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Volume 85, No. 5

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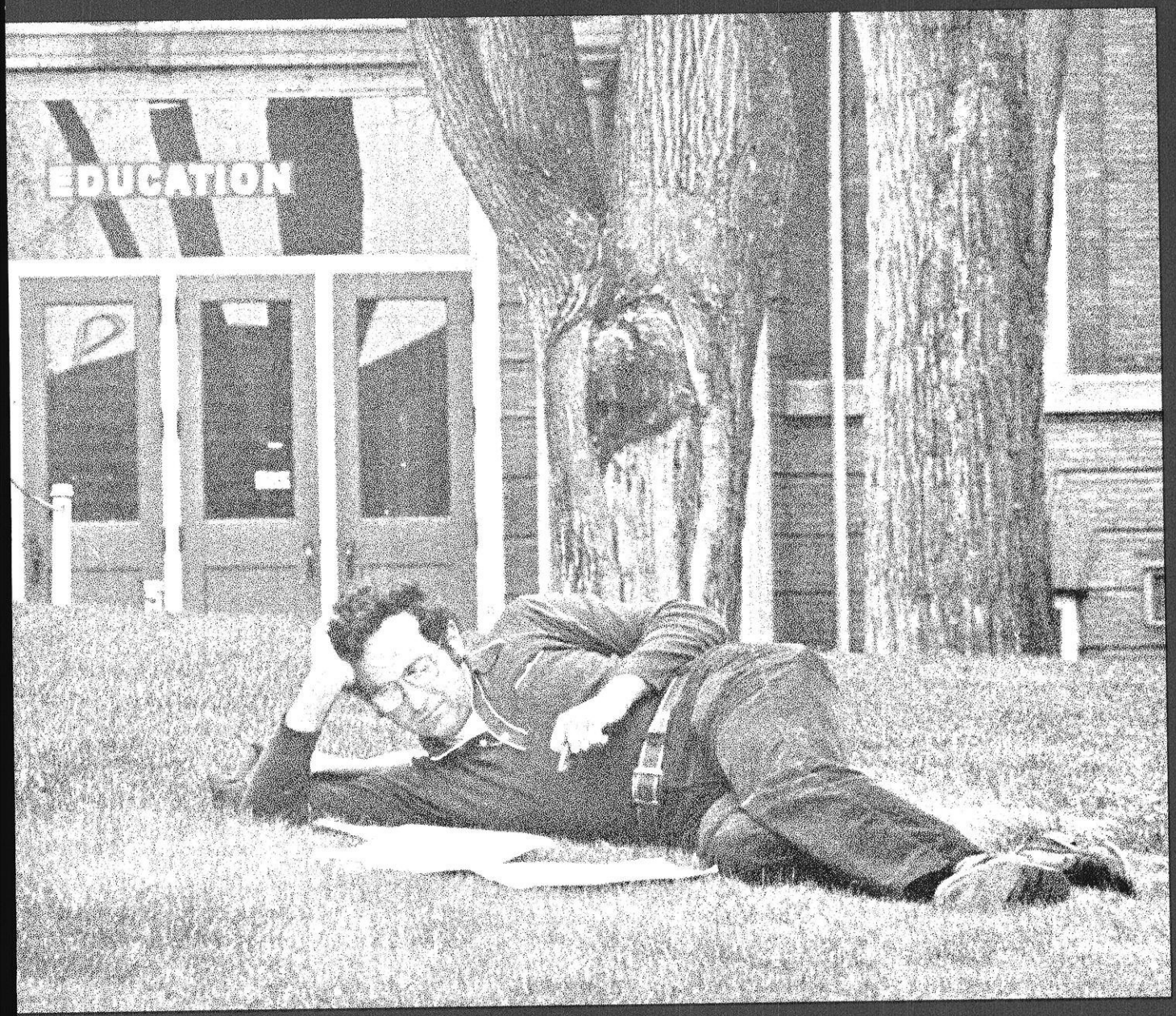
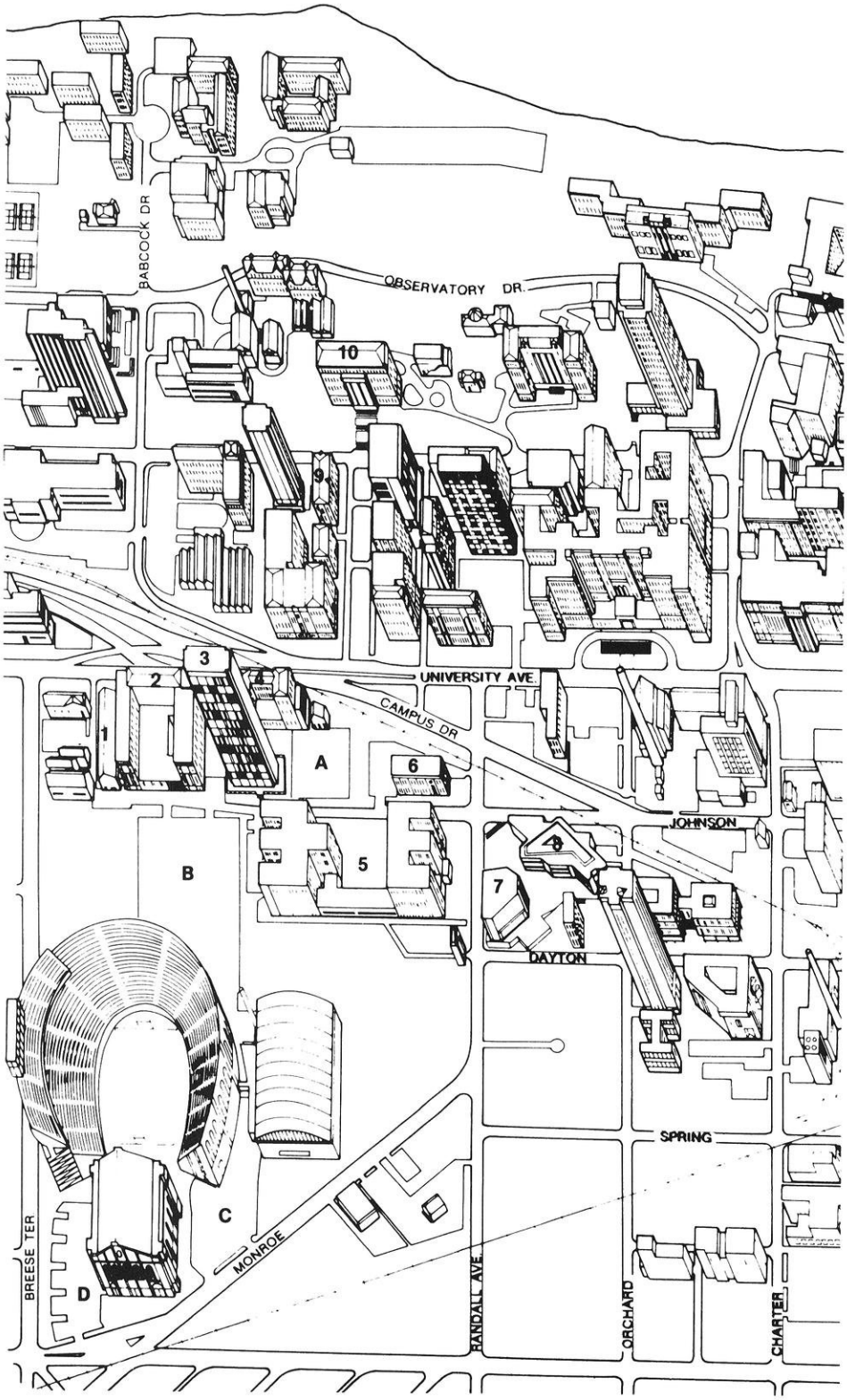


