidence in scientific expertise, democracy's faith in technocracy.

Today, the plant remains crippled, and the radiological, economic, political, legal, and psychological effects of the accident will be felt and scrutinized for years. Three Mile Island has joined Skylab and Titan as a symbol of technological failure. But it appears that the accident was caused by human error: technocrats blundered, lost control of technology and, refusing to admit it, gave confusing, inconsistent, and jargon-laden explanations. (How many Americans knew what was meant by a hot leg, a candy cane, or a primary loop?) As a result of the failure of government officials and scientists to communicate to the public, the line between real and imagined risk became blurred: citizens were no less traumatized because the event happened to them emotionally. Risk perceived is risk endured.

Those who felt their lives threatened cannot accept the reality: a minor loss-of-coolant accident that caused them less radiation than their dentist, less risk than their automobile, and less heart trouble than Edward Teller gets listening to Jane Fonda. They feel they have lived through hell. They have come to distrust statements from an industry that calls a bomb a "device" and an accident an "incident." They remain confused, afraid, and angry.

In trying to reconstruct and explain the human past, history itself is part science and part art. Like a scientist, the historian deals in evidence, inference, and logical argument; like an artist, he creates aesthetic order out of the chaos of experience. The historian must narrate a reasonably true story of events based on documentary evidence, but he must also understand
through empathy the actions, motives, ideas, hopes, and fears of human beings at other times and places.

I suspected that history and the humanities were essential in understanding America's worst civilian nuclear power accident when I first heard that the reactor was operated by a man named Faust. The Faust of literature, of course, is a sixteenth-century learned man who makes a fateful pact with the Devil to understand the innermost secrets of nature to dominate it. The Faust of this story, Craig Faust, is a pleasant young man, trained in Admiral Hyman G. Rickover's naval reactor school, who was on duty at 4:00 a.m. on March 28, 1979, operating the Unit 2 reactor of the General Public Utilities' Metropolitan Edison plant at ninety-seven percent full power.

The literary Faust symbolizes one dimension of Western civilization's myth of power: man's aspiration for and striving after knowledge. The second dimension of that myth is embodied in the Greek legend of Prometheus, who defied the gods by stealing fire—the energy source of heat and light—to give to his fellow man. Throughout the growth of modern, rational, secular, scientific development runs this double thread: the Faustian bargain to sell one's soul for power, and the Prometheusian aspiration to become god-like by stealing the secrets of energy. Both myths suggest the costs and sacrifices of our drive toward secular happiness, for Faust lost his soul to the Devil and Prometheus was punished by the gods—chained to a rock in the Caucasus, he was tortured by eagles which gnawed at his liver.

There is a related tradition in Western thought which we may call "utopian." Sir Thomas More's Utopia (1517) took its title from a pun on Greek words for "the good place" and "nowhere." Like subsequent utopias, More's was an imaginary idealized community situated on an island (a good place for imagining a heaven on earth). Perhaps the best example of a scientific utopia is Francis Bacon's New Atlantis, which describes a seventeenth-century fictional island society where the scientific elite works miracles through experiment, exchange of ideas, and technology.

But utopia has its price: we give up our freedom to those who promise to plan our happiness. Technocracy supersedes democracy. As the Russian writer Aleksandr Solzhenitsyn never tires of reminding us, the utopian aspirations of Western secular humanism since the Renaissance have repressed or ignored essentially religious values, which he finds more apparent in the suffering islands of the Gulag Archipelago than the happy islands of Western utopias.

In the context of Three Mile Island, utopia was a dream of secular abundance through cheap, safe, and even renewable energy sources. The nuclear nightmare there, on the contrary, resembled Dante's fourteenth-century literary vision of hell in The Divine Comedy—the island of Mount Purgatory surrounded by seven circles corresponding to the seven deadly sins. Here man is not god-like, but sinful. At Three Mile Island, hell took the form of concentric circles around the plant, circles which plotted the plume of radioactive gases and the contingencies of evacuating hundreds of thousands of people from the area. Three Mile Island, then, may be thought of as a symbol of nuclear utopia encircled by the imagination of nuclear catastrophe. Let me examine this by conceiving of the Three Mile Island accident in terms of seven circles, or levels, of human decisions that affected the events.

