Cardiothoracic surgeon Richard E. Clark, who holds a joint appointment in the University's Schools of Medicine and Engineering, also finds time to drive Formula V racing cars. Above, he is shown leading the pack around a curve at the Mid-America Raceways at Wentzville, Mo. Dr. Clark is the principal investigator of a University team that is designing a revolutionary prosthetic aortic heart valve. See page 2.
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COVER: Elizabeth Vine, chemistry doctoral student, inserts a uranium sample in the "rabbit," a plastic cylinder which is shot through a pneumatic tube to the University's cyclotron for irradiation. See "Probing the Nucleus," page 14.

Photo credits: pages 20, 22-27, back cover, Morton D. May; pages 36-39, courtesy, Salzburg Seminar; all others by Herb Weitman.

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Richard E. Clark, M.D. (left, seated on desk) and key members of his biomedical engineering team. Back row (left to right) Dr. W. Milton Swanson, Dr. Salvatore F. Sutera, Edward H. Finke, Ron Hagen; (front row, left to right) Dr. John L. Kardos and Dr. Phillip L. Gould.
Artificial Heart Valves:
Latest Approach to Cardiac Plumbing

By DOROTHY BROCKHOFF

Heart disease is a formidable killer in the United States. Its victims include many who die because of a defective aortic heart valve. At Washington University, Dr. Richard E. Clark heads a biomedical engineering team which is developing a prosthetic aortic valve to simulate as closely as possible the device designed by nature.

The damage done by Cupid to the human heart is sometimes acute, bards, balladeers, and torch singers all agree. Fortunately, it is seldom fatal. Injury caused by cardiovascular disease is another matter. In 1971, heart disease and related ailments killed over a million Americans.

Malfunctioning of the aortic heart valve is one of the causes of heart failure. Until the advent of open-heart surgery, the prognosis for a person with a defective heart valve was poor. Now, because this crucial valve can be replaced surgically, many people suffering from this kind of problem have been given a new lease on life.

But for how long? That is the question. Because heart valve replacement is a relatively recent development (open-heart surgery itself was not performed in this country until 1953), precise and reliable long-term statistics are unavailable. It is known, however, that many people continue to function effectively today with prosthetic heart valves which were implanted almost a decade ago. It is also recognized that the perfect artificial heart valve has yet to be designed. New and improved valves continue to be introduced because the need is so great. It is estimated that some 25,000 persons a year require aortic heart valve replacement.

At Washington University, a complex, concentrated effort is in progress to design a prosthetic aortic heart valve which will simulate as closely as possible the efficiency and durability of the valve as it functions in the human body. The project requires the close cooperation of a variety of experts on both the Hilltop and the Medical School campuses. Working together as a biomedical engineering team, utilizing advanced technology, some of it the product of the space-age, these professionals are about half-way through what was originally funded as a more than a quarter of a million dollar, four-year research program. The grant came from the National Heart and Lung Institute of the National Institutes of Health.
Artificial Heart Valves

The Washington University group has benefited not only from this substantial governmental financial support, but also from the technical help of experts at universities as widely dispersed as Utah, Illinois, and Virginia in the United States, and Laval University in Quebec, Canada. The Illinois assistance, which involves applying a technique used to map the moon to the synthetic aortic heart valve project, was made possible by a special NASA (National Aeronautics and Space Administration) grant given to researchers on the Urbana campus. It provided for the payment of $20,000 each year for the past two years.

Also directly involved is the highly specialized Fabric Research Laboratories, Inc. (FRL), in Dedham, Massachusetts. FRL is responsible for producing gossamer-like, superpure, polyester filaments and weaving them into a fabric valve laboriously and meticulously engineered by the Washington University team and its collaborators.

The quarterback of the team is an energetic, intense surgeon of thirty-nine, Richard E. Clark, who is unusually well qualified to be the principal investigator because he holds degrees in both engineering and medicine. He has a joint appointment as associate professor in the University's Medical and Engineering Schools and is assistant surgeon in cardiothoracic surgery at Barnes Hospital. In 1962, while acquiring a master's degree in surgery at the University of Virginia, Dr. Clark developed a prosthetic mitral heart valve (another of the four valves in the heart).

Describing this experience in his thesis, Dr. Clark wrote: "The cardiovascular surgeon has had to try to understand problems in plastics, organic chemistry, cellular physiology, kinetics, fluid dynamics, manufacturing, and many other fields, as well as to keep abreast of the tidal wave of surgical information. Such is the problem of the development of prosthetic valves for the heart."

What Dr. Clark observed twelve years ago is no less true today. He compared the University team's task to that of an individual trying to put together a jigsaw puzzle with hundreds of pieces. "The easiest job is to fill in the borders first. Now, we're fitting in pieces toward the middle and that is much more difficult."

At first glance, the human trileaflet aortic heart valve looks as if it should be rather simple to duplicate. It varies in size just as the human heart does. The smallest is about as big as a dime; the largest is roughly the size of a quarter. To understand how it functions as a one-way check valve between the left ventricle and the aorta, one must keep in mind a few basic facts about the heart itself.

A hollow organ about the size of a clenched fist, the heart is the most efficient pump ever devised. It pumps five quarts of blood through the body every minute for a total of three million barrels in seventy years. To perform this astonishing feat, the human heart has been engineered ingeniously. It is divided into four chambers. The top two cavities, known as the right and left atria, act as reservoirs. The lower chambers, called ventricles, perform the actual pumping of the blood. The right atrium collects the blood from the veins, and the right ventricle pumps it into the lungs. Their counterparts on the left collect the blood from the lungs and pump it throughout the body. The left ventricle squeezes blood through the aortic valve into the aorta and the arteries in regular rhythmic beats—approximately seventy a minute. For the Biblical three-score and ten, that amounts to 2,700,000,000 beats in a lifetime.

To simulate the configuration of the human aortic heart valve is not an easy assignment. The leaflets must be thin and flexible, strong and durable, and constructed of a material which is non-toxic and resistant to surface clotting. Incorporating these precise specifications into a valve is an exacting job in itself. The problem becomes even more complicated because the valve must have a special type of elasticity which varies throughout the leaflets.

No one was more aware of the necessity of complying with all of these requirements than Dr. Clark. Even before he sought support from the National Institutes of Health, he had done fundamental studies on human heart valves in an effort to discover the secret of their peculiar and unique stretch-ability characteristics. His research, published in a scholarly journal and never previously reported, showed that aortic leaflets "are significantly more elastic and have less tensile strength in the radial direction than in the circumferential."

At least a part of the leaflet's ability to withstand the wear and tear it is subjected to in the human body is attributable to this quality, known in scientific circles as anisotropic behavior, another way of saying that the leaflets have unlike properties in different directions.

At present, there are no trileaflet prosthetic aortic heart valves on the market. Manufacturers make ball and cage...
types and different kinds of disc models. All of these me­
ch­
chanical valves are what Dr. Clark calls “variations on a
theme.” They are occlusive devices, which invariably cause
some obstruction of blood flow. “What we really need is a
central orifice free-flow device,” Dr. Clark said. This Feb­
ruary, the first such trileaflet valve, designed by the Wash­
ington University team, is scheduled to reach Dr. Clark’s
desk. In St. Louis, it will undergo rigorous testing, and then,
if the results look promising, valves of this type will be
implanted in baboons in the Surgical Research Laborato­
ries at Washington University. Then, these beasts will be turned
loose at a primate center, where they will be carefully ob­
erved to see how they are able to function with such arti­
ficial devices in their hearts.

D r. C lark pointed out that some surgeons have given up
on prosthetic aortic heart valves and have begun to use
allografts, which are human valve transplants, or xenografts,
which are transplants from the hearts of animals. These
valves have certain built-in advantages according to Dr.
Clark. Their hydraulics are superior to those of any man­
made devices, and they do not cause clotting, a problem
commonly associated with man-made valves. But, they are
not, in Dr. Clark’s opinion, a panacea because they tend to
shrink when put into the human heart. This condition even­
tually can cause such valves to leak. He believes it is too early
to predict the ultimate role of these transplants.

“In the meantime,” Dr. Clark added, “I think there will
always be a place for the prosthetic heart valve which you
can take off the shelf and put in a human being. That’s why
we have continued to work on the development of such a
man-made device at Washington University.”

Aortic valve replacement operations, while by no means
as commonplace as appendectomies, sometimes become
necessary because the human heart valves break down for
a variety of reasons. Nature is not incompetent. The natural
valve is, in fact, “a gorgeous piece of engineering,” accord­
ing to Dr. W. Milton Swanson, professor of mechanical engineer­
ing and one of the key members of the University’s investi­
gative team. But congenital defects, weakness induced by
rheumatic fever, narrowing of the valve, with a consequent
sticking of the leaflets stiffened by scar tissue, and bacterial
infection potent enough to eat a hole in the valve are some
of the reasons why the heart surgeon must, on occasion,
excise the faulty aortic heart valve.

It is not a decision made lightly because, as Dr. Clark
was careful to explain, “Aortic valve replacement still carries
with it probably an average initial mortality rate of between
10 and 15 per cent.” Without open-heart surgery, however,
about half of those patients suffering from a very narrowed
aortic valve have a life expectancy of somewhere between
six and eighteen months.

During the intervening years since Dr. Clark developed
his original mitral valve, which he, incidentally, eventually
scraped because it lacked the necessary strength to meet
his standards, he continued to ponder the problem inherent
in making improved heart valves. Finally, in 1970, he de­
cided that the time had come to try again to make a leaflet
heart valve because of the tremendous development of new
 technological knowledge and the expertise available at
Washington University.

“All kinds of engineers and researchers from a variety of
Medical School departments, including pathology, radiology,
and histology, have contributed to our team effort,” he ex­
plained. “We have learned to speak each other’s language,
with the result that I think we have an excellent cooperative
biomedical engineering program.”

Basically, what this team has done for the past two and
one-half years is to concentrate on the anatomy and the en­
gineering aspects of the human aortic valve in order to un­
derstand its mechanics. To gain such insight, the researchers
found it helpful, in some cases, to make comparative studies
of artificial valves to obtain a truly comprehensive under­
standing of the working structure of the natural device.

Dr. Swanson’s studies are a case in point. One of his
major responsibilities was to determine what engineers call
the hydrodynamics of both the human and the artificial
valves. Initially, his task was to study the interaction of the
fluid flow and the fluctuations in pressure exerted on the
valve as it responds to contractions of the heart. He noted
that in the natural aortic heart valve, the three leaflets be­
have rather like pockets attached to bulges in the aortic
wall, called the sinuses of Valsalva. When the valve opens,
the leaflets fold back, allowing the blood to flow swiftly
through this enclosure and out the aorta at about one-and-a­
half miles an hour, into the body.