Engineering Campus



Key to Facilities

1. General Engineering Building
2. Mechanical Engineering Building
3. Engineering Research Building
4. Metallurgical & Minerals Engineering Building
5. Engineering Building
6. State Highway Laboratory
7. Kurt F. Wendt Library
8. Union South
9. Agricultural Engineering Building
10. Agriculture Hall

Key to Parking Lots

A. Lot 14
B. Lot 17
C. Lot 18
D. Lot 19

wisconsin engineer

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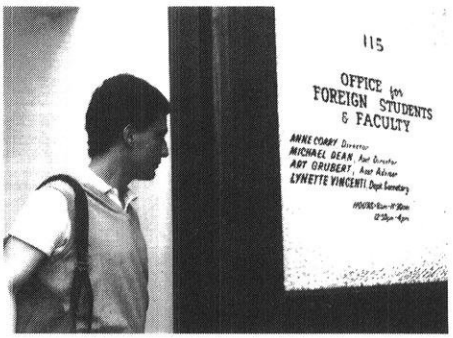
FEATURES



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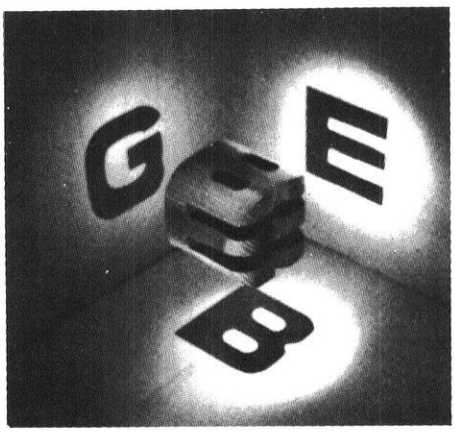

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TO GET THERE FROM HERE

by Dean Leidel

Dean Leidel is an Associate Dean of Engineering and is the Freshman Advisor.

This is a "Welcome to the 1981-1982 School Year" for all engineering students, but especially for those of you that are new to UW-Madison. You have selected an exciting and rewarding career, and we want to help you to have as pleasant and successful a college experience as possible.

College is more competitive, more difficult, and more time consuming than high school, and requires more initiative; the first step toward success is to believe this. Most of you will do well. Some of you will have problems, and it will be up to you to recognize and solve your problems, and to come to us if you need help.

At the freshman level, help begins at the Engineering Freshman Office, 22 General Engineering Building (once T-24), telephone 262-2473. At the upperclass level, help begins at the office of your assigned advisor. Also available, however, is the Academic Affairs Office, 266 Mechanical Engineering Building, or Engineering Counselor Jackye Thomas, 271 Mechanical Engineering Building, both at telephone 262-3484. If we cannot help directly, we know to whom to refer you for the help you need.

The 1981-82 school year promises to be different in many respects. We will have the largest engineering freshman class on record, more than triple that of a mere nine years ago. We will be operating under severe budget constraints which promise to make conditions interesting if not difficult. We hope that we will have enough classes to satisfy the demand, but some of you will undoubtedly have to compromise your selection of classes or class times or credit totals to accommodate what is available. It will be more important than ever before for students to look out for themselves, to seek help quickly, to make good decisions and to work hard.

Those of you that are about to begin your careers as engineering students, whether as new freshment direct from high school or as transfer students from other colleges and campuses, are beginning under regulations that are as new to the college as they are to you.

For the first time, the school year begins with a large group of pre-engineering students - basically those with less than twenty-four credits - who are in the College of Engineering, but whose acceptance as degree candidates is dependent upon academic performance at a higher level than is required for academic "good standing." In addition to the twenty-four credits, to be accepted as a degree candidate, each student must (a) have passed first-semester calculus (Mathematics 221) with at least a "C" grade,

(b) have passed an additional ten credits of courses chosen from more advanced calculus, chemistry, physics, computer science and engineering mechanics with at least a "C" grade average, and an overall gradepoint average of a level dependent upon the particular degree department. Bear in mind that we assign grades on a 4.0 scale, with a "B" grade worth 3 gradepoints per credit, and "C" grade worth 2 gradepoints per credit.

