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W. ROBERT MARSHALL APPRECIATION DAY MAY 7, 1981

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FEATURES

Cover Story: *Dean Marshall, the father of modern spray drying, stands next to a spray dryer. This dryer has served as a model for many similar units around the world.*

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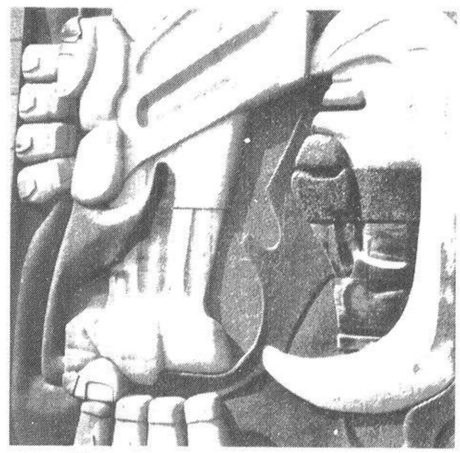

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Editorial, October 1971.

Welcome Dean Marshall

With the retirement of the distinguished Dean Kurt Wendt, William Robert Marhsall has aspired to the position c Dean of the University of Wisconsin School of Engineering. We, the staff of the *Wisconsin Engineer*, welcome Dea Marshall to the office, and proudly dedicate the first issue of the 1971-72 school year to him.

Dean Marshall is no stranger to students, faculty and alumni of the School of Engineering. A member of the Unive sity staff since 1948, Dean Marshall has many friends. He knows what makes the school run, and he has ideas on how t improve it. He's accustomed to spending a limited budget in the best way possible. Dean Marshall understands peop and people-type problems, and his activities and attitudes reflect this strong interest. Equally important, he appreciat the vital role of the technological world in improving people's position in life.

A member of many engineering organizations, Dean Marshall stays abreast of the world of engineering. Mar societies have conferred various honors upon him, including his election to the National Academy of Engineering (Se "Meet the Dean" article).

Dean Marshall worked closely with the former Dean Kurt Wendt to improve old programs and innovate new ones fo the school. Dean Wendt claimed that "Wisconsin is singularly fortunate in having Bob Marshall as the new Dean in th College of Engineering. Nationally renowned as a distinguished scientist and engineer, he is inquisitive, imaginativ analytical and logical." The former dean also called his successor "a skillful administrator and a stimulating teacher. Wendt also emphasized that "Above all, he is a true gentleman, always kind, sympathetic and courteous. Our college in good hands."

Members of the faculty, student body and alumni of the College of Engineering share Dean Wendt's sentiments fo the new dean.

In welcoming Dean Marshall to his new office, we extend our best wishes to him for a successful career as dean of th School of Engineering. His humanitarian approach to problem solving, tempered with good technological knowledg make him the kind of individual any college would be proud to have. The College of Engineering at the University c Wisconsin will continue to be a better place for its students, faculty and the people of Wisconsin and the world becau of Dean Marshall's service.

The preceeding is reprinted from the October 1971 issue of Wisconsin Engineer.

Dedication — May 7, 1981

The staff dedication of 1971 symbolized the faith and trust placed in the incoming Dean W. Robert Marshall. Th former Dean Kurt F. Wendt, heralded Dean Marshall as the man to meet challenge. Today, ten years later, th challenges Dean Marshall has met have had far-reaching effects for us all.

By establishing foreign exchange programs, increasing the enrollment of women and minorities in engineering, pro moting the growth and direction of the Experiment Station, Dean Marshall has demonstrated his concern for people. H has provided the type of engineering education we must have if we are to solve the technological problems of the futur Dean Marshall has been an example of the type of engineer and scientist we should all try to be. As a token of our gre appreciation for this man, we dedicate this issue to Dean Marshall.

—THE WISCONSIN ENGINEER STAF

Engineer and Educator

W. Robert Marshall, Dean of the University of Wisconsin College of Engineering for the past decade and Professor of Chemical Engineering since 1947, retires as Dean of the College in June. This is an appropriate time to review some of his activities and accomplishments in the university and elsewhere.

During the past ten years the College has seen difficult times. Enrolments have almost doubled, but budgets have not kept pace, and real dollars have actually diminished in the past several years. In the face of this, under Dean Marshall's guidance, the College has remained an outstanding engineering school, has encouraged the enrollment of women and minority students, and has remained active in international exchange programs with Germany, Mexico, Indonesia, and other nations. The Wendt Engineering Library has been constructed and made available to engineering and other students on the southwest side of campus.

Prior to becoming Dean, Bob Marshall was Associate Dean and directed the activities of the Engineering Experiment Station from 1953 to 1971. During this time he played an important part in establishing the Nuclear Engineering Department, the Engineering Computing Laboratory, the Solar Energy Laboratory, and other college programs.

There is another side to Dean Marshall's university career. He was a graduate student here from 1938 to 1941 and received his Ph.D. based on studies of simultaneous heat and mass transfer done under the direction of Professor Olaf Hougen. He then worked for the Engineering Department of the du Pont Company, where he became involved in spray drying and related problems. This led to his spray drying research when he returned to the Chemical Engineering Department in 1947. He advised many students in their Ph.D. research and published a series of 15 papers on spray drying and the book "Atomization and Spray Drying" in 1954 (described by a colleague as a "classic masterpiece . . . the most influential treatise concerned with putting the design and operation of spray dryers on a quantitative basis.").

Bob Marshall's research has been important to many industries. Ninety-six percent of all food dehydration in the United States in 1978 was done by spray drying, and the present U.S. production of spray dried skim milk is two billion pounds per year. Fertilizers, pigments, pharmaceutical products, mineral concentrates, plastics, detergents, and other materials are processed or preserved by spray drying on a large industrial scale. So, Dean Marshall's contributions to engineering are used by industry on a massive scale.

While bringing his many talents to bear on research and administrative problems in the University, Bob has not neglected other activities. He has served his professional society, the American Institute of Chemical Engineers, as a member of the Council of the Institute, as Vice President, as President, and most recently as Treasurer for four years. His election to these national offices is only one of the ways in which his work in engineering has been recognized. He has received all of the major awards bestowed by AIChE for meritorious contributions to engineering and the Institute. He was instrumental in developing the AIChE continuing education program, which is a model for professional societies. He has also been active in the American Society for Engineering Education.

His accomplishments in engineering led to his election to the National Academy of Engineering early in the history of the Academy (in 1967). He has been active in several commissions and committees of the Academy. He chaired the Committee on Interplay of Engineering with Biology and Medicine; the report of this committee served as a base for the growth of Biomedical Engineering.