A s t h i s a c t i o n takes place, a swirling flow is set up in
the sinus cavities, which helps trigger the rapid closure
of the valve. Once the valve is closed, it effectively prevents
any blood leakage into the pumping chamber below. In a
healthy human valve, therefore, there is no back flow and no
consequent loss of efficiency. Dr. Swanson contrasted the
human valve’s remarkable capability with that of artificial
valves, all of which offer resistance to blood flow when they
are open, with a consequent increase in turbulence. Such
turbulence can often be a problem because it causes damage
to the blood cells and a pressure drop around the occluding

The Starr-Edwards
cloth-covered, caged-ball
aortic valve prosthesis.
The ball is made of
hollow metal.
device itself. This difficulty, coupled with the man-made valves' tendency to leak because they do not close as rapidly as their human counterparts, makes it necessary for the heart to work harder and less efficiently. It can ill afford to waste its energy on such extraneous tasks because it must supply the force to drive the blood throughout the body. The heart's power is awesome. It performs enough work every hour to lift a small car a foot off the ground.

To determine the back flow and power loss characteristics precisely, Dr. Swanson utilized equipment originally built ten years ago by Robert Arnzen, one of his students at the time. Arnzen described his work in a prizewinning paper, and eventually went on to earn the doctor of science degree. He devised a circulation simulator, which Dr. Swanson has modified and improved over the decade. This simulator is able, with the proper hardware, to measure pressures, pressure drops, and flow rates. The pressure and the flow rate can, in turn, be used to determine the actual power of the heart. With other electronic equipment, this figure can then be calculated for the cardiac cycle in order to evaluate the performance of the heart valve.

Dr. Swanson himself has perfected sophisticated equipment for measuring the flow turbulence quantitatively. He uses a technique called streaming birefringence. Dye put into a fluid as it flows across the valve causes a polarization of light placed directly behind it. This procedure produces striations of color corresponding to the stress on the fluid. One can calculate the velocity from this stress information. High speed movies taken of this operation reveal the exact flow patterns in the region.

Noorallah Gillani, one of Dr. Swanson's assistants, is attempting to analyze this flow in the aorta with a computer. So far, however, the computer has choked on the program fed into it, and quit working. Eventually this problem will be solved.

During the course of the investigation, Dr. Swanson also realized that it would be necessary to figure out the overall geometry of the human aortic valve because it explains, in part, the device's remarkable durability. He and his student assistants obtained vital and precise information by producing silicone rubber molds of the human heart valve and the sinus of Valsalva region made at various pressures. By measuring the molds, they were able to determine that, contrary to traditional belief, the shape of the leaflets of the valve when closed is rather simple. The leaflet surface is pushed into a near-cylindrical shape by the high pressure loading in the aorta when the heart muscle relaxes and blood flow ceases during the regular cyclic intervals. The semi-cylindrical surface is curved in only one direction instead of two.

This efficient design markedly reduces the amount of bending stress in the leaflets as they open and close, with a waving, flapping motion. Once the precise geometry of the valve when closed was determined, it could be analyzed to provide guidance in producing a synthetic valve of comparable shape and strength. Dr. Swanson's contributions to the prosthetic valve design were supplemented by advice from another mechanical engineer, Professor Salvatore P. Sutera, chairman of the department, who provided guidance on many phases of the team project.

Professor Phillip L. Gould, a structural engineer who is a specialist on "shell theory," has provided key information about stress in the leaflets of the valve. The geometrical form of the valve is similar to that of curved, thin-shelled structures which form the roofs of many buildings. Dr. Gould knew that a computer program for analyzing such complex concrete shapes had been developed by two Laval University researchers, Gouri Dhath and Arup Chattopadhyay. This program, adapted to Washington University's particular needs, utilizes what is called the finite element method to analyze such smooth surfaces, which have no known geo-
Two views of the free edge of a human aortic valve leaflet in relaxed (left) and stressed (right) states as seen through the scanning electron microscope (SEM). Left, note pleating of relaxed surface and resemblance to airplane wing. Mag. 57 X. In right photograph, observe that the pleated surface disappears when the valve is fixed in a stressed state. Mag. 102 X. It is believed that Dr. Richard E. Clark and Edward H. Finke are the first researchers to have perfected techniques for viewing the human aortic valve under stress through the SEM which gives scientists a different way of looking at the invisible world.

metrical equations. In the course of the analysis, it is necessary to relate mathematically points on the surface to a frame of reference or coordinate system. To accomplish this objective, Dr. Gould, assisted by a Turkish graduate student, Altay Cataloglu, sought the assistance of Professor H. M. Karara of the University of Illinois civil engineering department at Urbana.

Dr. Karara is a specialist in photogrammetry, the technique that was used to prepare lunar maps for the space program. He applied this same basic method to the infinitely smaller surface of the leaflet of the aortic valve. In photogrammetric measurement, two photographs of aortic valve molds made from human aortic valves were measured in a stereo-plotting instrument. The effect is similar to that of the old-time stereoscope. Dr. Karara himself explained: “When the two photographs are taken from different angles, the eye sees the pictures as three-dimensional.” The leaflets are measured with high precision through this process, and ultimately the computer is able to relate the points on the surface of the molds to individual numbers on the background grid of the camera and then produce topographical maps of the leaflet’s surface.

After the points have been located by Dr. Karara, the Washington University team connects them to form small triangular sections of the shell, which are ultimately assembled using the finite element computer program. The results of this analysis provide the required information about the magnitude and distribution of the stresses throughout the leaflets.

Another member of the University’s heart valve team, Edward H. Finke, research assistant in the pathology department, took several hundred pictures of the human aortic valve with the scanning electron microscope, an instrument which also enables the viewer to see with three-dimensional vision. He and Dr. Clark examined these photographs carefully. In this initial stage of the study, the valve, of course, was in a relaxed state, the shape it has naturally when not responding to pressure from the pumping heart. Under these conditions, the elastic fibers shrink and pull down the surface cells so that they appear, through the SEM, to be compressed against each other in a rippled design much as the folds of an accordion are squeezed together when the instrument is closed. The viewer thus gets a false impression of a perpendicular fiber arrangement, contrary to the information derived from the stress-strain analyses done previously by Dr. Clark.

Confronted with this anomaly, Dr. Clark and Finke decided to fix the valve in a stressed state exactly as it is in the body when the leaflets are closed and subjected to intense pressure. The techniques required to do this are tricky and had to be improvised, because it is believed that these experiments marked the first time researchers have ever looked through the SEM at the human heart valve under stress. William Petty, Dr. Clark’s surgical assistant, provided assistance on this project. The results were worth all the effort. The cells on the aortic side of the valve where the pressure is most intense were thicker and supported by bundles of round, sturdy fibers. On the ventricular side of the valve where the pressure is much less, nature had not provided for any such supportive arrangement.

The overall effect on the aortic side of the valve tissue was that of a sheet of tissue paper (the cellular layer) resting on skeins of rope (the fibers). With the aid of a light microscope and special stains, Dr. Clark and Finke were able to determine that these supportive bundles were collagen fibers, some of them about ten microns in diameter (roughly a millionth of an inch). They could easily be distinguished from the elastic fibers whose bundles were arranged in flattened layers. These findings confirmed the information assembled by the engineering studies. The remarkable arrangement of the fibers contributes to the valve’s durability.
and explains why the leaflets are able to open and close so smoothly.

One of Dr. Clark's most exacting responsibilities has been to assimilate the voluminous information and statistical data compiled by team members into a comprehensive and precisely accurate blueprint for FRL. He gave this profile, which outlined the dimensions and geometry as a function of pres­

lul a r reactions by varying the surface character of the syn­

Dr. Lyman, also assistant professor of surgery, confirmed

Artificial Heart Valves

measure, the in-plane stresses, the porosity, and the shape of the

t rea t ed by a n e w method dev i ded by another Salt Lake City

A

L

THOUGH NO final decision has been made, it is possible

that the fabric will be treated with a special solution to help prevent clotting and retard bacterial infection. This preparation was formulated by Dr. Clark and Dr. Harry W. Margraf, research assistant professor in the Medical School and a member of the Surgical Research Laboratories there. It is being tested with encouraging results on dogs at the University's Medical School and on calves at the University of Virginia by Dr. Stanton P. Nolan.

Dr. Clark is also attempting to determine if alteration of the mechanical surface geometry of the fabric's texture can produce differences in the amount and type of tissue which the body lays down on the synthetic valve when the device is implanted in living creatures. Tests in rats and dogs support his theory that one can create markedly different cellular reactions by varying the surface character of the synthetic material.

The fabric itself must be attached to a stent, or framework. This structure, which supports the fabric much as tent poles hold up a canvas, will be made of polypropylene treated by a new method devised by another Salt Lake City researcher, Dr. William O. Statton, research professor of materials science and engineering at the University of Utah. His innovation, developed within the past two years, markedly improves the bending durability of the plastic. Dr. Clark located this expert with the assistance of Dr. John L. Kardos, associate professor of chemical engineering and director of the Materials Research Laboratory at the University. Re-

searchers at this laboratory have performed many mechanical studies on the human heart valve, and Dr. Kardos himself serves as a consultant on the team. An authority on composite materials, he joined the project when it became apparent that additional mechanical property analyses of the valves were needed.

Dr. Clark has used a special fatigue tester, modified to his own specifications, to test the durability of a variety of valves on the market. He will employ this instrument, which runs approximately thirty times faster than the heart (thirty-four times per second), to test the team's new prosthetic device under both normal and abnormal pressures. Ron Hagen, research assistant at the Biomedical Computer Laboratory, has hooked this tester up to some complex instruments, including an electronic digital controller which operates a movie camera modified to take high-speed time-lapse pictures.

With this hardware, Dr. Clark will be able to photograph automatically the new prosthetic valve at hourly intervals, with each succeeding picture showing the valve advanced one twenty-fourth of a full valve cycle. Thus, he can com­

press twenty-four hours of testing into a one-second cycle and thirty years into one year. By playing back these movies, Dr. Clark will be able to see precisely when and where the team's valve breaks down under high pressure loads and to predict the mechanical fatigue life of the valve. By keeping careful records of when these breakdowns occur, and at what pressures, he will be able mathematically to compute an overall average for the life span of the new prosthetic valve. Then he intends to run the fatigue tester at the heart's normal pace under pressure conditions identical to those on the valve in a healthy human being to see if the valve's performance under these conditions matches his mathematical calculations.