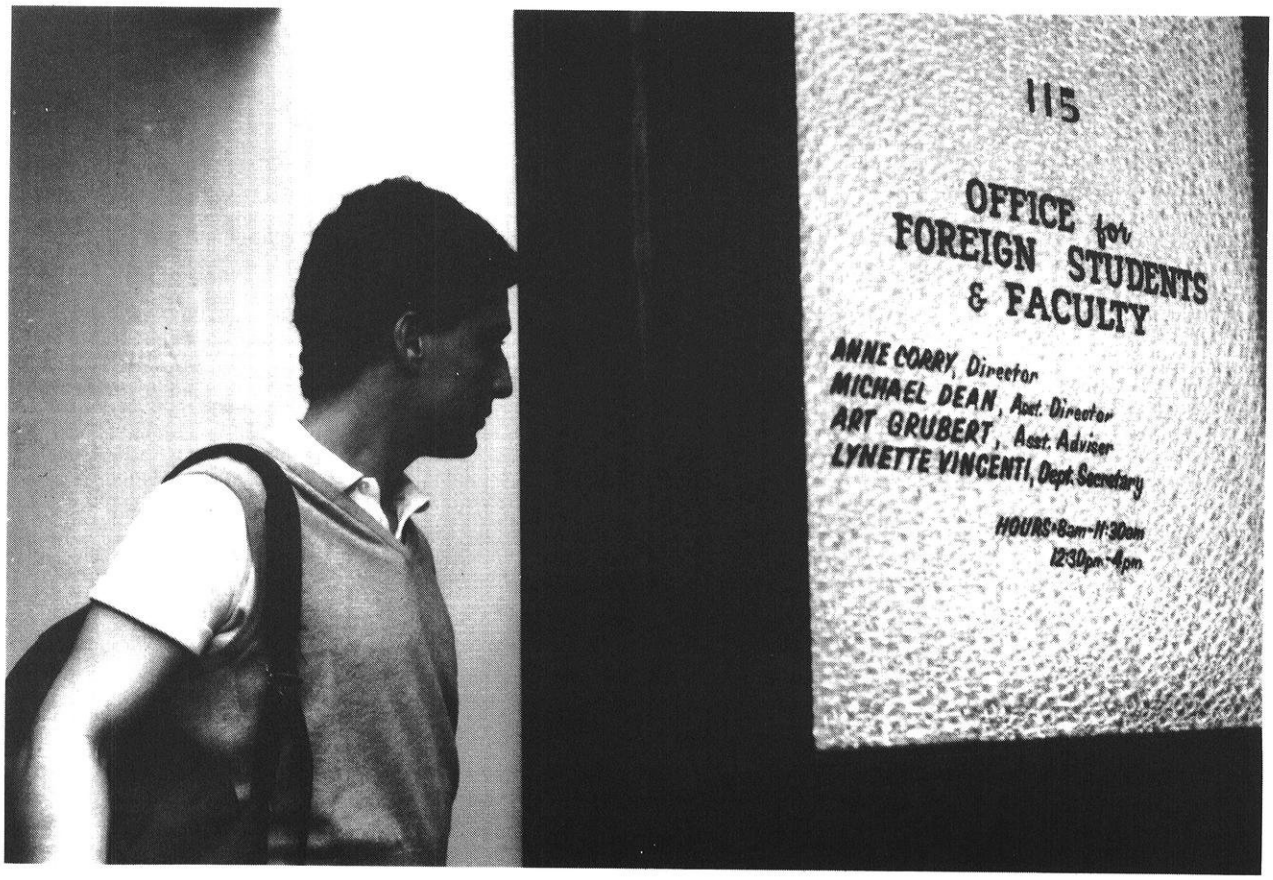
For the next school year (1981/1982) four departments will require a 2.25 gradepoint average: Agricultural Engineering (ALE), Civil and Environmental Engineering (CEE), Engineering Mechanics (EM) and Nuclear Engineering (NE). Five departments will require a 2.50 gradepoint average: Chemical Engineering (ChE), Electrical and Computer Engineering (ECE), Industrial Engineering (IE), Mechanical Engineering (ME) and Metallurgical and Mineral Engineering (MME). Those students who have not been accepted as degree candidates by the time they have accumulated 53 credits will be required to transfer out of the College of Engineering. Once the student has been accepted as a degree candidate, the student must maintain a "C" average and pass 12 credits each semester to be in good standing, which is the same as in past semesters. Most students will have no difficulty becoming degree candidates in two semesters.