His international activities and reputation have extended over most of the world. Mexico, Germany, Indonesia, Netherlands, Korea, Japan, and Canada are some of the countries which have given him honors or have invited him to lecture or consult. Under his guidance exchange programs have been developed between the University of Wisconsin and Mexico, Germany and Indonesia.

On the national scene, he served as member and chairman of advisory panels on engineering in the National Science Foundation, and in doing so contributed to stronger graduate education in engineering in this country. His service on the Commission on Engineering Education led to the development of innovative programs such as cooperative programs between institutions, exchange programs, and matching equipment programs. He has served on the boards of Associated Midwest Universities and Argonne Universities Association, and through these organizations he led in the development of programs under which midwestern universities were linked up with Argonne National Laboratory.

Bob Marshall has not neglected Wisconsin and his home town. He served as a member of the Board of Education in Monona from 1955 to 1961, including three years as Treasurer of the Board. He was a founding member and first President of the Wisconsin Ballet Company from 1961 to 1964.

Bob married Dorothy Robbins, a Madison native. When the Marshalls came to Madison in 1947 they moved into what was then a summer house on the shore of Lake Monona with a beautiful view of the state capitol across the lake. There they entertained their graduate students and friends and expanded the house as the family grew. Their three children, Peggy, Mary and Bill, grew up there. Water skiing and skating were favorite sports. The younger Marshal have married and left the fami home, but Bob and Dorothy are sti enjoying the lake, the view, an occa sional round of golf, and visits fro the children and grandchildren.

Many of us on campus hav known Bob Marshall for h research, his teaching and his ad ministrative work. Perhaps his care can best be described in terms of h deep concern for people—his co leagues, students, and those wh ought to have the opportunity for a engineering education. In times o difficult administrative problems, h has sought to minimize the impac of these difficulties on the facult Few of us have been aware of th range and magnitude of contribu tions that he has made to his profe sion; to broadening engineerin education and increasing its a cessibility to women and minoritie to international relations; to the e fective functioning of national agen cies; and to communities in which w live. On the occasion of his retir ment, we his friends and colleagu thank him and wish him well.

Materials for the article coordinat by Professor John Duffie.

The Engineering Building during the early days.

Pioneer in Research

Addressed here is the worldwide ıfluence of Dr. Marshall's technical oresight, imaginative investigation nd lucid exposition in the quantiza-ion of the numerous physical henomena encountered in spray rying. The seed of this contribution as planted and began to sprout in n academic environment. Sprouting ontinued, the seedling grew and the esulting plant began to bud in an in-ustrial atmosphere. A return to cademic surroundings allowed the lant to continue to bud and ltimately flower in profusion.

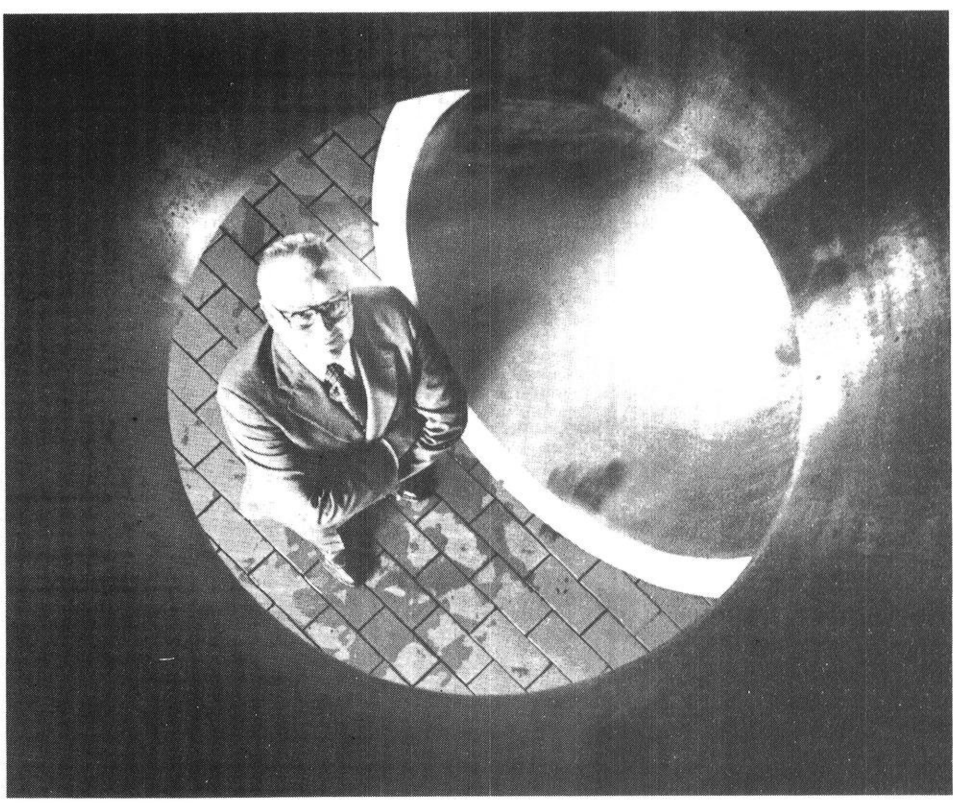
It was apparently under the ıtelage of Professor Olaf Andreas Iougen, Department of Chemical ngineering, University of Wiscon-n, that Dr. Marshall developed his ıterest in simultaneous heat- and ıass-transfer and its relation to the ıdustrial drying process. His talent or analytical description of this and elated technology evidently matured uring this period as evidenced by he nature of three joint publications ith Professor Hougen between 1940 nd 1947.

In 1941 Dr. Marshall joined the aff at the Engineering Research aboratory, Experiment Station, .I. du Pont De Nemours and Com-any, Inc., Wilmington, Delaware, here he encountered many in-ustrial drying problems. That single rying operation to which he seem-ıgly devoted most of his time was oray drying. His involvement in a onsiderable amount of commercial esting indicated the dire need for the evelopment of design criteria in this rea. Initial efforts to place various spects of drying and spray drying in articular on a firmer analytical ooting were made during this period of industrial service. These efforts resulted in seven publications between 1943 and 1952.

Employment with the du Pont Company was terminated in 1947 when Dr. Marshall accepted a position as Associate Professor of Chemical Engineering at the University of Wisconsin. Academe now provided the freedom of fundamental investigation which allowed a broad program of study into the various facets of the spray drying process to be developed. It was this program that did so much to take spray drying out of ca. 75 years of black-box, qualitative speculation and put it on a quantitative basis.

The importance of the spray drying operation is illustrated by the fact that such product classes as plastics, resins, ceramic materials, detergents and surface active agents, pesticides, dyestuffs, pigments, fertilizers, mineral concentrates, inorganic and organic chemicals, milk and egg products, plant extracts, fruit and vegetables, carbohydrates and related materials, pharmaceutical products, forest products, and offal and fish products are processed and/or preserved by this operation.