Let us call the first and innermost ring the circle of technology. Machines are central to man's power over nature in many utopias, and the innards of Three Mile Island, with gray-green generators and miles of pipes and ducts, remind one of Jules Verne's Nautilus or its modern equivalent. The first circle is the reactor itself: the reactor vessel and its circulating loops of coolant inside a thick concrete containment building. The accident began here with a technological event: the demineralizer that removes silt from river water entering the reactor system became clogged, blocked the flow of secondary-loop coolant water, and caused the reactor to "trip," or shut down. This happened automatically, by a "scram"—control rods descended among the fuel elements (zirconium alloy tubes filled with thousands of uranium pellets) to absorb neutrons and reduce the fission process that produces heat. The machine responded appropriately within seconds, and activated an emergency core cooling system designed to flood the core with water and help reduce the temperature.

Unfortunately, human beings interfered with the machine from the outset, making choices that turned out to be in error. Maintenance men working on the demineralizer for eleven hours trying to clear it ended up clogging it. A day earlier, other maintenance men had closed two block valves that supply non-radioactive water to the steam generators, and had forgotten to reopen them. For eight minutes these valves remained closed and unnoticed, while temperatures rose in the secondary loop. This happened automatically, by a "scram"—control rods descended among the fuel elements (zirconium alloy tubes filled with thousands of uranium pellets) to absorb neutrons and reduce the fission process that produces heat. The machine responded appropriately within seconds, and activated an emergency core cooling system designed to flood the core with water and help reduce the temperature.

When the action moved to the second circle, a circle of technology. In the Unit 2 control room, Craig Faust and other operators knew within seconds that they were seeing an unexpected "event," or malfunction. The reactor itself had shut down; something was wrong. But what?

The blocked coolant line was not indicated by control room instruments, because their green and red lights showed...
only whether valves were open or shut, but not whether that
was the correct or incorrect position: in normal operation some
valves are open and others are shut. Because the emergency
core cooling system had activated, operators decided that the
immediate danger was that the reactor would "go solid" or fill
up with water; in a pressurized water reactor this means that
one loses control over the reactor, control normally maintained
by an air bubble in a device called the pressurizer. In reality,
no water was flowing into the core, and for a number of hours
on Wednesday the core would be uncovered, producing
temperatures well over 2000°F. In the minds of the operators,
however, the problem was not too little water, but too much.
Within minutes they made a human choice that appeared to
be correct, but turned out to be wrong: they throttled back
the emergency core cooling system and further reduced the
flow of water to the core.

This choice was less important than another problem.
Eight minutes into the accident, operators noticed that the
block valves were closed, and reopened them. They thought
they were thus restoring the normal flow of water to the
reactor. In fact, another valve, designed to open automatically
when reactor pressure becomes abnormally high, had stuck
open, a fact also not indicated on control room instruments.
Had they known this, operators might not have paid much
attention, since the same valve had stuck open more than a
hundred times at other Babcock & Wilcox reactors, and
several times at Unit 2 itself. They were now, unknowingly,
reenacting a 1977 loss-of-coolant accident at the Davis-Besse
plant in Toledo, Ohio. Operators had made a choice in which
they thought they were restoring normal coolant flow to the
reactor; instead, they were pouring hundreds of thousands
gallons of radioactive water directly through a drainage
system onto the floor of the adjacent auxiliary building.
They had made a choice based on what they thought was
happening, rather than on what was actually happening, a
phenomenon that was to be repeated by many other people as
the accident wore on.

Not making a choice can also have effects. At about
2:00 p.m. Wednesday an event occurred which operators chose
to ignore. A thud was heard in the Unit 2 control room and the
pen graph of an instrument recorder that monitors containment
building pressure rose from around zero to a point measuring
twenty-eight pounds per square inch. "We didn't know what it
was," recalled shift supervisor Bill Zewe, "and no one really
had any good ideas or answers." Operators at first thought it was
an electrical problem with the instruments. Because they did not
know that the core was uncovered, it did not occur to them
that the thud signified a burning of hydrogen released by the
reaction under high temperatures between the zircalloy fuel
cladding and water, or that the released hydrogen was forming a
bubble in the reactor vessel. They chose to do nothing. As a
result, it was two days later that the Nuclear Regulatory
Commission learned there was a hydrogen bubble inside the
reactor and responded with sudden alarm.