Even though students are classified as pre-engineering (EGR) for at least the first 24 credits, they should declare their degree department, which they will do on their registration form by recording a departmental major code number. It is possible to be "undecided" as to departmental major, although course selection is more easily done by students who know their intended degree department. We have a 1 credit elective course, General Engineering 100 (Engineering Freshman Professional Orientation) for those students who need help in deciding which branch of engineering is their best choice. Those students who start as "pre-engineering undecided" should have selected their degree department by the end of their freshman year. All of this is very complicated. If you have not understood, please come to the Engineering Freshman Office and tell us what you need to have clarified.

As a service to the College of Engineering, to help you meet other students, faculty and deans, Triangle Fraternity is reviving a very pleasant activity of past years. All new engineering students are invited to a picnic at the Vilas Park shelter house from 3 to 9 PM on Friday, August 28, 1981. There will be games and other festivities, beer, soft drinks, chips and roast pig for your enjoyment. It should be a nice way to wind up Registration Week, and I look forward to meeting many of you there.

FRESHMAN YEAR REVISITED

by Salah Hamdan



The college of engineering maintains a diverse community of Wisconsin, out-of-state, and "out-of-country" students. Though most students have difficulty at first getting used to college, my jump from the Middle East to the Mid-West presented many challenges unknown to U.S. students.

My approach to the University of Wisconsin was similiar to any student. My final days of high school were aimed at achieving the grades required for all UW applicants. I knew better than to play around and neglect my studies.

A foreign student is required to sit for tests which indicate his ability to suceed in an American school. As do most American students, I took the SAT (Scholastic Aptitude Test) and different achievement tests in chemistry, physics, math and other subjects. A foreign student's proficiency in English is extremely important. The TOEFL (Test for English as a Foreign Language) and the Michigan Test are required by most U.S. schools.

After completing all my examinations, I requested that the agency which provided the tests to send the scores to my prospective universities. It was also required that I send my own certified credentials to a special decision committee at each U.S. school I applied to.

I was lucky enough to enjoy the last days of summer by arriving before school began. I enjoyed Madison's extraordinary autumn. **BUT**, when the thermometer dropped, I wished I had never set foot so close to the Artic Circle as is Wisconsin! The first semester is often the first time a foreign student will see snow. My first winter would get down below zero degrees and then stab me in the back with its wicked wind chill. Everybody kept telling me it was but a mild winter. What a comfort. But, eventually came spring to melt away all chilly memories of winter.

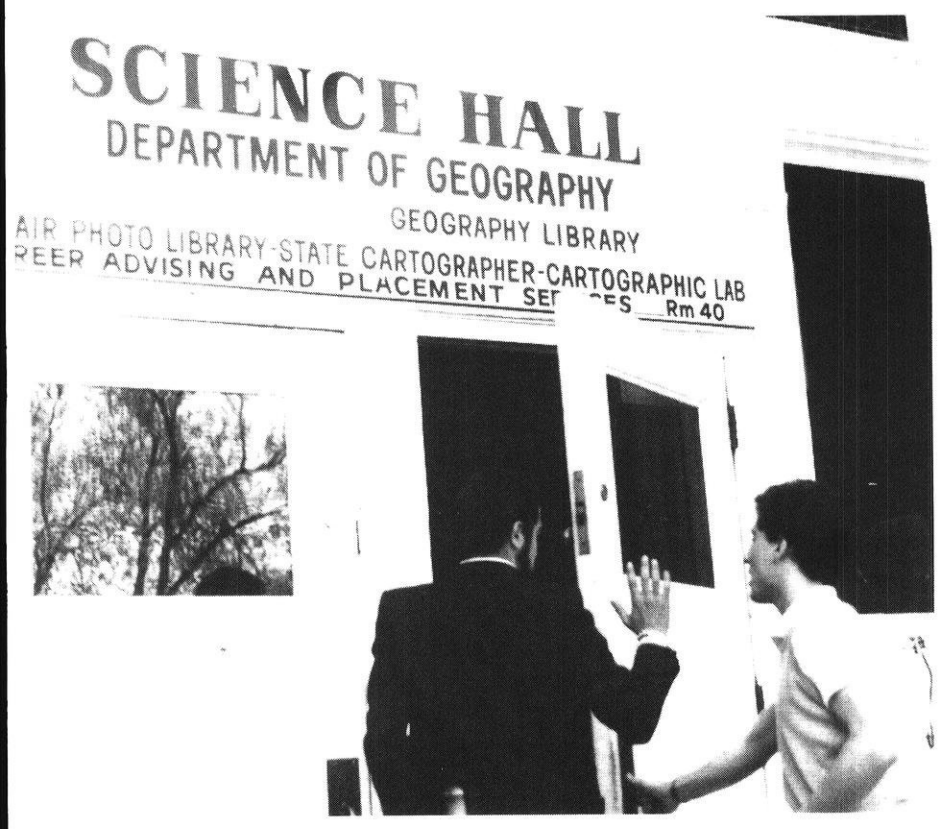
For incoming foreign students, the Office of Foreign Students located in Science Hall can be a big help. The Office pleasantly provides foreign students with assistance in locating housing and introducing the student to his new American environment. The Office also serves to publicize organizations and communities that serve foreign students on campus.