Prior to World War II, spray drying found use primarily in the dairy and detergent industries. Interest in and application of this processing technique grew markedly during and after these war years. It has been only during the last three to four decades that the majority of the technical



literature related to spray-dryer design and performance has been generated despite the fact that the first US patent related to this operation was issued in 1865. The number of significant contributions to the related design literature up to that time could be counted on one hand and they were almost exclusively related to atomization. The work of Dr. Marshall and his co-workers during the first half of these latter decades resulted in about 26 publications related to drying, of which 15 were concerned directly with spray drying and constituted the single most influential contribution of engineering research in spray drying.

Since ca. 1950, Dr. Marshall has been considered the world's single most qualified authority in spray drying. He has been visited by industrialists from around the world and has been invited to lecture over a similar geographic area. In 1952, for example, he was visited by Johan Ernst Nyrop, founder of the Danish firm A/S NIRO ATOMIZER which today enjoys approximately 40 percent of the world's sales in spray dryers. This firm feted Dr. Marshall in June 1965 in Copenhagen, Denmark, as the "father of modern spray drying." His counsel is sought regarding spray-dryer design and performance to date.

Among Dr. Marshall's publications is the classic masterpiece entitled "Atomization and Spray Drying" which was published in 1954 by the American Institute of Chemical Engineers as No. 2 in its Monograph Series. This 135-page work was the first and singly most influential treatise concerned with putting the design and operation of spray dryers on a quantitative basis. During the ensuing years a number of similar publications have appeared— particularly in languages other than English. These publications have been modelled closely after Dr. Marshall's pioneering work.

The most ambitious effort to emulate Dr. Marshall's pioneering work is a nearly 700-page book by the English author and employee of A/S NIRO ATOMIZER Keith Masters entitled "Spray Drying" which was first published in 1972 and whose third edition is entitled "Spray Drying Handbook." Like a great number of handbooks nowadays, this effort is written in essentially encyclopedic format and is basically a source of general information rather than an engineering tool. As opposed to the purpose and achieved goal of Dr. Marshall's monograph, there is no specific mention of design procedures and there is no indication as to how the included technical matter might be integrated to effect only a very approximate design. As a result, Dr. Marshall's monograph still receives more citations than any other single publication related to spray drying.

One is always hard-pressed to measure societal contributions in a completely tangible fashion. For example, as a result of the studies of Dr. Marshall and his associates, it was possible to design the spray dryer now located in the Department of Food Science, University of Wisconsin-Madison, which has operated so well since its installation around 1956. This dryer has served as a model for many similar units around the world. It has also allowed the development of techniques for the spray drying of many foodstuffs not previously so dried.

The exact number and nature of such spin-offs of Dr. Marshall's efforts to develop design procedures for spray dryers is unknown. However, it can be stated that his farsightedness, inventiveness and ability to model and communicate the results of his studies have contributed more to transform the unit operation of spray drying from an art to a science than the efforts of any other individual.

This article was reproduced from a letter written by Professor E. Johansen Crosby nominating Dean Marshall for the Ragnar E. Onstad Service to Society Award, March 2, 1981. Professor Crosby is a professor in the Chemical Engineering Department, and a colleague of Dean Marshall.

JW'S International Engineering Champion

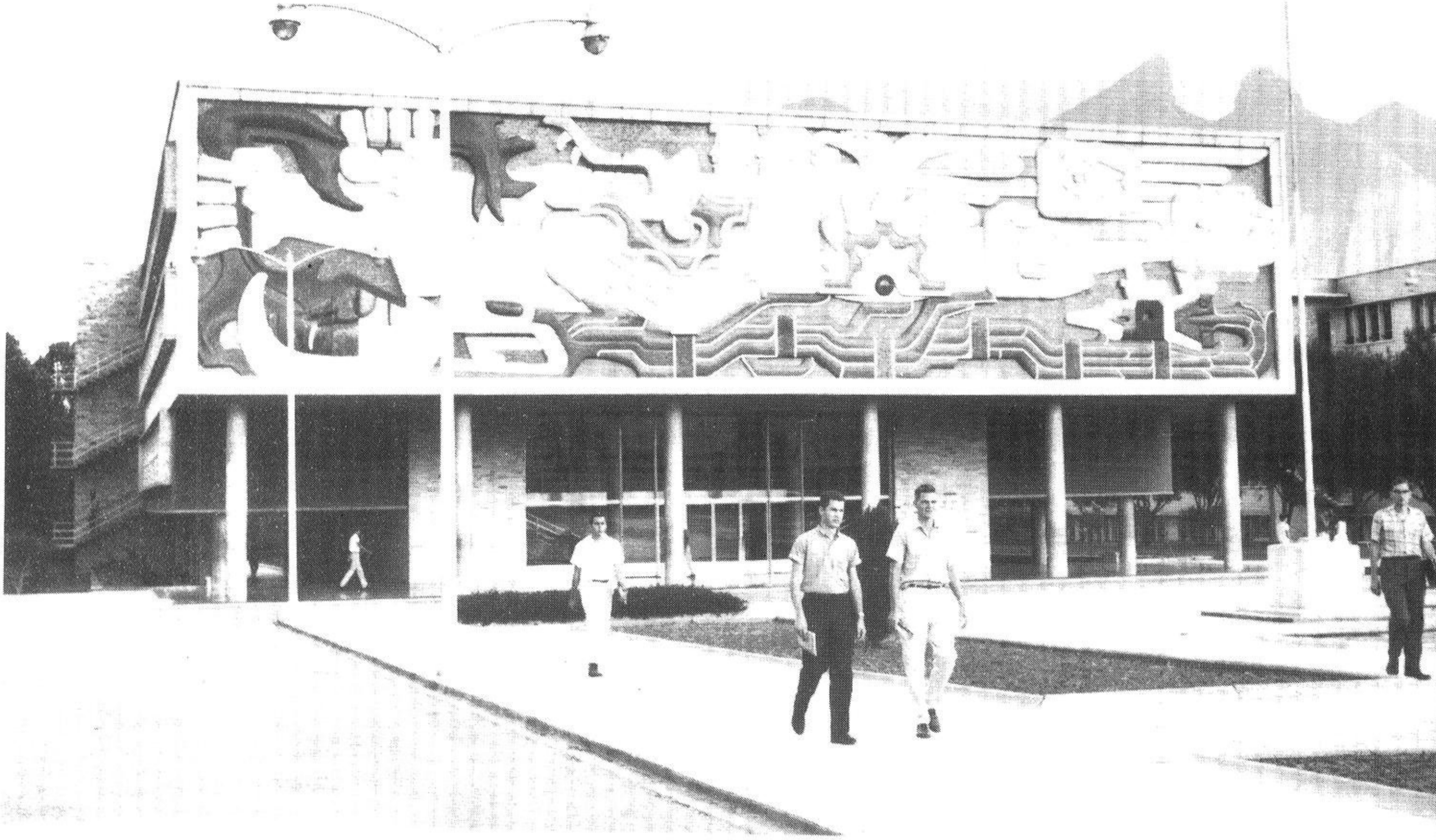
Of the many contributions Dean Iarshall has made to the Universi- / of Wisconsin, the international ngineering programs reflect his evotion to the enrichment of the udent's college experience. The ducational exchange between the niversity of Wisconsin and El In- ituto Technologico y de Estudios uperiores de Monterrey in Ionterrey, Mexico would not have een as successful without Dean Iarshall's involvement in the pro- ram's development.