D

ESPITE THE MANY important contributions which Dr. Clark has made to the scientific information amassed by the University's team, he continues to insist that the really significant research has been done by others. "My role," he reiterated, "is basically that of planner, coordinator, and writer of the many reports we are required to compile."

A confident, articulate man with a decisive bearing, Dr. Clark speaks candidly and to the point. When asked the obvious and crucial question, "Will this new prosthetic aortic valve perform the way all those who helped develop it hope and expect?" he responded quickly, "If anybody has a chance of coming up with a trileaflet valve which will perform consider­

ably better than those artificial models currently available, we do."
William Gass

By DOROTHEA WOLFGRAM

William Gass is one of a half-dozen prominent contemporary writers who teach at Washington University and, at the same time, pursue writing careers. His philosophy classes draw hundreds of enthusiastic students and his writing continues to win wide critical acclaim. But like many dedicated artists, William Gass finds it as difficult as rewarding to divide his time between serious teaching and serious writing.

Some ten years ago, William Gass wrote to poet Mona Van Duyn: "I have no proofs of books because I have no books; there are no translations for there are no translators; I have no letters from writers about my work because writers do not write me; I have no letters from editors, either, except those that say no; I have made no tapes, attended no workshops, conferences, or symposia, and I have made only one public appearance; all I possess are dull and repetitious sheaves of typed or pen and penciled papers representing my staggery attempt to cross a paragraph..."

Gass, then forty, was assistant professor of philosophy at Purdue University. In the late 1940's, his stories began to appear in journals and anthologies. Their appearance was usually preceded by numerous rejections and almost always followed by serious recognition. Three had been included in Martha Foley's anthologies of the best short stories of the year and one had won a Longview Foundation award for fiction. On the basis of this material, Van Duyn had written Gass, asking that he participate in the Washington University Rare Book Department's pilot program to establish a modern literature collection. Library consultants had selected writers whose time and fame, they felt, had not yet come.

In his reply Gass opened: "It is certainly a splendid idea—put peaches in thy mouth, money in thy purse, peace in thy soul, honey in thy horn, and papers in thy vault—but its success depends on your guessing right at least some of the time. It will scarcely distinguish you to have the largest—and only—collection of Solly Wallow in the country. So I must tell you that there is at least one lame horse on your list."

He demurred from accepting; Van Duyn pursued him by post; manuscripts arrived. Among these were a number of different drafts of the novel Omensetter's Luck, which Gass had been working on for several years.

In 1966, Omensetter's Luck was published to tremendous critical acclaim. Publication, two years later, of a collection
of shorter fiction, *In the Heart of the Heart of the Country*, solidly established Gass's reputation as a writer.

Although the decade has driven Gass's stock to a bullish market, now, nearing fifty, professor of philosophy at Washington University, and a writer of impeccable reputation, Gass holds lightly to the aura of success. Reminded of that letter one recent afternoon he said, "Well, I don't have trouble finding a publisher, but I haven't gained much in audience."

That slight, deflating comment is a mark of this supremely self-conscious man of vast talent and gentle wit. Writing does not come easily to William Gass; a student of philosophy and a lover of language, he weaves words with painstaking care, taking months, even years, to write a short story and years to complete a novel to his satisfaction. Yet the words he weaves with such intense concentration that a day's interruption can cost him months, form a whole cloth brilliant with image, intricate in design, engulfing in depth.

In his latest novel, *Willie Masters' Lonesome Wife*, he writes: "I'm only a string of noises, after all—nothing more really—an arrangement, a column of air moving up and down, a queer growth like a gall on a tree, a mimic of movement and silent readers, maybe, a brief beating of wings and cooing of a peaceful kind, an empty swing still warm from young bloomers.... Imagine the imagination imagining...."

Critics of his fiction have attempted to define his finely honed, always experimental style, comparing him to Joyce and Faulkner, yet unable to isolate, and, still more difficult, to name those mystical elements which make his work beautiful. And there is no doubt that students of literature for many generations will continue that pursuit. If Gass himself were asked to analyze his genius, he would take exception to the application of that term to himself, insisting that if his writing is good—a point he is sure of only a small fraction of the time he spends writing, but then he is sure—it is because he makes himself an artist. He recently told a reporter, "I have to replace my lack of genius with patience, work, and a carefully cultivated taste. I've no choice."

There is no doubt that the labor of love and torment, which refines and revises and produces the whole, shows in his work. Critic Roger Shadduck says both Gass and Joyce and Faulkner, yet unable to isolate, and, still more difficult, to name those mystical elements which make his work beautiful. And there is no doubt that students of literature for many generations will continue that pursuit. If Gass himself were asked to analyze his genius, he would take exception to the application of that term to himself, insisting that if his writing is good—a point he is sure of only a small fraction of the time he spends writing, but then he is sure—it is because he makes himself an artist. He recently told a reporter, "I have to replace my lack of genius with patience, work, and a carefully cultivated taste. I've no choice."

In 1966, Gass himself confided, "I write, like so many others, because I have to, but my interest is in the language itself: the music it makes, the patterns it forms, the concepts it can be made to carry." And he admonished students at a Graham Chapel lecture this fall "to use language like a lover."

There is a marvelous paradox in William Gass, for he seems to hold no illusions and every illusion. In an essay in *Fiction and Figures of Life*, he writes: "The damper of content, the constant one-der-another of sound, the shapes of words, the terrible specter of spelling, are each due to the fact that meanings are heavenly bodies which, to our senses, must somehow announce themselves. A word is a concept made flesh, if you like—the eternal presented as noise...."

Remarkably on the final sentence as he sat in the white-washed barrenness of a basement office in Busch Hall, where the clutter of framed illustrations atop a filing cabinet give evidence of a previous tenant more scrupulous of comfort, Gass said, "I do that a lot, or try to—pin the abstract to the concrete; it is the way my mind works. I think in a very fundamental manner, in pictures, images, diagrams. My train of thought will run 'flesh' and 'noise' first, then I have to extrapolate the abstraction. It's not very valuable in anything but a literary way."

Like a standup comedian, Gass is a master of the final throwaway line. It saves him from ever being considered pompous or even stuffy, for his mind seems to refuse to hear and accept his pronouncements without exposing feet of clay. He is assured and critical in self-assessment.

"I think of myself first as a writer. I teach philosophy, which I like to do, but I teach in order to live. I regard philosophy as extremely difficult and a great and noble enterprise for which I have no fundamental ability. I love to talk about philosophy: I love to teach it; I love to dabble around in it; but it is vanity, sheer vanity to suppose that I could do any of it at all."

Many disagree. Literary critic Alfred Kazin wrote, "Gass is a philosopher who literally reconstructs the world in every sentence."

"Bill has a considerable reputation as a philosopher," says Professor Robert Barrett, chairman of the Philosophy Department. "Ours is an unusual field in which one's reputation can be built on one article. Bill did an article on ethics, printed in *The Philosophical Review* in 1957, which is highly regarded and has been variously reprinted. It may be unconscious, but his choice of teaching is not unrelated to his writing, in which he works out his philosophical ideas."

It is also not infrequent that Gass is referred to as a philosopher-writer, although he contends that in criticism, as well as in fiction, he is applying philosophical ideas, not developing them. The contradiction may lie, at least in part, in Gass's deep veneration for philosophy and philosophers, which shines through several of his essays, particularly his recollection of Ludwig Wittgenstein and his tribute to Paul Valery, and in his demanding differentiations between the philosopher and the writer of fiction.

In *Fiction and Figures of Life*, he writes, "The concepts of the philosopher speak, the words of the novelist are mute;
the philosopher invites us to pass through his words to his subject: man, God, nature, moral law; while the novelist, if he is any good, will keep us kindly imprisoned in his language—there is literally nothing beyond.” Philosophy, he says, is most concerned to talk about what the world of our experience is fundamentally. In that sense, philosophy speaks much more to what most people think of as their ordinary daily lives.

LIKE MANY other artists of our time—novelists, poets, painters, sculptors—William Gass finds university teaching a way of life that makes it possible to pursue a creative talent that is, at best, meager in financial reward. In the United States, the audience for serious fiction is small, which prompts Gass to remark, “So, if you lose your audience, you haven’t lost much.” Washington University writer-teachers, whose names and work make up a portion of the considerable roster of the New York Review of Books, Book Week, The Nation, Atlantic, New York Times, and a legion of small, quarterly magazines, include Gass, Howard Nemerov, Stanley Elkin, Donald Finkel, and Mona Van Duyn.

Although some writers, most vocally Ernest Hemingway, fear a sort of cloisterphobic atrophy of “experience” within academic halls, many of today’s creative talents thrive on the teaching-learning exchange. Such a one is William Gass, whose enthusiasm for the teaching of philosophy communicates itself to the hundreds of students who fill his introductory and advanced classes to capacity and sometimes beyond.

“It is awesome to be in the presence of a mind like his,” said one. “Even when you are sharing the experience with seventy other students, it is a personal one.”

Gass’s classes are large—as one measures classes in philosophy. He teaches an extremely popular introductory course in the philosophy of literature, courses in aesthetics and ethics, Greek philosophy, and seminars on various specific topics. One semester, an introductory class was moved to Graham Chapel, where Gass had to lecture from the stage. Most semesters he hopscotches around campus to a half dozen of the University’s large tiered-seat lecture rooms. Only his seminars are small, with fifteen to twenty students.

At Purdue, Gass twice received awards from students as an outstanding teacher. Washington University students share that enthusiasm. Reports by students, published in course evaluation booklets, exhaust the superlatives—fantastic, insightful, humorous, informative—even noting that although the class was large, it was worthwhile.

A slight, soft-featured man, whose hair is streaked with grey, Professor Gass strides the stageboards in the front of the classroom. He fills the blackboard with diagrams, he paces and gestures, he enacts vignettes of analogies, frequently dealing with children. His lectures are filled with “let us suppose . . . ” In a lecture on political poetry he says, “Let us suppose that Allen Ginsberg, having had a change of heart, has written a long poem in Sanskrit in praise of heterosexual love and Adolph Hitler. That is a political act.” Nietzschean disdain of failure is described as Vince Lombardian; Nietzsche’s concept of “joy” is translated as analogous to “that Lifebuoy thing where you rise above everyone.”

“Professor Gass is an entertaining lecturer, but always to the point,” said a young man completing his third Gass course. Gass comments, “That’s the fictional mind at work.”