The Wisconsin people are very friendly, I would rather be in Madison than most other places in America. Though adapting to my new life here was difficult, now I find life not that hard and am looking forward to another successful year here in my home away from home, the University of Wisconsin.

It is extremely difficult for whoever is responsible for processing the student applications. Evaluating a student's achievement from a Wisconsin high school is much easier than a Jordanian student's education. A foreign student shares the "out-of-state" status as any other non-Wisconsin resident.

Once I set foot on campus, the size of the UW proved to be physically devastating. Moving from one building to another seemed to be an expedition in itself. The physical challenge compounds ten-fold on Registration Day. Registration is a frustrating experience that a newcomer will not forget for the rest of his life.

Sal is a Jordanian. He is a sophomore in Civil and Environmental Engineering.



ENGINEERING FRATERNITIES

Kappa Eta Kappa: ECE Fraternity

To those pursuing a degree in Electrical Engineering, the Kappa Eta Kappa (KHK) fraternity offers the chance to meet and get to know other ECE students and professors in a social-professional atmosphere. The fraternity has two major goals: to promote top academic performance while at the same time encouraging the development of a wellrounded person who is able to interact with others.

With these goals in mind, Alpha Chapter of KHK was founded at the University of Iowa in 1923. The Madison based Delta chapter was formed a year later. There are currently three active chapters in the national organization: Beta at the University of Minnesota, Delta at UW-Madison, and Theta at the Milwaukee School of Engineering.

An engineering education prepares the student for the complex world we now live in. Rapid social and technological changes in our society require that electrical engineers bear the responsbility to make well-informed decisions based on the principles learned in school. Kappa Eta Kappa provides an opportunity for these engineers to live and work together in a professional environment during college. A major benefit of the fraternity is that its members provide academic assistance to those trying to understand difficult topics and theories. A helpful suggestion may be no farther than a roommate or a phone call away.

The development of the organizational and communication skills needed to function effectively in the group oriented engineering profession is another important part of KHK. Participation in the operation of the fraternity, either through an elected office or in events like the Engineering Exposition, contribute to the management and technical expertise so important in today's busy world. This part spring the members presented an Expo exhibit that demonstrated various methods of computer generation of sound, and received the award of Honorable Mention.

Alumni of the fraternity has formed an Alumni Association which provides scholarships and fosters professional contact with the active members of the fraternity. This organization helps to bridge the gap between the classroom and industry. New graduates often find it

The Kappa Eta Kappa Fraternity house located at 114 N. Orchard Street.

useful to consult with these alumni about particular employers and job locations before finalizing their career decisions. The well informed opinion of an alumnus has contributed to the early success and satisfaction of many recent graduates.

The importance of social growth is stressed at KHK to support the premise that a person who has only technical abilities cannot expect to go far if he is unable to collaborate and communicate well with others. Social development should be as much an aim of life during college as scholastic achievement. The student who cultivates these ideals has an advantage over the student who neglects one or the other.

At KHK, many social activities are held during the course of a semester such as organized theme parties, an annual Road Rally, a Faculty-Fraternity softball game, and a National campout. The members of the fraternity meet the faculty on a social level each semester at a get-together. The athletic chairman organizes various intramural activities including softball, water polo and volleyball.