The Wisconsin-Monterrey Tec rogram originated during Dean Iarshall's years as a chemical engi- eering professor in the late 1940's. He had a brilliant graduate student named Fernando Garcia-Roel, who had come from Mexico to pursue a masters degree in chemical engineering. Their friendship continued past Mr. Garcia-Roel's graduation and his subsequent return to Mexico, where he became a professor at Monterrey Tec. The following ten years were successful for both; the early sixties found the titles of the student and professor elevated to Rector of Monterrey Tec Garcia-Roel and Associate Dean Marshall of the UW College of Engineering.

In 1960 the Carnegie Corporation offered the Tec a grant to develop a study abroad program with a U.S. university. The offer was accepted by Mr. Garcia-Roel. When the Corporation inquired about which U.S. school he would like to work with, quite naturally he thought of his own alma mater, the University of Wisconsin.

At this time, Dean Marshall was the Director of the Engineering Experiment Station and began communications with the Tec for setting up the exchange. Professors were sent to the Tec to review its facilities, study programs, and the opportunities available there for UW students. The program's goal was to provide students with worth-

Shown here with Dean Coberly and Dean Marshall are the students from the Technologico in Monterrey, 1974-75.



The Library Frieze at Monterrey Tec, Monterrey, Mexico.

while educational and cultural experience.

The concept was for the student to pursue his degree while studying in a foreign country and using that country's language. Unlike other existing study abroad programs the Tec program was available to all qualified engineering students, rather than a set number of participants who must compete to be accepted. Engineering students who had completed one year of college level Spanish and maintained a "B" or better average were eligible to participate in the Tec program. In the fall of 1961 the first group of seven students left for Mexico on the maiden voyage of the new exchange.

The Wisconsin-Monterrey Tec program evolved into a "true exchange" in 1963 when the UW began awarding partial scholarships to the Tec's four best engineering students. These students were then able to come to Madison for a year of undergraduate studies.

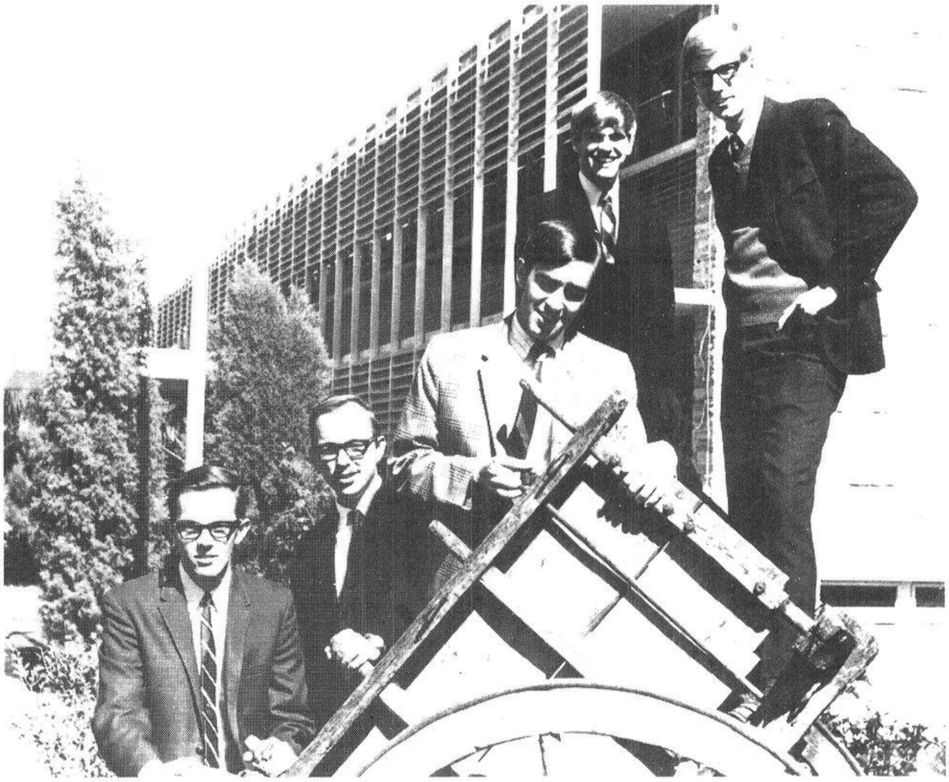
Wisconsin-Monterrey Program 1964-65 Social Hour, Memorial Union.

The Tec is highly regarded throughout Mexico and has offered many challenging courses to the UW student. The exchange students live in dorms or off campus housing with other Tec students and learn all lessons (both social and academic) in Spanish.

In addition to other lessons, students learn not to classify certain aspects of the new culture as being "better or worse" than at home, but instead they discover the reasons for the differences. Students spend their vacation time traveling throughout Mexico. This gives them a chance to gain a better perspective of the country, its industry, and its people.

The rewards of the program are not easily won; they come only after the culture shock and communication gaps (that confront the participant upon his arrival) have been overcome. Numerous trials must be endured. Ms. Bonnie Kienitz, the coordinator for the Undergraduate International Engineering Programs, believes the participants deserve the title of "survivors."

The completion of the program is not the end of the exchange, the program alumni continue correspondence with the friends they made at their "college-away-from-college." Dean Marshall's involvement with the program also became an even more personal exchange. Rafail Rangel, an early Tec participant who came to Madison on the program, later became the husband of the Dean's daughter Peggy. As Ms. Kienitz put it, "Dean Marshall has two bilingual grandchildren as a result of having started this program;



Above Right: Gene Melton, Dave Haas, Fred Turk, Scott Johnson, and Bob Elliot on the Tec campus at Monterrey, Fall '68.