In the three years since he came to Washington Univer-
sity, Professor Gass has taught a heavy load for three semesters in order to take a fourth off to write. He had hoped to complete a novel entitled "The Tunnel" during his first off-semester a year ago, but he says, "Unfortunately for my work, fortunately for me, I had twins."

"In order to sustain my output while I teach, I turn to the essay. It's short and can be held together by the intellect; fiction needs to be held together by the emotions. I need dreadful concentration—months and months without distractions—when I am working to establish a primary text."

He works most often in his large old home a few blocks north of the University, realizing, he notes, "that abstractly home is the worst place to work. Even when everyone is trying to keep out of your way, a crash or a scream brings you right back into that world. But I've got to be able to stomp around, shout at the top of my voice some sentence or other, go to my library for a book, have another cup of coffee, beat on the typewriter."

AFTER SPENDING eight years on his first novel, including completely restructuring after the manuscript was stolen and then rewriting his rewrite, he wrote wistfully, "I certainly hope my next book doesn't take as long." By now, he accepts the fact that it will, or, at least, it might.

"I work very slowly and I revise constantly and compulsively. I am an extremely self-conscious writer, perhaps disastrously so. In no way do I say that this is necessarily a good thing; it is just my temperament. Many writers I admire were self-conscious—Paul Valery, Henry James; others were not. Faulkner, for instance, was totally uninterested in being an analyst of his work. But I think, as Valery himself thought, that work must appear to be organic. That, of course, is the most contrived of all. When you work as slowly as I do, years pass—two, three, six—you are looking at the work of another life. You have an opportunity to see what is in it, but you change, and you cannot allow the changes to disrupt the work, so I am constantly bringing the work up to date. That's how the novel gets as long as it does. It's the first paragraph rewritten to 300 pages."

BILL GASS is jealous of his time, yet, contradictorily, he gives freely of it. On days when he is teaching, he is constantly available to students; he will lecture this spring to architecture students, faculty, and alumni; last year he taught two alumni courses and a seminar; and, although he hates to do it, he seldom refuses to advise a student who asks for criticism of his writing. Although he is a man driven to that lonely, demanding, "staggery attempt to cross a paragraph," he believes that it is important for writers to have a good life sense, to make the right decisions about how to live life day by day. "Good writers," he told a reporter recently, "have that sense as a part of their talent—they don't do anything that is not 'feeding in' somehow."

"If you are going to spend part of your life doing something so you can afford to do something else, it's a great mistake to make what you are doing to live a throwaway. That's why I like teaching—even when it does take time away from writing, it's not some junky thing." Then that irreverent Gassian genie must have said: "Tell the rest." Gass continued, "Once you're a teacher you have a captive audience of a certain size, whereas you can write your whole life and not have any audience at all."
Probing The Nucleus

By ROGER SIGNOR

Washington University is one of a few academic institutions with a well-developed radiochemistry program. Faculty and students in the program focus on nuclear chemistry and are making significant contributions toward the goal of a more complete picture of the atomic nucleus. Their work requires creativity in employing both old laws of physics and new instrumentation. Nuclear chemistry also requires dedication: experiments often demand round-the-clock measurements. This article outlines a few of the imaginative ways in which the University's rebuilt cyclotron and new detection devices are being used for a better understanding of the basic nature of matter.

In the December 4, 1903, St. Louis Post-Dispatch an anonymous writer reported that one-quarter of the world's supply of radium would be displayed at the 1904 St. Louis World's Fair. The writer called the radioactivity of radium "the most wonderful and most mysterious force in the world," and speculated that the energy in radioactive elements might someday lead to the invention of a doomsday explosive. The World's Fair exhibit, however, probably marked the zenith of interest in radioactivity on the part of most St. Louisans of that era.

With the development of nuclear power in World War II, it would seem that public knowledge of radioactivity has advanced considerably since 1904. Certainly, applications of this "most wonderful and mysterious force" are widely known; but in seventy years, the most basic questions about the nature of radioactivity still haven't been answered. With that truth in mind, Washington University's Department of Chemistry has become one of a few academic departments in the nation to have a well-developed radiochemistry program which focuses on nuclear chemistry.

Traditionally, radiochemistry is the study of chemical interactions employing radioactivity as a tool. Nuclear chemistry, on the other hand, is the study of the nucleus, using special chemical techniques as research tools whenever possible. Although radiochemistry at Washington University includes highly specialized studies to gain a more complete picture of the atomic nucleus, the three chemistry professors in radiochemistry involve many graduate students in their experiments. The professors teach radiochemistry and nuclear chemistry in freshman and advanced undergraduate lecture and laboratory courses. They also supervise independent undergraduate research projects.

Dr. Arthur C. Wahl, the group's senior professor, took time out from writing a research proposal one weekend this winter to talk about nuclear chemistry and how he entered the field. He recalled that in his high school days in Des Moines, Iowa, he studied classic descriptions of the atom. It was fascinating to visualize the fundamental unit of nature, the atom, as having a deceptively simple structure: negatively charged electrons travelling at great velocities and in huge orbits around a relatively minute nucleus. Most chemists study the interactions of electrons: the ways in which the outer orbits of electrons in atoms interact to form chemical compounds.

Most intriguing to Dr. Wahl when he was in high school were tables of radioactive elements at the back of his high school text. This was information about the emission and absorption of various particles by the nucleus, events which determined the energy and structure of the nucleus. The emissions of the nucleus, or radioactivity, that lead to the decay of the nucleus are: alpha rays, which are helium nuclei; beta rays, which are free electrons; and gamma rays, which are made up of the basic particles of light. To satisfy his curiosity about the nucleus, Wahl bought his high school physics book at the end of one semester so that he could study it during the summer.

When he entered Iowa State College, he wasn't sure whether he'd major in physics or chemistry. For two years, he literally lived in the physics building, where he was janitor and was given a room in return for his work. Despite his economic ties with the physics department, he ended up majoring in chemistry. His first independent research project came in 1937 during his junior year at an agricultural research station in Iowa. He analyzed hams and bacon for sodium chloride content. "It certainly wasn't a glamorous job," Professor Wahl continued with a smile, "but it was a way to earn some money and I had the chance to experiment with a variety of chemical separation techniques and find out what worked best."

After graduation from Iowa State in 1939, the University of California at Berkeley accepted him for doctoral work in nuclear chemistry. He assisted Glenn T. Seaborg (who later became the first chairman of the Atomic Energy Commission) as an instructor in a freshman laboratory course. Seaborg's informal, after-class discussions led to Wahl's specific doctoral project. This was one of the most unusual Ph.D. theses in recent history: it included first, the creation and discovery of the radioactive isotope, plutonium-238, and, later, the fis-
Elizabeth Vine, one of Dr. Wahl's doctoral students, adjusts electronic equipment used in making very rapid chemical separations during a fission experiment.

Professor Demetrios Sarantites makes calculations with a computer-based analyzer. Some of his experiments involve nuclear phenomena which exist for one-million of one-millionth of a second.

sionable isotope, plutonium-239. The latter and uranium-235 were used in making the first atomic bombs in the government's World War II Manhattan Project. (Fission is the splitting of the nucleus either spontaneously in nature or by induction in a cyclotron.)

"The forces between electrons and between electrons and the nucleus," Dr. Wahl continued, "have been described in significant detail. But when you ask about the nucleus, it's another story. There is no one theory that explains the structure and behavior of the nucleus—just parts of the picture are known."

In addition to the forces that exist between orbiting electrons and the nucleus, there are the extremely strong nuclear forces. The latter are so strong that when certain nuclear particles are brought together, part of their mass is converted into energy. In the sun, for example, helium is constantly produced by the fusion of four protons; the result is the helium nucleus of two protons and two neutrons. By this tremendously energetic conversion of two protons to two neutrons about .5 to 1 per cent of the mass of the original four particles is converted to energy. "Because of this simple fact, we get energy from the stars," Dr. Wahl pointed out.

While each element has a fixed number of positively charged protons, it has species of atoms called isotopes. The word is derived from the Greek, isos, meaning equal and topos, meaning place. While the term isotope should be used in discussing the various nuclear species of a specific element, the word nuclide is used as a general term for all nuclear species. Although isotopes behave the same chemically, they have varying numbers of neutrons. Neutrons have no electric charge but add to the atom's mass. They also interact with protons to hold the nucleus together; the
positively charged protons would otherwise repel one another and the nucleus would fly apart. The heavier an element, the more neutrons it needs to hold the nucleus together. Uranium is called element 92 because it has ninety-two protons. The isotope of uranium, uranium-235, has 143 neutrons, so its mass number is 235 (the number of protons plus neutrons). Isotopes of elements heavier than bismuth (eighty-three protons) are unstable and undergo radioactive decay into other elements until a stable nuclide is reached.

The immensely diverse nuclear products of fission are the objects of Dr. Wahl's research. When uranium-235 undergoes fission, the uranium nucleus rarely splits exactly in half. It will form two nuclei, or nuclides—each with its own specific number of protons and neutrons. In one of Dr. Wahl's experiments, there may be an estimated ten billion fissions, or splits into pairs of nuclides. It is necessary to have at least this large a number of fissions in order to measure the fractions, or yields, of a given nuclide that results from fission. Theoretically, there are from 800 to 1000 different nuclides formed in fission. Experiments by many scientists have identified from 300 to 400 nuclides, but yields for only about seventy-five nuclides have been measured.

Dr. Wahl and his students have measured many of these yields. In their experiments, they deal with nuclides which have half-lives ranging from a few minutes to a few seconds. The rate of radioactive decay of a given nuclide can be expressed by its half-life, which is the time required for half of the nuclides to decay. Uranium-235, for example, has a half-life of 700,000,000 years. When uranium-235 undergoes fission, some of the nuclides produced have half-lives as short as one-tenth of a second. These nuclides (along with hundreds of others) are produced by using neutrons to fission small amounts of uranium-235 in the University's cyclotron.

To give a specific example of one of Dr. Wahl's experiments, technetium-105 is made both directly in the fission of uranium-235 and indirectly through the radioactive decay of another nuclide made in fission, molybdenum-105. Just what fraction of technetium-105 is produced directly by fission and what part is made through beta decay (the emission of an electron) of molybdenum-105 isn't known. Instantaneous measurement of the technetium direct yield is impossible. But it is possible to measure the total yield (the direct plus the indirect yields) of technetium-105 at various times following the fission of uranium-235. Use of known equations then permit calculations of the direct yield of technetium-105 at the time of fission.