The reactor was thus encircled by the "mind set" of
operators whose training taught them to imagine a situation
of too much water in the reactor, when in reality their choices
had the effect of interfering in a loss-of-coolant accident. Yet
reality—a partially uncovered core and a near meltdown—
would not be known for days; in fact, one might argue that
reality will not be known until scientists reenter the
containment building and are able to reconstruct more
precisely the technical process of the accident.

We might call the third circle the *circle of containment.*
By this I mean not the containment building, but the
entire plant on the island, from which radiation could
and did escape to the atmosphere and the Susquehanna River.
The dangerous core fission products appear to have been
successfully contained inside the reactor at Three Mile Island:
what escaped was mainly inert gases from the radioactive
primary loop water which flowed out of the reactor and onto
the floor of the auxiliary building, then through its vents to the
atmosphere. The most prominent gas was xenon-133, a radio-
active gas with a half-life of 5.3 days that is not absorbed by
body tissues and is soon eliminated if inhaled or ingested. Its
effects are trivial compared with, say, plutonium products
with a half-life of thousands of years.

From what we know so far, the radiation released at Three
Mile Island was rather minimal. The average dose to two
million people in the area has been estimated at 1.4 millirem.
less than one percent of the average annual dose any American
receives from background radiation sources—cosmic rays,
bricks, granite, the dentist's office. A person standing at the
North Gate of the plant throughout the accident (twenty-four
hours a day for six days) without any clothes on would, beside
attracting a lot of attention, have received an estimated dose
of less than 100 millirem, or about two thirds of the annual
average dose received by all Americans.

Let me hasten to add that I am no expert in radiation
matters and that my response is simply that of an informed
citizen who has studied reports of the accident. I am aware
that the effects of low-level radiation are the subject of
considerable debate, and I do not wish to minimize the risk.
What I would emphasize is that at the time of the accident,
no precise radiation figures were understood by the public,
so that the reporting and interpreting of available figures by
government officials played a crucial role in elevating
public concern.

Radiation releases were also a matter of human choice.
For several days Metropolitan Edison officials told the public
that releases were nonexistent or accidental (when they were deliberate) and said that the reactor was under control (when it was not). The key human beings on the circle of containment were the plant managers, men with a great deal to lose economically from the accident, and they were as concerned about containing information as containing radiation. For example, the famous 1200 millirem release early Friday morning was said to be accidental when it was deliberate, based on a decision by shift supervisor Jim Floyd to vent radioactive gas. Floyd later testified that he knew he was releasing radioactive gas, but feared that unless he made that choice he would lose control of the borated water necessary to cool the reactor and would risk a possible meltdown. He said he thought he was choosing the lesser of two evils.

The human factor was equally important in misinterpreting radiation release data. Early Friday morning officials in Bethesda, Maryland, at the NRC Incident Response Center learned of the 1200 millirem release and became alarmed. For one thing, they had just been considering some worst-case calculations for offsite radiation in which the figure 1200 millirem had coincidentally appeared. Having just learned about the hydrogen explosion of Wednesday afternoon, they jumped to the conclusion that the 1200 millirem reading was taken offsite and away from the plant, when in fact it was taken by a Metropolitan Edison helicopter hovering directly over the auxiliary building stack from which the gas was coming. This confusion was important since it led to the NRC decision to recommend evacuation to Governor Richard Thornburgh.
It also typified the problem of getting accurate radiation readings accurately interpreted as the basis for action, a problem rarely solved.

On the circle of containment the great fear was radiation, and news of radiation. Radiation can be dangerous, but it is also invisible and misunderstood: the failure of technocrats at Three Mile Island to communicate to the public about radiation helped generate panic and fear. Metropolitan Edison spokesmen continued to believe publicly in the utopia of nuclear power—safe, clean, and efficient—while refusing to admit that an accident they said would never happen was in fact happening. In effect, they lied to the public. What leaked out was thus not only xenon-133 but evidence that ultimately destroyed the credibility of the nuclear managers. And the major radiation releases were not inadvertent technological breakdowns, but the result of deliberate human choices: technology was merely used as an excuse.