Kappa Eta Kappa invites all electrical engineering students to consider these and other benefits offered by joining the brotherhood. The nights of September 14 and 21 have been set aside as Open House, during which time prospective members are introduced to the fraternity. However, inquiries are welcome at any time. Call 257-1354 or stop by the house at 114 N. Orchard St. (1 block south of Union South) and talk to any member for more information.

Contributing writers: Paul Agarwal, Paul Anderson and Roger Hermann.

The Theta Tau Fraternity house.

Theta Tau:
The Engineer's Choice

Why join an engineering fraternity? What does it have to offer? These might be two questions you have about engineering fraternities. In this article I would like to try and give you some insight into what one engineering fraternity, Theta Tau, has to offer. I will do this by relating some of my own experiences, then general benefits and responsibilities you will find in Theta Tau.

Let me start from my beginning at the University. I enrolled as a new freshman in the fall of 1979. When I came to school I didn't have a dorm to stay in. So I started looking around for a place to stay. After looking at many places I decided to stay at Theta Tau. My decision was based on the friendly atmosphere which greeted me. The atmosphere was that of a group of very close friends working together on the house and not of someone trying to rent out a room.

I moved that fall and pledged that semester. I was initiated in December and was elected as house manager in January. The house manager is in charge of collecting rent and keeping the house running smoothly. In the fall of 1980 I was elected social chairman. I ran the program with such success that I was elected Regent (President) in

January 1981. A new Regent was recently elected for the fall and I will fill the position of Vice Regent. Now that you have a general idea where I stand I would like to discuss some of the general benefits of Theta Tau.

As I have already mentioned we have a house. We use the house for rooms, it has beds for twelve, meetings, and general social gatherings. As I stated earlier the house was being worked on. This included a new basement and heating system. Right now we are tieing up some loose ends. This remodeling was a good learning process for all involved. Besides general construction we learned how to do our part in working towards a common goal. This learning is only one of the benefits that Theta Tau has to offer. Since the fraternity is made up of all engineers, there is always someone around who can answer a question.

Theta Tau also has a full social program to give every engineer what he/she might be missing, a meaning to life. You may have noticed I said he/she, which points to a unique feature of Theta Tau. Theta Tau is the only engineering fraternity which admits women. We have been doing this for over five years and we feel that this is a great asset to our fraternity.

The responsibilities of the fraternity can be beneficial too. These responsibilities vary with the job you accept and how much you are willing to put into it. With the positions I have held came many responsibilities. As the house manager, I had to handle the house money and keep the house going. As social chairman, I had to organize a series of events around other schedules. I then had to organize the preparations and clean-up to ensure a successful event. As Regent I had few organizing jobs, but the main responsibilities were to oversee and moderate the fraternity. I'm sure you can see the benefits derived from these responsibilities and how they may help you in your future careers.

I have given you a brief look at what Theta Tau has to offer to its members. But beyond these benefits and responsibilities, being in Theta Tau is just plain fun. If you have any further questions, feel free to contact us either at our house or in school.

Good Luck

Michael Farmer
Vice Regent

Triangle Fraternity

The men of Triangle would like to express a warm welcome to the University of Wisconsin, College of Engineering. Triangle Fraternity, in its sixty-eighth year on campus, is a Fraternity of Engineers, Architects, and Scientists.

The name "Triangle" stands apart from the greek letter fraternities in that it is an easily recognizable name which symbolizes our background as a distinguished professionally oriented social fraternity.

Triangle offers you unique benefits at this time as an undergraduate, and later as an alumnus, offering encouragement and assistance in developing the highest standards of personal and professional ethics.

All fraternities, especially Triangle, recognize and support the goals of the Alma Mater and those of the community through responsible participation and action. Triangle encourages its members to associate actively with any of the professional or honorary societies on the Engineering Campus. Triangle also sponsors activities every semester which assist the elderly or underprivileged through the Department of Social Services in Dane County.

Our Fraternity is in many ways the final gap between undergraduate study and the vocation of the individual in the academic world, industry or government. A member of Triangle is exposed to a variety of professional opportunities simply because he has the leadership experience gained as an active or an officer.