Dr. Wahl, his colleagues and students do their research purely to understand more about the nucleus. Their research is supported by the Atomic Energy Commission. Although the major part of the research simply contributes to a better understanding of the nucleus, some of the data have practical relevance. For example, the fission-product yields measured and estimated by Dr. Wahl and his students (and many other scientists) are considered in the design of nuclear power reactors. Reactors, of course, use the uranium fission process to generate energy on a large scale and to produce electricity. The point is that any information Dr. Wahl and his students gain about fission that might be applicable to reactor design is strictly a by-product of their studies.

Dr. Wahl's faculty associates in the radiochemistry group are Dr. Demetrios Sarantites, associate professor of chemistry, and Dr. Edward Macias, assistant professor of chemistry. Their research involves different aspects of nuclear behavior; they use quite different techniques to study other aspects of nuclear structure.

The main research tool they have in common with Dr. Wahl is the University's cyclotron. "While the cyclotron has the main magnet of the one built in 1940, a few years ago it was completely modernized," Dr. Macias pointed out. The new machine can accelerate many different particles at various energies, which was beyond the old cyclotron's capabilities. "The beauty of the machine is that you can change energy easily in the course of an experiment. Last night, for example, we were able to reset the machine and change energies in fifteen minutes." It had been a busy night for Macias and his students. They had been doing an experiment at the cyclotron from 2 p.m. to midnight.

Macias has built a detection system which he uses in conjunction with the cyclotron to measure properties of very short-lived tin isotopes. In recent months, he and his students have pro-
duced two heretofore undetected (but predicted) isotopes, tin-106 and tin-107. Macias pointed out that tin, because of its nuclear structure, is the record-holder among elements for its number of stable isotopes, which is ten; but, curiously, it also has sixteen known unstable isotopes, whose half-lives are too short for them to exist in nature. Macias and his students have determined that the half-life of tin-107 is one minute; tin-106 appears to have a half-life of ten seconds, according to preliminary measurements. They are also measuring the radiation energies of these and other isotopes and at what angles the radiation is emitted from the nucleus. How can they measure an isotope with a half-life of only ten seconds? By producing a continuous flow of tin-106 isotopes which do not have to be handled by the radiochemist. The answer sounds simple, but designing an experiment to do this was a complex and lengthy project.

To explain his experimental technique, it is helpful to outline the problems which confront Professor Wahl, who must do a certain amount of physical handling of chemicals in measuring the products of fission. The uranium is contained in a small amount of foil, powder, or liquid. The material is placed in a plastic cylinder, called a rabbit. The rabbit is shot through a 150-foot pneumatic tube between the radiochemistry building and the cyclotron. After the uranium sample has been irradiated at the cyclotron, the rabbit, containing the material with fission products, is shot back in five seconds to the radiochemistry building.

These isotopes are then trapped in clusters of water molecules in a chamber adjacent to the foil; the clusters are pumped out of the chamber in tubing with an inert helium-carrying gas. The tubes go through the cyclotron’s concrete wall to adjacent experimental equipment. The large clusters of water molecules are forced by the gas to hit a magnetic tape. As the clusters strike the tape, they break up and the tin isotopes adhere to the tape. Thus, a constant supply of fresh isotopes is fed on to the tape. The tape is automatically advanced in front of detectors which record data that may eventually yield an isotope’s half-life and radiation characteristics.

The basic idea for the Helium Jet Transport System, Dr. Macias said, was developed by Professor Ronald MacFarland of Texas A & M University. The transport system built at Washington University, however, is of Macias’s own design and is probably unique in its application to nuclear chemistry.

An ingenious technique and its application in science are very rarely the work of one person. Professor Sarantites

Macias has built a system that sounds like a Rube Goldberg contraption: the Helium Jet Recoil Transport System. Indeed, to describe the system in non-technical terms takes on a Goldbergen ring. The first step: the cyclotron accelerates a rare isotope of helium (two protons and one neutron) to bombard a cadmium foil. The very high energy of the helium nucleus bombarding the foil will create tin isotopes throughout the foil: two protons fuse with the forty-eight-proton nucleus of cadmium, producing a nucleus with fifty protons, which is tin. The tin isotopes are produced throughout the thickness of the thin cadmium foil and a few tin isotopes are actually knocked out of the foil through the tremendous momentum transferred during the reaction.

As many hundreds of fission products may have been made in that sample, the samples must be physically handled in order to do the complex chemical separations to extract the isotopes of interest. Obviously, it would be very difficult to work with an isotope as short lived as tin-106.

To get around the time problem, Dr. Professor Arthur C. Wahl, one of the discoverers of the element plutonium, inserts a neutron-moderating device at the cyclotron.
Probing the Nucleus

has made a novel application of another highly sophisticated technique. Dr. Sarantites, pointed out, "Most experimental work today is too complex for just one scientist to carry out. It takes at least two to three years to develop a new line of research. You simply don't read about a technique and go right into the laboratory and put it to use."

Dr. Sarantites has put to its fullest use a technique employed by various physicists. Work on the application of the technique that Sarantites has perfected was begun by Dr. Edward Hoffman, his former doctoral student, now a research fellow in nuclear medicine at the medical school. Hoffman's developmental work "saved me at least six months of research time," Sarantites said. Sarantites's application of this work involves an old law of physics, the Doppler shift.

The Doppler shift is named for a physicist, Christian Doppler, who discovered it in the nineteenth century. Most everyone has experienced one aspect of the Doppler shift while listening to the pitch of a locomotive whistle. If the locomotive is standing still, the pitch sounds normal or constant. If the locomotive is moving toward you, the whistle's pitch is higher; after the whistle goes by, its pitch drops to a lower tone. This is the Doppler shift and it applies not only to sound waves, but also to gamma rays emitted from the nucleus. By detecting the Doppler shift associated with the radiation from a nucleus in various excited energy states, Dr. Sarantites has been able to deduce the lifetimes of these states.

To give an example of the application of this technique, Dr. Sarantites described some of the properties of copper-61, which consists of twenty-nine protons and thirty-two neutrons. It is known from a commonly accepted theory that the properties of the excited states of the copper-61 nucleus are determined to a large extent by the motion of its twenty-ninth proton (the least tightly bound proton). Such properties include the energies of the excited states in the copper-61 nucleus and their half-lives. The way in which the excited states of copper-61 dissipate their energy is by emission of discrete units of light called gamma rays. The energy of the emitted gamma rays indicates the difference in energy among the excited states.

One of the forty-five known excited states of copper-61, for example, has an energy of 1,311,000 volts. It de-excites directly to the lowest state and when it does, a gamma ray of the same energy is emitted. Each excited state has a characteristic half-life for gamma ray emission. The half-life for each state may be calculated from the theory that the motion of the twenty-ninth proton determines the properties of the nucleus. To confirm this assumption, one must see experimentally whether the predicted half-lives hold true. These half-lives are predicted to be extremely short, from $10^{-14}$ to $10^{-12}$ (one-millionth of one-millionth) seconds. The 1,311,000 volt state is predicted to have a half-life of $6.1 \times 10^{-15}$ seconds.

To use the Doppler shift technique to measure such extremely short half-lives, the copper-61 nucleus has to be put into its excited states, and, at the same time, the nucleus must be given a large velocity. This can be done simply by bombarding a foil of nickel-58 with helium nuclei (two protons and two neutrons) at the cyclotron. A very short-lived nucleus, zinc-62, is formed which instantly emits a proton to form copper-61 in one of its excited states. After this reaction, the copper nucleus is moving approximately at 2000 miles per second. The above analogy to the Doppler shift is applied to Dr. Sarantites's experiment as follows. If the nucleus were moving toward the gamma ray detector at the maximum speed (the nucleus being the "train"; the detector, the "observer"; and the "sound," the gamma ray), the energy of the gamma ray would increase to its maximum value. This increase in energy is the Doppler shift. Actually, in the course of the experiment, the moving nucleus recoils into the thick nickel target and therefore it loses energy with time. Its velocity also decreases with time. If the life-time of an excited state is short, then the gamma ray will be emitted early, when the velocity of the nucleus is high. The Doppler shift in this case will be high.

On the other hand, if the half-life of the excited state is long, the gamma ray will be emitted later, when the velocity of the nucleus is lower. In this instance, the Doppler shift will be smaller. It is the detection of this reduced Doppler shift that allows Dr. Sarantites to deduce the velocity of the nucleus at the time of gamma ray emission. If he has the value of the velocity, he can use this number in known equations that will yield the half-life of the excited state. (Of the forty-five known excited states of copper-61, he has been able to measure the half-lives of thirty-two.)
In Dr. Sarantites's copper-61 experiment, the 1,311,000-volt state was found to have a half-life of $5.3 \times 10^{-13}$ seconds, which is very close to the predicted value. On the whole, the theory was satisfactory for many states, but deviations were found for several others. This suggests that refinements should be made in the theory. For example, the results suggest that, in addition to the twenty-ninth proton, the motion of at least four of copper-61's thirty-two neutrons play an important role in determining the properties of this nucleus.

The Doppler shift experimental technique—like that of Dr. Macias—is novel in the simplicity of the idea behind it; but their experiments require many hours and repetitions in work at the cyclotron to minimize experimental error. One such experiment can last between ten and twenty hours of continuous measurements. Six years ago, instrumentation was not sophisticated enough to permit these experiments.

These descriptions of how Professors Wahl, Macias, and Sarantites collect information represent only a few phases of their experiments. Dr. Sarantites, for example, also needs data about the energy of the gamma rays, the angles of emission of nuclear particles, and the energy states, as well as their half-lives.

It will take many scientists years of investigating nuclear behavior before a complete picture of the nucleus may be drawn. To these scientists, their work is far from being merely time-consuming and painstaking. It is highly creative and meaningful. As Dr. Sarantites put it, "Our goal is simply to try to understand nature."
Washington University's Steinberg Art Gallery during the month of December was the setting for an unusual and memorable exhibition of photography. On display at the Gallery was a sampling of some forty-four years of the photography of Morton D. May. Mr. May, a member of the University's Board of Trustees for many years, is widely known as an outstanding businessman and community leader, an amateur painter, and a noted art patron and collector. His collections, especially of the German expressionist painters, the primitive art of New Guinea, and pre-Columbian artifacts, are internationally known.

Until the Steinberg Gallery exhibition, however, not many people were aware of Morton May's lifelong devotion to photography. Through the years, his photographs have appeared in various publications, but until recently, they were published under his pseudonym of "Satsuki," Japanese for the month of May.