The fourth circle lay outside the plant in the emergency response efforts made by local, state, and federal officials. The main problem was to monitor offsite radiation and take measures to protect the public from it, or from some more catastrophic possibility. Emergency response was the primary function of the Environmental Safety branch of the Department of Energy: by Wednesday afternoon DOE teams were monitoring ground and aerial radiation around the plant and had established a command post at nearby Capitol City Airport. By Friday afternoon, a second wave of politicians and other government officials descended on the area on White House orders to bring more expertise to the aid of the plant.

DOE scientists soon found that reality was hard to establish. Almost no information was available from Metropolitan Edison about the plant itself. Regular helicopter flights were made around the clock in hopes of catching releases, but these releases were often unannounced, or announced and then cancelled. Emergency teams brought very sensitive instruments used in looking for tiny radioactive sources, such as the fragments of the Soviet nuclear-powered satellite lost over Canada in 1978, and were astounded when they went off scale: they knew that radiation was higher than they expected, but not how much higher. Other teams, following up early (erroneous) readings by Met Ed monitoring, came looking specifically for iodine-131, an isotope that does severe damage to the thyroid and liver; finding no iodine, they felt that there really was no emergency at all, and asked to be sent home.

In general, scientists did not know what to expect because communications were so poor. They had no data from the plant itself, and did not know what was happening to the very low radiation readings they and the Pennsylvania Bureau of Radiation Protection were regularly monitoring and reporting to NRC: these readings were lower than those monitored in the same area after a 1976 Chinese nuclear bomb test. They could not understand why they were seeing government officials on television speculating about evacuation, explosion, and meltdown. The public excitement over Three Mile Island did not make sense to scientists in terms of the levels of radiation they were monitoring, and they tended to ascribe this to politics and the media.

The first four circles had largely to do with technocracy itself—plant operators, managers, and scientists. The last three circles have to do with the public and political response to the accident, a response in which imagination and ignorance played a major role.

Let us call the fifth circle the circle of evacuation. At Three Mile Island thousands of citizens had to choose whether or not to leave their homes for safety, and a number of politicians and government officials had to decide whether or not to advise them to do so. Evacuation of people from areas endangered by floodwaters is common in southern Pennsylvania, but there were no plans for evacuation in connection with a nuclear power plant accident. Like radiation, evacuation was plotted on a series of concentric circles with radii of five, ten, or twenty miles. Like so much else at Three Mile Island, evacuation turned out to be imaginary: the major step was to publish in Monday’s Harrisburg Patriot maps of how to get out of the area.

The reality was not evacuation, which implies orderly planned action by government, but exodus and flight. Over the weekend of March 30 and April 1 the people of Three Mile Island voted with their feet. They did not wait for an evacuation order that never came (aside from an advisory by Governor Thornburgh that preschool children and pregnant women leave the immediate area) but got in their cars and left to spend the weekend with friends or relatives, some as far away as St. Louis.

The circle of evacuation generated confusion by telephone: many government officials did not listen, or heard only what they wished to hear. At 8:30 a.m. Friday, Jim Floyd of Met Ed called the Pennsylvania Emergency Management Agency (PEMA) about the 1200 millirem release. A PEMA official asked: “Are you ready to evacuate?” Answered Floyd: “Yes, we’re always ready to evacuate.” Floyd later testified that he meant that plant personnel were always ready to evacuate the island if needed; the PEMA official understood him to say that people living around the plant should be evacuated from the area, and began urging evacuation.

People simply failed to communicate. At 9:15 a.m. Friday, Harold Collins, an NRC official, telephoned Oran K. Henderson of PEMA and said: “It is our recommendation that you execute immediately a ten-mile evacuation in the direction
of the plume out to ten miles.” Henderson later testified that he heard Collins say: “We are recommending that you execute immediately a ten-mile evacuation around Three Mile Island.” On the basis of this muddled conversation, PEMA recommended evacuation to Governor Thornburgh and was surprised to find itself hotly opposed by the health physicists of the Bureau of Radiation Protection on the basis of their extremely low radiation readings. Thornburgh’s children-and-pregnant-women advisory was a compromise.