Right: Professor Barry (of the International Engineering Programs office) spends a minute with Tec students during Fall '66 Social Hour.

El Instituto Technologico y de Estudios Superiores de Monterrey.

that is one of his rewards for his devotion to international education." Rafael returned to Madison to earn his Ph.D. as many of the Mexican alumni have done.

When interviewing for jobs, program alumni have found their Tec experience attracts a great deal of attention from potential employers. Their involvement in this program is usually considered a "plus." Ms. Kienitz is often asked by employers who are looking for Spanish-speaking engineers for the names of the program alumni.

The value of Dean Marshall's efforts are exemplified by the profound effects the exchange has had upon the "survivors" from both schools. Susan Melendy, a 1979-80 alumnus, was first attracted to the UW because of the exchange program. She is now going on to graduate school in electrical engineering. Alumni who have completed their formal education include not only top-ranking engineers, but doctors, lawyers, researchers, and executives in companies of both countries. Their great interest in the whereabouts of their fellow program alumni is indicated by their continuing response, through the years, to the annual request for an update on their addresses and activities.

Dean Marshall not only started the Wisconsin-Monterrey Tec Program but in 1972 he also inspired the beginning of a program through which engineering students can go to Germany for their third year of studies. To qualify, a student must also have a "B" or better grade point average, but in this program he or she needs a minimum of two years o college level German language study The choice of the German universit depends on the student's major. T date there have been students i Munich, Karlsruhe, Aschen, Darm stadt, and Braunschweig.

Alumni of both programs are wel aware of the effect that their par ticipation has had on their profes sional and personal lives. They wil always be grateful to Dean Marshal and the College for providing the with this extra dimension to thei engineering education.

"Muchas Gracias" and "Viele danke!", Dean Marshall.

Written by John Wengler. John is freshman in Civil and Environment Engineering and also an assistan editor of the Wisconsin Engineer.

Educators Get Obsolete Too

They have a job to upgrade themselves and then work to help practicing engineers in continuing education programs

In a sense, the term "obsolescence" is not wholly descriptive of the continuing education problem faced by the individual engineer. Actually, the engineer does not become obsolete in the sense that he is not able to continue to function effectively in engineering assignments. Rather he suffers from the ignorance of the vast amounts of new information which are continually created and, hence, which are unavailable to him in the solution of new problems. It is evident, therefore, that so-called "obsolescence" is a problem to be fought, in large measure by new educational methods and information dissemination programs. And here we encounter a vicious circle, namely, that faculty are also overwhelmed by the inundation of new knowledge.

Thus, the practicing engineer is not alone in his problem of keeping abreast of new knowledge. The engineering educator is in an equally difficult task, possibly more difficult in some respects because of the ex pectation that he is the person who should know about all new scientific developments. It is not strange, therefore, that colleges of engineering have undertaken programs to keep their faculty up to date and abreast of the new advances. It was the recognition of the need for continuing faculty training that prompted the Ford Foundation to grant substantial sums of money to aid in the development of engineering faculties. The funds from the Ford Foundation, granted to many colleges of engineering, were used in a variety of ways, many of which were traditional. However, some programs developed under these funds have enabled the engineering teaching profession to develop new "habits" for keeping up to date. One of these is the habit of leaves of absence for further study and research. Historically it has not been the custom for an engineering faculty member to spend a year in scholarly pursuit or research at another institution. Thus, when the National Science Foundation first announced its program for supporting postdoctoral study in science and engineering, it received a total of just twelve applications from engineers for the entire country, in contrast with several hundred from the sciences. Today this pattern has changed, and applications for postdoctoral study in engineering have increased substantially.

In-House campus programs

Another type of program which has proved especially feasible for keeping faculty abreast of new developments is the so-called "in-house training program." This program was found to be very effective at the University of Wisconsin as a result of three summers of experience. The program consisted of selecting a topic of interest to a substantial number of faculty and inviting an expert or experts in the field to spend the summer and teach the subject to those faculty who wished to participate. The three summer programs at Wisconsin were concerned with Advanced Mathematics, Numerical Analysis and Computing, and Statistics. Each was taught by a prominent mathematician who had excellent teaching qualifications. Those faculty members who enrolled in the program attended the course

on a half-time basis for eight weeks and were paid stipends in proportion to the time. The courses were intensive and involved problem-solving sessions as well as lectures. The results of the sessions involving numerical analysis, computing, and statistics found immediate use in a number of engineering courses and enhanced the College.

Engineering's computing lab

A similar type of in-house program was conducted during a spring recess for department heads and other administrative people to acquaint them with the principles of programming and operating a 1620-type computer. Significantly, this one-week program suffered virtually no loss of attendance by virtue of the fact that programming of a problem was required during the afternoon of the first day of the session. Subsequently, instruction in programming the 1620 was recorded on magnetic tape in conjunction with colored slides to illustrate text material and other computer functions. This material has been exhibited to over 2,000 students and faculty and has proved to be a most effective teaching technique without the formalities of a scheduled credit course.

The experience of universities in upgrading engineering faculty is useful and meaningful in connection with the continuing education of engineers in industry. There is no reason why in-house training programs in industry could not be conducted in the same manner as they are conducted within a university. The costs might be higher, but the same procedures and techniques could certainly be effectively employed. As a matter of fact, many industries over the past several years have conducted in-house training programs for their professional personnel for periods of time ranging from a few days to several weeks.

How far can retraining go?

A more basic question, however, should be raised regarding how completely a practicing engineer should be expected to be brought up to date in all new fields. It seems unlikely that most individuals can be made fully knowledgeable about all recent advances. How then does one compensate for the fact that there is a limitation to our time and capacity to keep it up to date in all areas?

Early construction of the Engineering Research Building.

One answer might be that universities can serve an important role for industry and the individual engineer by establishing themselves as centers of information or clearinghouses with respect to "who knows what." That is, if an engineer becomes engaged in a problem which might be advanced or solved by new scientific information, as a minimum requirement he should be able to find out what individuals are expert in the fields which impinge on his problem, where they can be found, and how they can be approached. It is an unfortunate fact that even within a large university there are individuals with knowledge and experience in many fields but who are unknown to their colleagues.

It would seem, that one of the most important functions of a university would be to coordinate and catalog the vast array of scientific and engineering talent which exists within its domain. The next step should be for the university to enlarge its awareness and comprehension of existing scientific frontiers first throughout the nation and then throughout the world. This broad problem becomes another aspect of information retrieval and dissemination, and a very great service could be rendered by the university to the scientific and engineering community in providing the practicing engineer and scientist with information on new areas as needs develop. Admittedly, all this is only a first step, and beyond the role of an information and disseminating center, the university must then consider new, efficient approaches for presenting and providing information to the engineer who must keep up to date. This aspect of the problem is being approached in many schools by means of filmed lectures, programmed learning, teaching machines, and so forth. A basic problem in all this is one of utilizing the time of a limited number of people who are constantly being importuned for their knowledge and services, and who obviously cannot fracture and disperse themselves into small pieces to satisfy all the demands and needs.