For the exhibition, more than two hundred May photographs went on display, ranging from his first serious picture, "Fisherman's Fantasy," taken when he was fifteen years old, to a group of color studies he made in Australia a few weeks before the show opened. Included in the exhibit were many of the remarkable pictures he made in 1935 in Russia, Japanese-occupied Manchuria, China, and Japan, on assignment for the March of Time; his wartime photographs from Guadalcanal, and examples of his early experiments in color printing.
Points of View

Japanese schoolroom, 1935

Soldiers of Army of Manchuko, 1935

Chinese woman, Jehol, 1935

School children, Japan, 1935
Points of View

Lioness and cub, Africa, 1972

Korokoro boatmen, Kenya, 1972

Guatemala festival, 1947

Hippopotamus, Africa, 1972
Points of View

Guatemala, 1947

U.S. Marines, Peking, China, 1935

Guadalcanal, 1943
Talks With Two Deans
Dean Edward T. Foote on The School of Law

Edward “Tad” Foote, vice chancellor and general counsel of Washington University since 1970, became dean of the School of Law in November. He had served as acting dean since shortly after Hiram H. Lesar left the deanship in March to become dean of a new law school at Southern Illinois University in Carbondale. A graduate of Yale University and Georgetown University Law Center, Dean Foote was a member of the law firm of Bryan, Cave, McPheeters and McRoberts before joining the University. In the following interview with staff writer Cheryl Jarvis, the new dean discusses the present state of law education in general and at Washington University in particular, making the point: “the law has always been important to human society, but it has never been more important than it is right now.”

Dean Constantine Michaelides on The School of Architecture

Constantine E. Michaelides became dean of the School of Architecture this fall, succeeding George Ansellevicuiss, who is now chairman of the Architecture Department of Harvard University’s Graduate School of Design. Dean Michaelides, who joined the faculty in 1960, had been associate dean of the School of Architecture since 1969. His professional experience includes work with Carl Koch and Associates of Cambridge, Mass., and Doxiadis Associates of Athens and Washington, and he was the architect associated with Smith & Entzeroth for the University’s new chemistry and engineering laboratory buildings. Talking with staff writer King McElroy, Dean Michaelides gave this view of the School’s main goal: “to see our graduates leave the school with an open mind and a broad understanding of architectural ideas, principles, and challenges, and primarily with the ability to face change and to be able to adapt to it.”
What was involved in your decision to give up a presumably lucrative law practice and go into academic law?

Without necessarily accepting your presumption about my practice, I came to the University in 1970 at the request of Chancellor Eliot to fill a new position—that of vice chancellor and general counsel. It was a time when the law was more visible on university campuses than it had been in the past, and I thought there was a need for a lawyer at the University, though not necessarily me. Someone was kind enough to think it should be me. I knew this was a fine university, and I decided it was an exciting thing to do, so I accepted the job.

In your nine-month tenure as acting dean, what influences led you to accept the position permanently?

I took the Chancellor's offer of the deanship because I had become convinced that this law school has both the potential to reach the highest plateau of excellence and the commitment to fulfill that potential. I am also convinced that this law school has a rare, and perhaps passing opportunity, to take a long stride toward that end, because of a combination of circumstances that exist now both in the law generally and at this law school in particular.

The law has always been important to human society, but it has never been more important than it

In a working paper you have written about the School of Architecture, you say that it should resist attempts to be everything to everybody. Would you elaborate on that?

I should like to look at the school as a part of a wider constellation of schools and departments of architecture in this country—about eighty-five, to be more specific. Each school has its own character and outlook which, in turn, depends very much on the faculty it has assembled, the students it can recruit and its particular institutional and geographical associations. No single school can claim to do everything that everyone else is doing. We are a small school with finite resources, I believe we would be making the best use of those resources if we channeled them in such a way that we could continue building on our strengths rather than to diffuse them by directing them to additional areas.

As a school with finite resources, what should we be pointing toward?

Perhaps I should preface my answer with a brief explanation of our curriculum. It has two major components: undergraduate studies and professional studies—each a four-year program. The first leads to an A.B. degree, the second to a Master of Architecture degree. A student may choose to overlap the two, by one or two years, or to keep them separate.
is right now. And it will continue to grow in importance. The law has never been more talked about, more visible, more a part of the public consciousness in America than it is now. This visibility is reflected in many ways, one of which is the strong interest of many young people in becoming lawyers. Our law school is the largest it has ever been in its 106-year history. We had 2000 applicants last year for 200 places. Almost every law school in the country is filled to capacity with extremely able students. Currently, there is broad interest among Americans in the institutions of the law, in lawyers, and in what lawyers do. Part of the publicity is the kind one wouldn't necessarily seek, but just the same, the attention is there.

There is also a great deal of interest in the law school at the University. The Chancellor is committed to making this the finest law school possible. There is a very good faculty here. We need money, lots of it, but the chances are good that financial resources can be found to provide the institutional underpinnings for the kind of excellence I am talking about. Right now, there is the opportunity for a real take-off. For these reasons, I accepted the deanship with tremendous enthusiasm.

Q. What specific plans do you have for making the law school take off?

A. I do not have any detailed blueprint of what this law school should be a year from now, or five years from now. I'm a little suspect of such blueprints. But basically I think this law school should continue to grow in the teaching, the study, and the researching of the law. It should be a challenging and stimulating place for the students, and it should also make an important contribution to the furtherance of legal knowledge.

What makes a great law school is a great faculty. Deans can help, but only that. We are presently in the midst of a nationwide search to expand the faculty by five senior positions. We have a good library, but there is room for improvement. We are also looking for a new librarian. In answer to your question, day by day and month by month, we want to get better. And we want to be not just a good law school, but one of that handful that are nationally recognized as being at the very top. I think it can be done.

Q. Are new faculty members being sought in specific fields of legal education?

A. No, not at this stage. What we are trying to do is to isolate a pool of outstanding scholars and teachers who are real intellectual leaders in the law. Once we isolate that pool of people, then we will try to put together a package of five senior faculty mem-

The early part of the professional curriculum may be covered at either the graduate or undergraduate level, but the advanced part of this curriculum, the last two years, must be covered by graduate studies. It is in this area where I believe we should concentrate future efforts in strengthening and enriching our program.

Specifically, what changes in the graduate curriculum do you have in mind?

A. I should like to see us study, develop, and implement three new degree programs at the master's level. One would be in architectural history, in association with the Art and Archaeology Department. An historian with an architectural background is very much sought after in the architectural academic world. I also see a future for such a person in the art/environment—criticism world of journals and magazines. Secondly, a graduate program in architectural technology and/or research methodology. This program would be addressed to students who have interests in those areas and who at this time have few opportunities to develop them within a formal architectural academic structure. Graduates of such a program would be valuable to medium-size and large architectural firms, particularly those with a research orientation. Thirdly, a graduate program in urban planning. This would be a sister program to the present Master of Architecture and Urban Design program but would differ in that it would not have any architectural requirements for admission.

These three programs, with crisscrossing courses, would offer attractive opportunities for branching off at the graduate level for both our undergraduates and for students who would transfer from other schools. They also would enrich the elective offerings of our mainstay, the Master of Architecture program, making it in itself more attractive.

Q. Who are the students entering the School of Architecture today?

A. As in the past, a good number of young high school graduates enter the school as freshmen. But in recent years we have also been receiving an annually increasing number of applications from college graduates with majors in fields other than architecture. In both instances, students who enter the school these days seem to feel much more strongly about the "social art" aspects of architecture than did their predecessors of ten or twenty years ago. But the most significant change in the composition of our student body is occurring in the increasing enrollment of young women who are planning to make architecture their career. This, I believe, relates directly to the Women's Liberation movement.

Q. What is the relationship between the school and the
Q. Is the study of law changing? If so, how?

A. Yes, it is changing. In legal education we are in an era of deep questioning of things that have gone on for a long, long time. Clinical law has been introduced at most schools, including ours. There is a new emphasis on individual kinds of study by students, as well as a new interest in interdisciplinary study. And yet, the freshman year, here and elsewhere, remains pretty much what it has been in the past.

A great deal of attention has been devoted recently to the curricula of law schools. Prestigious studies and books have challenged some of the basic principles by which the law has been taught for many years. But not all new suggestions have been embraced with wild enthusiasm. There is a suggestion, for example, which has not met widespread approval, that law school ought to be two years, instead of three. There are suggestions about the content and the balance of the courses that are offered. Many new ideas are emerging, but most law schools are still looking skeptically at the most radical proposals that have been made. That's not to say that they have rejected them, but that they need convincing.

Q. The clinical law program is new to Washington University this year. Can you tell us more about it?

A. Clinical law, simply defined, is legal study in a real setting with actual legal problems under the close supervision of a practitioner and faculty member. Students work with public defenders, prosecutors, judges, or other lawyers, then return to the law school for discussion and theoretical consideration of this practical experience.

Clinical law was instituted at the law school after two or three years of debate on the subject, which was part of a larger, national debate. And I think it's fair to say that clinical law is still a matter of controversy in legal circles. There are those who believe that it is the most important recent development in legal education, and there are those who believe that it is not the best way to teach the law. I think that it is a very exciting addition to our curriculum, but there are pitfalls. If a clinical law program becomes simply interesting experience rather than education, then it is not doing its job. But when clinical law works right, it is a balance between experience and academic theory, for example, between the nitty-gritty of what happens in the prosecutor's office and the theory of what happens or should happen in criminal law. And it is that balance that is a very exciting component of legal education. Our clinical law program, incidentally, is finding that balance in a very satisfactory way.
More and more law schools are opening their doors to women; Washington University admitted forty-three this year. What kind of future is there for women in law?

I think the future for women in law is bright. I am delighted that this law school has been able to attract so many able women students. The law is a wonderful profession for anybody, and it is certainly just as good for women as for men. There are certain presumptions and stereotypes now, but I think the future will ultimately hold no distinction between the sexes in law. Such distinctions as may exist will exist only on the basis of professional competence, which is the way it ought to be.

How do you feel about part-time students?

We have some part-time students, and in some cases it is a good way to study law. Indeed, it is the only way some people can study law. Some risk, however, is involved. An intensive jostling of ideas can occur when you study one subject in depth over a period of three years. If you spread out classes too much, the counterpoint and comparison between courses and fields has a tendency to diminish and the study of law to become too diffuse. But, there are many fine lawyers who spread out their legal education over four or five years and haven't suffered a bit.

profession in the community?