In the end nobody chose to recommend evacuation, because there was no plan as to how to evacuate: but many individual citizens sought safety far away.

The sixth circle was the circle of politics, in which technocracy confronted democracy. Here events involved the media, communications, and elected officials. Politically, Three Mile Island had happened in the public imagination well before it happened in reality. Technocracy created nuclear power; democracy rarely voted for it. Throughout the 1970s a public fear of science and technology had been reflected in popular hostility, tight environmental regulations, and reduced federal funding. Shortly before the accident, the NRC had withdrawn its approval of the conclusions of an earlier report by MIT Professor Norman Rasmussen, which predicted that a serious nuclear accident such as a meltdown was extremely improbable. The estate of a deceased nuclear processing worker, Karen Silkwood, had received a settlement that seemed to belong to the snail darter, not the Clinch River Breeder Reactor.

Fictional accounts of nuclear nightmares also sold well. The Prometheus Crisis (1975) urged us to “imagine a hundred thousand ‘towering infernos’—with effects lasting for generations to come.” The novel A Short Life (1978) warned us that “nuclear disaster is no longer a threat—it is a reality that is happening today as accidents in supposedly ‘safe’ power plants release clouds of radiation into our atmosphere.” And The China Syndrome, which appeared as a film coincidental with the accident, promised that a nuclear accident “means something very hot, very explosive. Something so big it could blow Southern California sky high!”

Given popular expectations of nuclear disaster, accurate communication of the risks to public health and safety was crucial at Three Mile Island. But for three days the utility acted as if nothing was wrong. Only on Friday, when the NRC learned of Wednesday’s hydrogen explosion and the existence of a noncondensible bubble in the reactor, did the federal government act to improve communications by sending Harold Denton and a team of experts to Three Mile Island. But even then the experts disagreed: scientists at the Idaho National Engineering Laboratory knew by Saturday that the bubble could not explode because of insufficient oxygen; they reported this to the NRC. Yet when President Carter arrived in Middletown early Sunday afternoon, the two chief NRC reactor experts still disagreed on the explosive potential of the bubble. In the end the NRC never did admit that its calculations of a possible explosion were simply erroneous. In general, the problem of the hydrogen bubble illustrated a more common one—scientific data were not being considered before political decisions were being made, or before statements were released.

Not that it would have mattered. When an NRC official, Dudley Thompson, used the term “meltdown” at a Friday afternoon news conference, no one noticed the laconic 6:30 p.m. NRC bulletin that said there was now “no immediate danger of a core melt.” What people heard and saw was Walter Cronkite’s “nuclear nightmare” coverage on the evening news. One NRC official speculating out loud on the remote possibility of a meltdown thus was amplified in the public mind. Only with Harold Denton’s subsequent press briefings did the media and the public get what should have been available from the outset—a single and credible scientific expert able to communicate reality.

In fact, all weekend the scientific data indicated low radiation levels and minimal danger of another explosion. But these data were not effectively communicated. Too many decisions were made on the periphery, in Washington and Bethesda, and not at the center of events. Scientific data did not inform political decisions, and the media generated alarm based on contradictory and confusing government statements, often in a language incomprehensible to the layman.

Within the seventh and outermost circle—the circle of mortality—imagination and unconscious fears were far more important than any accurate perception of risk. “We all live in Harrisburg,” as the slogan went, not only because of geographic proximity or television, but because we share the dread of radiological death in the nuclear age. The public has not forgotten that nuclear power originated in weapons: the bomb and the submarine. Behind the nightmare of Three Mile Island may well lie guilt and the fear that we too may one day experience our own Hiroshima and Nagasaki. At Alamogordo in 1945 at the first atomic bomb test, J. Robert Oppenheimer recalled the words of the Hindu epic poem, the Bhagavad-Gita: “I am become death, the shatterer of worlds.”