The University's job

The universities and colleges of engineering have engaged in many programs of a conventional nature to aid the practicing engineer to continue his education. Some of these are 1) off-campus programs near industrial centers, 2) extension or correspondence programs, 3) evening courses, and 4) short courses for a few days or weeks.

These traditional methods more or less met the post school educational needs of engineers until about ten years ago at which time the scientific explosion began producing new knowledge and information at rates which could not be assimilated, organized and disseminated by the more conventional methods. Accordingly, one important responsibility of the universities is to develop unconventional methods of retrieving, compiling and disseminating the vast quantities of new knowledge. Some of the new and unconventional methods which should be exploited and developed more fully are:

1. Taped Lectures with Slide Illustrations: This technique has been successfully employed at Wisconsin, in a small way, to teach engineering students, as well as faculty, how to program problems for the 1620 computer. Four 45 minute lectures have been prepared by an engineering faculty member and each lecture is presented continuously for several days at intervals throughout the semester. Thus, a student can attend the same lecture as often as he wishes. The lectures have been duplicated and can be rented or purchased. Thus, a group of engineers or an individual can hear the lectures and learn at their convenience without requiring the presence of the expert lecturer. This technique of teaching special, new topics is yet to be fully exploited. It is, in a sense, the oral and audio equivalent of a written book. If University faculty who are expert in new science and engineering areas could and would record special lectures in their fields, a whole new body of oral-audio literature would be prepared for the widespread instruction of practicing chemical engineers.

2. Filmed Lectures: These come under the same general category as the taped lectures, except that the costs are higher. More flexibility exists with the medium of filmed lectures through animation, special laboratory demonstrations, etc. Considerable progress has been made with filmed lectures, for example, the excellent lectures on fluid mechanics by Professor Shapiro.

3. Programmed Learning: The technique of teaching whereby subject matter and instructional material are stored in a machine is being studied to nearly every degree of sophistication. This method, generally, referred to as programmed learning, encompasses the basic concept of storing the basic knowledge of a subject in a form which is instructional and which is accessible to the student according to a definite pedagogical program. Probably the most sophisticated effort in this field is that at the University of Illinois where a CDC 1604 computer is utilized as the central unit to store and program courses which may be taken simultaneously by as many as 40 students. The development of this system, known as PLATO, Programmed Logic for Automatic Teaching Operations, involves the combined efforts of engineers, educators, and psychologists. Other less elaborate systems are under study and development at various locations throughout the country. An important aspect of this area is the need to study the psychology of learning as well as the development of new insights into the best methods of preparing and presenting information through the medium of a machine rather than a human being.

4. Information Retrieval: Much remains to be done in improving methods and procedures for making it easier and faster to keep abreast of the literature in any field. Some universities are establishing centers for attacking the information problem on a large scale. In other cases, individual professors have endeavored to encompass the literature in a specific field. However to attack this problem in any significant way, university libraries should undergo substantial transformations in terms of increased staff, automated record-keeping equipment, and much larger budgets.

5. Self-restraint on Publications: The scientific community might well reflect on its own responsibility in connection with the present "publish or perish" philosophy. An era of self-restraint on and critical review of publications is desperately needed. More assurance is needed, than now exists, that all the literature is really significant and fit to print. Further, the content and length of literature articles should be in proportion to the significance and timelessness of the information presented.

Summing it up

The foregoing observations concerning the universities' role in combating so-called obsolescence are based on the following implied assumptions:

...The problem of combating obsolescence is primarily a personal responsibility of the individual. Each of us must develop the urge, the energy, and the time for continuing study.

...Individual study requires assistance in the form of new approaches to information transfer to improve efficiency, accessibility and digestability of new knowledge.

...the universities possess the educational talent, environment, and, hopefully, motivation necessary to the development of new and improved teaching procedures. Therefore, their staffs, programs, and budgets should be modified and expanded to permit massive attacks on the broad problems associated with obsolescence and continuing education.

...The art and science of teaching should once again be studied, and viewed with importance comparable to that of research. Research programs in teaching and education for combating obsolescence should be undertaken.

This article is a reprint from Chemical Engineering Progress, vol. 60, no. 1 (1964).