We have had in recent years a reasonable, but not a close relationship, with the profession in the St. Louis area. I suspect this has been primarily because the character of the school has changed significantly. Twenty years ago, a majority of our students came from the St. Louis area. Now that is not true, and it is natural that our graduates will be returning to their home towns. As a result, our local architects don't see many Washington University graduates in their offices applying for jobs and feel that our ties have loosened. A closer relationship between the two will be to mutual advantage and I plan to take the initiative in promoting it.

In the past, architecture students have been involved in such community projects as improving the design of Union Market. Will they continue in this kind of activity in the future?

The School of Architecture and Washington University have, of course, a commitment to the St. Louis metropolitan area community. In fact, our school is the only school of architecture in the state. Students and faculty have participated in the past in a great number of projects, such as the design of Union Market through the Urban Design program, and particularly through the Community Design Workshop. We will certainly continue to participate. In thinking of this kind of involvement, however, two important considerations come to mind: first, that the school is an educational institution rather than a service institution. This means that we can deal more effectively with projects which can be interpreted within the school's academic goals and structure. Secondly, we do not want to compete with the architectural profession. Certain projects, because of their nature and character, can be more effectively handled by the profession. Others, for different reasons, can be better resolved within the teaching and research structure of the school.

Do you feel that students get enough practical experience before they graduate?

Yes, they do, but it varies from individual to individual. I cannot think of any recent graduate who has not worked for at least a summer in an architect's office or in the construction industry. Quite a few students will decide to stay out of school for a year or two and work in an architectural apprentice capacity before they return to graduate studies. The school also offers an opportunity for graduate students to gain additional practical experience by allowing them to fulfill part of the design studio requirements by working in an architectural office for a semester.
Q. Do Washington University graduates have difficulty finding jobs?

A. The market is very tight. It's not easy for law students to get jobs. They have to hustle. But our students have been more successful than many, because Washington University has excellent students, a solid reputation, and an active and vigorous placement office. Virtually all of last year's graduates whose whereabouts we know have jobs.

Q. Are you seeing more law students interested in social consciousness issues, as, for example, those who work for Ralph Nader?

A. There certainly is an increased interest in the Ralph Nader-type approach to law and new legal solutions to human problems in the last few years. There have been studies made of this trend. One that I'm familiar with was based on a questionnaire given to all law students in the Chicago area. Not nearly so many students as you might imagine planned to go into consumer protection or a related field.

In our student body, idealism about the law is very high. Whether a student is going to spend his life practicing in a public interest law firm or the Legal Aid Society is not the only question. What is also important is the degree to which students and lawyers look on the profession as one of broad, human service rather than in a narrower way. It is that kind of heightened sensitivity to the potential of law as a vehicle for the solution of society's problems that is definitely apparent at our school, and I would guess in other law schools. It is probably too early to tell whether that sensitivity is going to translate into a high proportion of lawyers forsaking a good living for a less good living. But there are many ways, given that kind of awareness of the potential of the law, to put it to good use in one's practice.

Q. In this connection, you say in your working paper that "we are not turning out working-drawing wizards." What does that mean?

A. I suppose that the profession would like to see our graduates being 100 per cent productive the first day they report for work. They especially want the graduates to be good at producing working drawings. This is understandable, but the aims of the school are wider. We would like to see our graduates leave the school with an open mind and a broad understanding of architectural ideas, principles, and challenges, and primarily with the ability to face change and be able to adapt to it. We also do not want to imply that we are graduating fully formed professionals. Rather, we expect to see our graduates attain full professional maturity five, ten, or fifteen years after graduation.

Q. When you are considering applicants for the freshman class, what do you look for?

A. Mostly what the College of Arts and Sciences is looking for: a good academic record and an interest and curiosity about life. In addition, of course, we like to see an interest in architecture. It's adequate for us that the student is interested in architecture; we don't require any tests to verify his abilities. Actually, the first two years in the school are really an extended test period for the student to make a
You mentioned that the way students view the profession of law as one of broad, human service is important. Do you think the student view is changing in light of Watergate and its related incidents?

I think students view the profession critically and the law hopefully. Watergate has been a very sad time for the legal profession, as well as for the American people. The high proportion of lawyers involved in Watergate, either directly or indirectly, is discouraging and is a black eye for the bar. Students are aware of the problems, and I think they feel that they are going to do better as they enter the profession. I think they will, too.

What are your personal views on Watergate and the law?

There is so much to say, but I think the one abiding lesson from Watergate is how fragile the law and human society really are. Nothing in my memory has emphasized more the degree to which the law in particular depends on decency, fairness, and common honesty. You can write all the statutes in the world, you can have all the case law in the books, but if lawyers cannot trust each other, and if clients cannot trust their lawyers, if society cannot trust the law and its institutions, then the system will not work. I think we have learned from Watergate how much we depend on what is not written into law.

career choice.

The architecture school has combined degree programs with the School of Business and the School of Social Work. Is there any other combined program in the works?

We have informal relationships with the School of Engineering and the School of Law that are mutually satisfying and might develop in the future into combined programs and we are open to relationships with other schools that might prove to be satisfying to the students.

What do you consider the main strengths of the faculty?

We are all pulling together in one direction to promote learning and understanding. The full-time character of the majority of the faculty, plus the informal attitudes which prevail in Givens Hall create an atmosphere that fosters learning and exchange beyond the confines of the classroom. The special talents of the part-time faculty also contribute to the professional orientation of the school. Of added strength to the faculty has been the annual visitor program, in most instances filled by European architects whose presence provides opportunities to both students and faculty for exposure to different points of view.

How do you view yourself in all of this?

I view myself, first of all, as a member of the faculty. I happen to be the dean. I see myself as a catalyst who makes the conditions available, who provides a general orchestration of the program for the students and faculty, and then lets everyone make his own positive contribution. I see myself very much as continuing the traditions of the school, but with a renewed measure of enthusiasm. I have been here for fourteen years and I know every nook and cranny in the building, but I feel excited about the future of the school and the prospects of being able to grow with it.

Even as associate dean you have always done your share of teaching. Will you continue to teach?

I couldn't do without teaching. I will, however, have to limit my obligations to teaching. I have been teaching a graduate design course in the fall and the thesis program in the spring. I'll have to drop the thesis work, but I will continue the design course every fall. You see, just because I have been named dean, I don't want anyone to think I've reached my level of incompetence.
Since his retirement as Chancellor of Washington University in 1971, Thomas H. Eliot has been president of the Salzburg Seminar in American Studies. He writes here of the Seminar's unusual contributions to international understanding, of the 250-year-old baroque palace that houses the Seminar, and of its recent sessions in which several Washington University faculty members and alumni participated.

All summer long across the little lake the buses stop. The tourists emerge with their cameras, and the guide points over the water to a cream-white baroque palace and says: "That is Schloss Leopoldskron, built in 1736. That is where The Sound of Music was filmed. It is an American music school, part of Harvard University." His first statement is correct. His second is mostly wrong. His third is totally wrong.

Some day, we who have the present responsibility for running the Salzburg Seminar in American Studies will persuade those Austrian guides to speak more accurately. They should say something like this: "That is Schloss Leopoldskron, built by Archbishop Firmian in 1736. From 1918 to 1938, it was the home of Max Reinhardt, the great theatrical producer who founded the Salzburg Festival. Since 1947, it has been the home of the Salzburg Seminar in American Studies, which from January until September brings people from all over Europe to study with eminent American professors."

Even that announcement, of course, is far too short to be a very good description. Also, it raises a few questions: Who are these "people," what do they study, and with whom? And what is the purpose of this unique institution?

The "people" we call Fellows. They do indeed come from all over Europe (including Malta and Turkey and the socialist countries) but they all speak and read English. They are men and women ranging in age from 23 to 50, with the average about 32; graduate teaching assistants, deputy cabinet ministers, television program directors, young poets and actors, research economists, judges (last summer there were four German judges, one Yugoslav, one Pole, all under 40 and three of them women) and promising people in other callings too numerous to name. (Among fairly recent European Fellows was Franzisika Hefti Plimpton, W.U. PhD 70.)

There is a very small smattering of American Fellows, too. A Washington University history professor, Michael Weinberg, was a Fellow many years ago. We are hoping now to have five or six Americans at every session. The European Fellows are eager for this.

What is studied? There are seven sessions, each of either three or four weeks, and at each there is a different group of about fifty Fellows and five American faculty members, plus occasional guest lecturers, usually European. Each session is on a different subject.

To answer the question fully, I must lead you into a brief historical byway. The seminar was founded in 1947 by three young men at Harvard, an instructor, a graduate student, and a senior, with no official backing other than the unimpressive sponsorship of the Harvard Student Council. That summer they opened a "summer school in American Civilization" at Schloss Leopoldskron, to which came ninety Europeans from both sides of the recent war. The young men's aim was to respond to a wish expressed by young Europeans, to have intellectual contact with people their own age. The subject was chosen primarily because it was unlikely to exacerbate the old wartime hostilities on the continent.

Three years later, threatened with bankruptcy (the Seminar has no endowment), some of the American participants incorporated the Salzburg Seminar in American Studies, Inc., as a not-for-profit Massachusetts corporation. This enabled them to get enough foundation support to keep going, and in 1959 they bought the Schloss, which they had hitherto rented from Reinhardt's heirs. (In 1973, the Seminar also acquired the Meierhof, a building on the same driveway and part of Archbishop Firmian's original estate.)

From 1950 to 1965 or thereabouts, the Seminar's faculties saw as their chief function the informing of Europeans about various facets of American life. They were expository, analytical, and critical; but they were all teaching about the United States. Today, in some sessions ("American Law and Legal Institutions," for instance, or "The American Theatre") they still do so, and in virtually all sessions American experience and American examples are components of most lectures, if only because most of the lecturers are American. But more than half of the seven sessions now concern problems common to both sides of the Atlantic—e.g., "Urban Problems and Planning," "The Social Impact of Mass Communications," and "The U.S., Europe, and the Developing World." This reflects the great change in the last decade or so: today, educated Europeans are far more fully informed about the United States than they used to be.

With whom do the Fellows study? The "eminent American professors" deserve the guide's adjective, if not always the noun. The roster of those who have taught at Salzburg

Salzburg Seminar

By THOMAS H. ELIOT
Thomas H. Eliot, president of the Salzburg Seminar, was Chancellor of Washington University from 1962 to 1971.

Schloss Leopoldskron, home of the Salzburg Seminar, is a baroque palace built in 1736. Parts of the musical *The Sound of Music* were filmed on the grounds.
Warren E. Burger, Chief Justice of the United States (left) chats with Paul A. Freund, AB 28, LLD 56, at a Seminar session. The Chief Justice was a guest lecturer at a 1971 summer session, when Freund, a Washington University trustee, was a member of the Seminar faculty.