Reports of psychological stress suggest that the main legacy of Three Mile Island may have been the survivor’s sense
that he has narrowly escaped death, and life continues to be out of control. To many people a nuclear reactor is simply a silent bomb, regardless of constant statements that it cannot possibly explode; the unseen threat of radiation adds to this feeling. No wonder children living in the area have had recurrent nightmares about death, and psychiatric patients have aged visibly under the strain. A grandmother says she now lives with a sense of doom; a physician reports emotional trauma, rather than physical effects; every stillborn litter of kittens or aborted sheep brings back old memories and associations; a housewife says, “It’s like we don’t have control over our lives.” Of all the residents near Three Mile Island only the Amish, devout believers who avoid contact with civilization, appear to have emerged relatively unscathed. Without television or newspapers, they learned of the accident more than a week after it happened; when they found out, they simply ascribed it to God’s will and man’s meddling with nature. The Amish still have what technocracy and utopia lack—a sense of man’s original sin and essential imperfection.

Thus on the seventh circle of mortality we come closest in our imaginations to nuclear hell. The cooling towers of Three Mile Island inhabit our consciousness, but the fireball lives in our unconscious along with other fears associated with nuclear power and radiation—of sterility, of cancer, of stillborn children, of death in the nuclear age.

Three Mile Island should be understood as an event of historical significance not only because of what actually happened, but because of what people thought was happening or feared might happen. Time and again people made choices based on inappropriate perceptions of reality. Technology, technocracy, containment, emergency response, evacuation, politics, and mortality—these are not the seven deadly sins of Dante’s hell, but varieties of human involvement in history at Three Mile Island. They remind us of the persistence of human choice in an age of science, technology, and specialization; we cannot blame technology for human error.

One scientist reminded me in fairly earthy language that what was amazing at Three Mile Island was that the machine survived and functioned despite a number of human attempts to screw it up. Most problems lay with experts who did not correct machine problems, who assumed that the machine was behaving one way when it was behaving another, who spoke out on matters of public policy without adequate scientific data, who used scientific jargon instead of clear and distinct English, who licensed the machine for operation despite numerous indications of inadequacies, and so on. More than this, many problems lay with the technocratic state of mind: narrow, technical, elitist, isolated, suspicious of public and press, going by the book, refusing to admit the possibility of error and accident, speaking in technical tongues. Yet if the key to Three Mile Island is human choice and belief, rather than technological breakdown, then it is the proper subject not of science itself but of those disciplines which enable us to understand human thought, motivation, and behavior: the humanities and social sciences.

The task of historians is usually to explain and understand the past, not to predict the future. Yet as a concerned citizen, I cannot resist sharing a few lessons learned from Three Mile Island with you. The major lesson, I believe, is that technocracy, not technology, caused the accident. Both by manhandling the machine and by failing to communicate quickly and accurately the risks to public health and safety. If human beings are to blame, then there are a number of changes that can and should be made in the nuclear industry to prevent future accidents, changes already recommended by the Kemeny and Rogovin Commission reports: stricter licensing regulations; better operator training; better communication of public risk; siting of reactors away from populated areas; citizen involvement in siting, constructing, and monitoring reactors. Three Mile Island was an accident that could have been avoided and should have been admitted and explained while it was happening. People made it happen. We must minimize the risk that it will happen again.

More broadly, I would conclude that Three Mile Island shows us that the human implications of science are too important to be left to the scientists alone. Technocracy must be ultimately responsible to democracy, especially when technology threatens public health and safety. Technical expertise is crucial to our civilization. But it is not appropriate if it loses control, if it cannot explain itself clearly in laymen’s terms, or if it threatens public health and safety. Three Mile Island was a human drama and trauma that is still with us; it is contemporary history here and now, not there and then. We still do not know when the accident will truly be over. For a moment science lost control; the liberal arts—history, psychology, sociology, political science, and economics, for example—may help us understand why. As citizens we cannot afford not to learn from history that science creates as many problems as it solves, and does not free us from the responsibility of choosing.
On August 22 James S. McDonnell died. Tributes to the energy and vision of this man, whose benefactions to Washington University were immense, filled the columns of the nation's newspapers. The Washington Post notes that when his company was just four years old in 1944, Mr. McDonnell began the missile research that led eventually to building the Mercury craft that carried the first American into orbit.