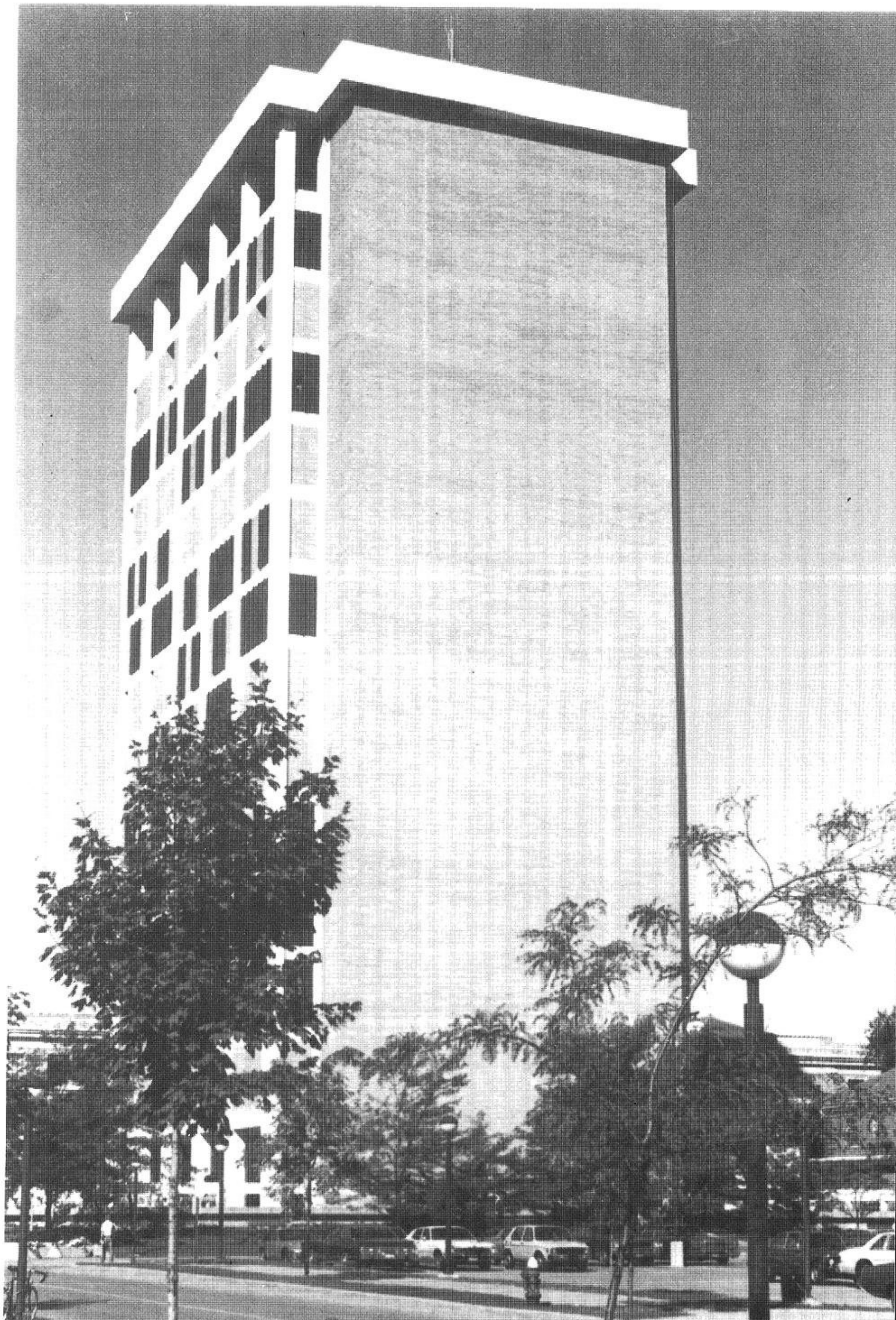
The Experiment Station

It would be difficult to walk across the engineering campus without at least momentarily directing your attention to its most dominant feature, the Engineering Research Building. The towering structure appears as a monument to the importance of research for today's university. Last year's 12 million dollar Experiment Station budget confirms this fact.

Acknowledging the dual role of the university as an educational/research institution, we might assume that these two functions are separate and distinct. This, however, is not the case. They are complementary, the quality of each being, to a certain extent, dependent on the other.

The idea that research should be an integral part of the Engineering School dates back to the early 1900's. At that time the Ag School was involved with research designed to aid the state's farmers. In 1914 the Board of Regents decided that a similar program could benefit the state's industry. Thus was born the Engineering Experiment Station.

The Experiment Station remained little more than a concept until 1947. At that time Kurt F. Wendt was named its first director. He was responsible for formally organizing the various projects that faculty members were already working on into a concerted research effort. When Wendt was named Dean in 1953, W. Robert Marshall succeeded him as Director of the Experiment Station, a post he held until 1971 when he, too, was named Dean. Marshall saw the growth and development of engineering research through its early years, and in 1969 during his tenure as Director the



Engineering Research Building was constructed.

When Marshall took over as Director in 1953 there were only a few projects under study. The two most important were the Solar Energy Project and the Motor Vehicle Research Study. The university was among the first to investigate the sun's potential as an energy source. The first step was to map the sun's radiation intensity around the globe. The study of solar energy is still very important and has become quite advanced. It includes a computer program that can design the most efficient system for a particular application in a given location.

The 1957 the launching of Sputnik was a turning point for engineering research. At that time our government encouraged the acceleration and expansion of technological research programs. This translated to an increased financial participation by the federal government. In the ten years between 1963 and 1973 the engineering research budget grew from less than 2 million dollars to more than double that amount. The federal contribution increased from 45% of the total to 55%. Of the 12 million dollars expended last year, 61% originated from federal sources.

The construction of the Engineering Research Building in 1969 was a notable event. Until that time, the College did not have a building dedicated principally to research. Today it serves as administrative headquarters and houses various research labs. Engineering research has expanded considerably since 1953. The current emphasis is on such areas as pollution; urban planning; transportation; medical treatment and care; and energy sources and production. Often these areas of research demand interdisciplinary cooperation to effectively deal with a broad scope of problem areas.

The existence of a separate building dedicated to engineering research may suggest that the research process is independent from the educational process. This however, is not the case. The professors who teach in our classrooms also constitute the research staff. Graduate students actively participate in research programs. It comes as no surprise that a strong research program and a quality engineering education go hand in hand, nor that students as well as the research staff need to be concerned about the future of engineering research.

According to the Experiment Station's present Executive Director, C. A. Coberly, the trimming of the federal and state budgets should not have too large an adverse effect on engineering research. The science and engineering programs of the National Science Foundation, the source of most of today's funds, have not been greatly reduced.

The destiny of engineering research should be of concern to all. Robert Anderson, writing in the January issue of *Omni* magazine sums it up: "There will be only one future. And we won't predict it, we'll create it... If we want progress in the future, we have to pay for it now. The less committed we are to creating the future, the less future we create. But conversely, the more committed we are to creating the future, the better future we can create."

In thirty-four years of service, Dean Marshall has exhibited the necessary commitment to research. Eighteen of those years were spent ensuring the growth and direction of the Experiment Station, and thereby, the destiny and growth of engineering research.

Written by Barbara Lasecki. Barb is a sophomore in Electrical and Computer Engineering and the latest addition to our staff.

Left to Right: Dean Marshall, Dean Coberly, and present Associate Directors of the Experiment Station, Dr. Richard R. Hughes and Dr. Clayton O. Smith.

A Farewell Word by Dean Marshall

When I come to the end of a long, pleasant journey, I like to spend time reviewing and reflecting on the many places that I have visited, the many activities that I have enjoyed, and the people I havv met. In many respects the ending of my tenure as Dean of the College of Engineering has the characteristics of the completion of any journey, and therefore it is appropriate to try to recall where I have been, what I have done, and what I have enjoyed. My journey has been largely through the decade of the 1970's—the period during which the College of Engineering has experienced unusual growth in numbers of students, in academic programs, in research, and service.

One of the many pleasant activities inaugurated during the journey has been a major effort to communicate better with our alumni, with our industrial friends, and with each other in the College. The establishment of *Perspective*, our alumni newsletter, in 1974 has helped tell over 17,000 alums how their College is doing and why they should be proud of it. Our *Annual Report* of the Engineering Experiment Station reached a new high with the 1979-80 Report, which describes hundreds of projects as well as many large interdisciplinary programs in the College. The *Wisconsin Engineer* experienced a remarkable revival to become a national award-winning engineering student magazine.

During the journey through the '70's, many outstanding faculty joined our College family. The quality of the faculty has clearly been recognized by the numerous awards they have received for outstanding teaching, research, and public service. The student body has been greatly enhanced by the addition of many fine young women engineering students and by a significant increase in the number of minorities.