A Salzburg Seminar in session. Seven sessions are held each year, with about fifty fellows from throughout Europe and five American faculty members participating in each.

is so distinguished that it's surprising that the institution is not better known. University presidents Conant, Brewster, and Sanford; U.S. Supreme Court justices Stewart and White; writers Alvin Toffler, Marya Mannes, Robert Lowell, Saul Bellow; economist Wassily Leontief; anthropologist Margaret Mead—the list could go on and on.

But at this point, I want to mention specifically the people with Washington University or St. Louis connections who have taught at the Seminar.

The first one was Paul A. Freund, AB 28, LLD 56, a Trustee of the University, who was at Salzburg in 1953 and again in 1971, and who has long been a member of the Seminar's Board of Directors. Next, in 1962, came poet Howard Nemerov, now Professor of English. I was a Seminar faculty member in 1966 and 1970. Robert K. Mueller, BS 34, now board chairman of Arthur D. Little International, was at Salzburg in 1970; Monte Throdahl, vice president of Monsanto, in 1971; and Eli Goldston, HHD (hon.) 73, in 1969, 1971, and 1972. All three now serve on the Seminar's Board.

Stanley Goodman, board chairman of May Department Stores, taught in 1972. In the same year, the faculty of a session on "The Changing American Political Scene" included William N. Chambers, PhD 49, Edward Malinckrodt Distinguished University Professor, and Carl J. Friedrich, Litt.D. (hon.) 68. Among the members of last year's faculties were novelist and critic William H. Gass, professor of philosophy; Jarvis Thurston, professor of English, and his wife, poet Mona Van Duyu, Litt.D. (hon.) 71; Huston Smith, formerly professor of philosophy; and Jakob Bakema, former visiting professor of architecture.

One of the most enjoyable parts of my job as the Seminar's president is selecting the seven different faculties each year, far in advance. This sometimes takes me into fields where I am massively ignorant. For example, this spring we are having a session on pollution control. I sought suggestions from a leading scientist, who recommended a woman whom he called "the best limnologist in the world." "The best what?" "Limnologist." "Ah yes," said I, "of course, Limnologist." I wrote it down—and looked it up later. And I invited her and she accepted; most people do, despite the fact that the Seminar, while providing travel fare and board and lodging in the Schloss, has never paid stipends to its faculty members.

Before trying to define the Seminar's purpose, I notice that my short list of questions omitted mention of a couple of things in the inaccurate tourist guide's spiel.
"Harvard"? The Seminar is totally independent and autonomous: responsible, as my predecessor has said, only to the spirit of free inquiry. (He, by the way, is Paul M. Herzog, LL.D (hon.) '71.) The three youthful founders were at Harvard, but when they sought the university's backing, President Conant thought their proposal utterly impractical and rejected it. Later, as I have mentioned, Mr. Conant taught happily at Salzburg.

"Music school"? There hasn't been a music session for many years. There is, however, music in the air in Mozart's city, and in the Schloss; frequent concerts in the Seminar's Great Hall (Mr. Goodman gave a violin recital there, and that same winter a young Romanian city planner who was also a fine tenor, unexpectedly sang a cappello for an hour) and, of course, an endless series of operas and concerts in the city itself, just one mile away.

"The Sound of Music"? Certainly the von Trapp family did not live in Schloss Leopoldskron. Some outdoor scenes in the film were shot on the edge of "our" lake, in front of the Meierhof; and I suppose that the glass summer-house in which a young von Trapp girl was "going on seventeen" will be our most stared-at possession as long as that tuneful cinematic confection keeps being reissued.

Mention of that film does remind me, though, of the Seminar's physical surroundings, which add so much to the incommunicable magic of the place. Everyone stays and works and plays in the Schloss, which has a good library and a good bierstube. The Untersberg towers a couple of miles away, with other snow-capped peaks beyond it. My wife finds special delight in the swans on the lake and the flowers in the Schloss gardens, but she's not the only one. Unquestionably, the quiet beauty of the old Archbishop's estate somehow seeps into the very being of many Seminar participants.

There are times when heading the Seminar is a worrisome task, for though the budget is very modest, still there is always the question of where the money's coming from. (The Fellows' tuition covers only about one-sixth of all expenses.) But somehow, the Seminar has survived for twenty-seven years, and increasing European interest in providing tangible support is a very encouraging sign for the future. Also encouraging is the upsurge of applicants for the 1974 sessions; many more than usual will have to be turned down, for there simply isn't room for all. We don't know the reason—American withdrawal from Vietnam? the U.S. less dominant and therefore more interesting? a keener awareness of interdependence?—but this upsurge, coupled with the devotion of many of the Seminar's 7000 alumni (about whom I could write another whole article) deepens our conviction that this is a truly significant enterprise.

So now I am left with the self-imposed duty of trying to define the Salzburg Seminar's purpose. I recall that when I used to be asked what Washington University's purpose was, I had to choose between responding in generalities or describing what the University does, and always felt that the latter answer had more meaning. At least part of the answer to my last question here, then, lies in the foregoing brief description of what the Salzburg Seminar does.

Like most educational institutions, the Seminar is an expression of faith in imponderables. Schloss Leopoldskron is a continuing intellectual center under American direction in the heart of Europe. We assume—we cannot definitely prove—that higher education is a positive good in the lives of those who participate in it, and for the societies in which they live. We cling to the faith that protracted, friendly, intellectual intercourse between, or among, nationals of the United States, Britain, and all the countries of continental Europe does something to further understanding across national boundaries and thus to improve, if ever so slightly, man's chance of survival. And we believe—and countless alumni and faculty members so state—that the intense experience of a session at Salzburg does in fact result in increased knowledge and heightened understanding. At its founding in 1947, the Salzburg Seminar was a gallant experiment in academic internationalism, a high adventure of the intellect and spirit. And that it still is and will continue to be.

Lois Eliot tends the flowers in the elaborate gardens of the Schloss Leopoldskron.
Comment

ODE TO A MEXICAN URN

A YEAR AGO this month, it was reported in this magazine that Washington University physicists, employing tests that they had developed to measure the age of moon rocks, had determined that a bronze statue of a horse in the collections of the Metropolitan Museum of New York was genuine and not a forgery, as some art historians had charged. The tests, developed by scientists of the University's Laboratory of Space Physics, proved that the controversial statue is at least 2000 years old.

Recently, the same scientific team tested 120 Mexican funeral urns from the St. Louis Art Museum and determined that all but seven of them were authentic. An exhibit of the urns and the measurements made on them opened in December at the museum.

The St. Louis museum's collection of Oaxacan clay sculpture, considered to be the finest in existence outside of Mexico, dates from about 500 B.C. to A.D. 1000. Art historians, however, had previously believed that at least 25 to 30 per cent of Oaxacan sculptured urns outside of Mexico are forgeries. As a result of the University scientists' tests, several of the St. Louis museum's urns that had been suspected proved genuine.

The definitive evidence resulted from thermoluminescence-dating tests of minerals from the ceramic urns. The research was a joint effort of Dr. Dave Zimmerman of the University’s Laboratory for Space Physics and Phillipa Shaplin, former curator of ancient and primitive art at the St. Louis Art Museum.

Thermoluminescence-dating has been used often to test the authenticity of art objects. Recently, however, some scientists have questioned the test's validity by pointing out that clever forgers could subject art objects to x-rays or gamma rays to make them appear older.

Washington University scientists have devised a way of making it impossible for a forger to fool the tests. Ceramic objects contain minute traces of rare minerals, such as zircon, in which the uranium concentration is a hundred to a thousand times greater than in the rest of the ceramic material. Energy added to the zircon grains by artificial radiation is negligible. The new technique, developed by University physicists, consists of isolating these uranium-rich zircon grains and measuring them separately. This research left no doubt that 113 of the 120 Oaxacan urns in the St. Louis Art Museum collection are authentic.

The application of such sophisticated scientific tests to art history is striking proof that the "two cultures" are not all that separate. Collaboration between science and the humanities, at least in this case, produced rich results.

ON NOVEMBER 12, Alexander Langsdorf, BSEn 98, died at the age of ninety-six. As student, professor, dean, informal historian, inspiration, and legend, he was associated with Washington University for nearly eighty years.

The eight-decade romance between Alexander Langsdorf and Washington University began in 1894, when he entered the school as a freshman engineering student. That was even before the institution moved to its present Hilltop campus. By the time that move was made in 1905, Langsdorf was a full professor and the head of the one-man department of electrical engineering.

Langsdorf joined the faculty as an instructor in physics after his graduation in 1898, was promoted to assistant professor of electrical engineering in 1901, and was made a full professor in 1904. In 1910, he was appointed dean of the School of Engineering and a year later became dean of the School of Architecture as well. He served as dean of the engineering school for more than thirty years.

Professor Langsdorf retired as dean in 1948, but continued as professor of electrical engineering until 1950. In the intervening years, he was actively involved with the School of Engineering and the University in countless ways. After his formal retirement, he compiled a history of the University that eventually filled two fat volumes. When asked a few years ago about the Langsdorf history, he said that he felt it hadn't been published yet because "it contains too many inside jokes."

The association of Alexander Langsdorf and Washington University will not stop at a mere eighty years. It will live on in the Langsdorf Engineering Fellowships, established in 1966, in the Alexander Langsdorf Seminar Room, dedicated a year later, and in the memories of hundreds of his former students and colleagues.

WHILE DEAN Langsdorf's eighty-year association with the University has never been equalled, Arthur L. Hughes, professor emeritus of physics, can look back on more than fifty years with the institution, although Professor Hughes has a remarkable tendency to look forward rather than backward.

Professor Hughes came to Washington University in 1923 and served as chairman of the physics department for thirty years. Since he took emeritus status in 1956, he has continued to work in physics, and still spends two days a week in the physics library.

In December, former students and colleagues helped Dr. Hughes celebrate his ninetieth birthday with a party in the room that will become the Arthur L. Hughes Lecture Hall. At the end of the party, Professor Hughes invited everyone there to come back in 1983 to help him celebrate his one hundredth birthday.

"I told them I would be glad to have them join me, if they were still alive and ambulatory," he said. "I'm assuming I will be."

FO'B
This winter saw the heaviest snowfall on the Hilltop campus since Washington University moved to the site in 1905. More than twelve inches of snow were dumped on the campus right before Christmas and another ten inches came down shortly before New Year's.