The St. Louis newspapers recorded Mr. McDonnell's business success, which meant so much to the city and the entire Midwest; his national leadership of the aviation and space industries; and his wise captaincy of public affairs, from the world concern expressed in his backing of the United Nations to his community leadership. Nation-wide, those who knew Mr. McDonnell spoke of the integrity, acumen, creativity, dedication, and tireless effort that characterized his life.

Many tributes came from Washington University. Not surprisingly, a number came from faculty members, for Mr. McDonnell was not a casual donor. Always, much thought preceded his gift. He identified areas of research he believed were at the forefront of scientific exploration: space sciences, genetics, psychic research, and, most recently, higher brain function. He read widely and delved deeply before he gave. He believed Washington University was an institution that could add to human knowledge—not because we told him so, but because he himself had researched our qualifications. Once committed, he gave generously.

The sums which James McDonnell committed—though large—are but a part of his legacy to this institution. He challenged us with every gift. He made us explore our potential.

Mr. McDonnell also lent us leadership and counsel. He served as a member of the Board of Trustees from 1960 to 1966 and as chairman from 1963 to 1966.

Washington University has granted only two honorary doctor of medicine degrees in its history: the first to Robert S. Brookings, the second to James S. McDonnell. In some respects—both in a larger sense and in detail—their careers were alike. Brookings became a member of the Washington University Corporation in 1891; he was forty-one years old, but had amassed a small fortune and thought of devoting the rest of his life to public service.

He studied the University for four years before he accepted the chairmanship and undertook that role with driving force. He had considered abandoning the ailing institution, but gave up the idea of founding a new university in favor of re-founding Washington University.

In spring 1963, James McDonnell, then a member of the board, told a commencement audience: "The day is probably past when privately established universities can be created, so we have the duty to make certain the ones we now have continue to flourish. They are our citadels of freedom and strongholds of creative activity." That October, he accepted the chairmanship of the board.

During Robert Brookings's era, a Carnegie report on the state of medical education condemned almost all medical schools, including Washington University's. The day after reading the report, Brookings and its author, Abraham Flexner, began discussing what was needed to put Washington University Medical School on the path to excellence.

When Mr. McDonnell became chairman, a dispute between the Medical School and its co-dependent Barnes Hospital was threatening to disable both. Chancellor Danforth recalls, "In the early 1960s several individuals caught a vision—the development of programs and the raising of funds that would make the Medical Center a world leader in medical education, research, and patient care. Unfortunately, as the School and Barnes Hospital found their interests were not in all cases identical, the effort necessary to realize this dream was set aside, replaced by suspicion. They battled each other to protect space, resources, and important principles.

"There were, and still are, fundamental differences in approach. Both perceptions were not only correct, but also essential to the common enterprise. What had happened was that honest differences of opinion about priorities became grounds for mutual distrust. Academic progress slowed; fund raising stopped. "The turning point came from Mr. McDonnell himself. The Medical School—the University—was then in a position of strength, but instead of advising us to use it, he advised that we do what was best for Barnes Hospital. It turned the tenor of debate. The hospital responded in similar fashion. Things were worked out; we regained forward momentum."

At the turn of the century, Brookings led the effort to purchase and build the Hilltop campus and during Mr. McDonnell's chairmanship the board approved the University's "Seventy by Seventy" campaign. "We were a new administration when Mr. Mac became chairman," recalls George Pake, who was then provost. "But he and Tom Eliot immediately determined to seek the massive funds necessary to move forward vigorously. He was the kingpin in that. No chancellor could carry the board into that kind of effort without absolute support."

It is clear from history that one man's leadership can cast a long shadow. Chancellor Danforth noted: "He had grand visions and the intellectual stamina to attend to the details. He focused his activities and nurtured his projects until they were large enough to be of enduring value. We shall miss him."

D.W.
The tension was high and the crowd was partisan in Edison Theatre drama studio in mid-June as Washington University's Division I champion College Bowl team met its match—Division II champions California State University, Fresno. As homestand for one of the CBS-radio national contenders, Washington University hosted the whole round of Division II finals. Then in the play-off game, the Washington University quartet was bested by Fresno to finish second nationally.