One of the truly great landmarks this traveler enjoyed on his journey was the construction of the Kurt F. Wendt Library. This stands as a tribute to a great man and a great journey as Dean of the College for eighteen years.

Toward the end of the decade, the College began to enjoy substantial support and attention from all areas of industry, which is destined to continue, I am sure. While the College continued to develop and become recognized as a truly outstanding state and national resource, its prestige and excellence were becoming significantly more recognized around the world. Foreign programs developed with Indonesia, Singapore, Korea, Japan, the People's Republic of China, Egypt, Saudi Arabia, and West Germany, not to mention the long standing program with Mexico and other parts of Latin America.

And so as the journey ends, the traveler reflects with deep satisfaction on where he has been and what he has done and on those with whom he has had the privilege to associate and help bring to the College of Engineering. The future of the College in the 1980's is bright. It will grow and continue to develop under a new traveler, who will find the journey through the '80's filled with challenges and opportunties to carry the College to new heights.

W. Robert Marshall
Dean and Traveler

Why should it take 450 pounds of metal to make a 19-pound part?

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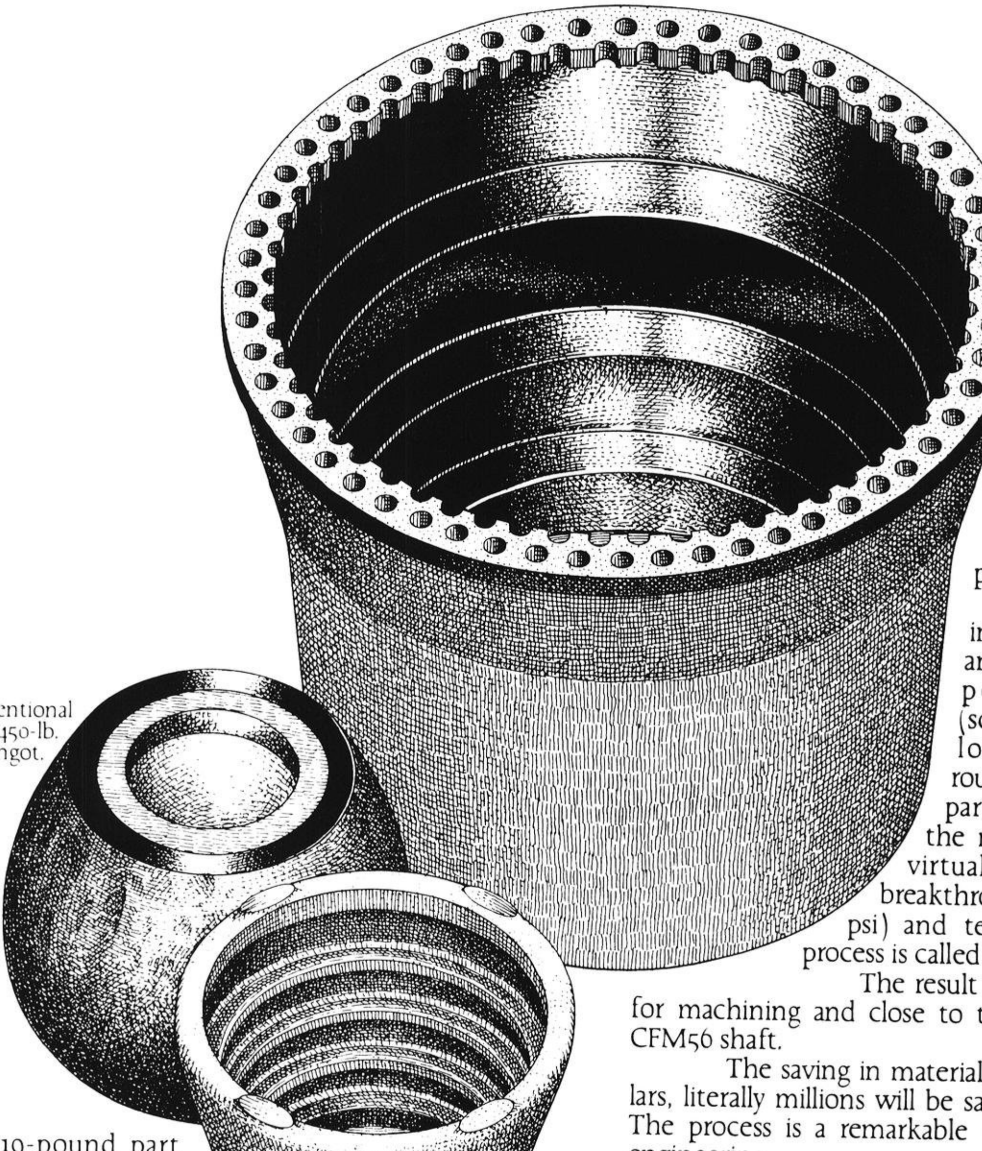

The 19-pound part is the forward shaft in the high-pressure turbine of a General Electric CFM56 jet engine.

The metal it's made of is Rene 95, a GE invention. Rene 95 is an exotic superalloy of nickel, cobalt, columbium, tungsten and 17 other elements. To fabricate a forward shaft from Rene 95 by conventional methods, you start with a 450-pound ingot. After forging, pressing and machining, you end up with a single 19-pound shaft...and more than 400 pounds of expensive scrap.

That's a distressing waste of critical raw materials and of the energy it takes to mine and refine them.

So GE engineers turned to near net-shape forming: fabricating the finished part from a blank shaped as closely as possible to the shape of the finished part.

But how could such a blank be created without starting with a 450-pound ingot? To solve that problem, GE engineers developed a truly unique application of powdered metallurgy.

Virgin or vacuum induction-melted Rene 95 is argon-atomized to create a powder. The powder (screened for particle size) is loaded into containers roughly shaped like the final part. Then, in an autoclave, the material is consolidated to virtually 100% density (that's a breakthrough) at high pressure (15K psi) and temperature (2000° F.). The process is called hot isostatic pressing.

The result is a 120-pound ingot ready for machining and close to the shape of the finished CFM56 shaft.

The saving in materials is more than 70%. In dollars, literally millions will be saved over the next decade. The process is a remarkable example of cost-effective engineering.

Inventing new materials and better ways to use them is just one example of GE research in progress. GE is constantly investigating new technologies and innovative applications for existing technologies—in such areas as power systems, information services and major appliance manufacturing.

This takes talent—engineering talent—not just in research and development, but in design and manufacturing, application and sales.

If you are interested in engineering opportunities at GE, check your Placement Office or write to: Engineering, Bldg. 36, General Electric, Schenectady, New York 12345.

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