Nationally, Triangle Fraternity schedules many important conventions, meetings and workshops for its thirty-three chapters. This year, and every other year hence, our National Convention brings together Triangle members from all across the nation. Workshops, legislation, installation of new chapters and organizational seminars constitute a large portion of the convention's three days.

Each individual chapter must work in conjunction with its Alumni Board of Directors and Building Corporation in efforts to maintain its house. Our chapter house, located on 148 N. Breese Terrace, was completely remodeled three years ago. Our basement bar and party room was remodeled this year, and we are presently replacing some much needed furniture on our main floor. Feel free to stop over and tour our facilities.

Our initiation fees and active dues are the least expensive of any Fraternity, and our rent is certainly one of the lowest on campus.

Our constitution does not allow us to initiate women at the present time. In regards to this, Triangle at Wisconsin pro-

Triangle Fraternity house, located at 148 N. Breese Terrace.

vides a base for our Triangle Sister Organization. Our sisters are not restricted to any field of study although half are enrolled in Engineering. Initiation as a Sister provides many opportunities through organizational meetings and social activities with the Fraternity.

Triangle provides many social activities for its Active, Sister and Alumni organizations, as well as the entire Engineering Campus. These activities include the New Engineering Student Picnic (NESP) to be held on August 28, the Friday of registration week. It will take place at Vilas Park and we will provide a band, plenty of beer, roast pig, sports events, and a chance to meet your engineering faculty. Our house holds pre-football game warmups, a semi-formal Homecoming dinner and dance, a Christmas Party, our Founders' Day celebration, Spring Picnic, and dinners at the house twice each semester with a guest speaker. Over the summer, members and friends organize camping and canoeing trips.

Triangle Fraternity is more than a club. Our chapter is comprised of individuals, each pursuing their own course of study. We learn from our members, alumni and friends. We learn as a group so that each one of us contributes to each other's life and to Triangle.

Our calendar is a very busy one, as you may realize, and Triangle emphasizes the importance of each and every member putting out his very best in order to attain our goals. Go for it!

I sincerely recommend that each undergraduate engineering student consider the advantages that any fraternity has to offer. Look into each organization, realize for yourself the potential it may have. I strongly believe in Triangle and hope you see the very same attributes that set us apart from the rest of the organizations on campus. Whatever your decision, I wish you the very best in your academic and professional career.

Sincerely Yours,

James J. Parker
President
Triangle Fraternity

GODEL, ESCHER, BACH

Summer Reading for the Wisconsin Engineer

School's out, and we are enjoying the simple pleasures of summer: the sun, the hammock, a chilled Leinenkugal's, and a good book. The sky provides the sun, and at any store can be had the hammock and hops. But, finding the right book for the vacationing engineer can be frustrating. College kids can't red *Hot Rod* and *Mad* magazines forever. Now it's time to read the "good stuff", books they award the Pulitzer Prize. Such a book is *Godel, Escher, Bach*, by Douglas Hofstadter.

Godel, Escher, Bach is a lively book exploring the abstract math of Kurt Godel (1930's), the art of Maurits Escher (mid-1900's), and the music of Johann Sebastine Bach (1700's). Douglas Hofstadter's combination of math and art is not only entertaining, it provides an education in the areas of philosophy not included in a standard engineering curriculum.

STRANGE LOOPS

In the effort to understand the world, philosophers and scientists have attempted to assign formal rules to nature. Universal truths, such as what goes up must come down were sought for every facet of life. For hundreds of years man has attempted to regulate the world into a formal system of all-true rules and regulations. Instead of finding such a formal system, thinkers have discovered the universal presence of what are known as Strange Loops.

A Strange Loop is a circular system of though or motion that never ends. What makes these loops "strange" is that they finish exactly in the way they begin, making infinite cycles. Their definition is actually their own existence. (Physically: a ball pushing itself into perpetual motion. Mentally: a Strange Loop is Descartes' famous line, "I think, therefore I am.") A Strange Loop can assume many forms, as in the following sentence couple:

The following sentence is false.
The preceding sentence is true.

Whether these statements are logical or not, they do exist. Or do they? This is the charm of the Strange Loop and the theme of the book; for these loops were studied by Godel, Escher, and Bach.

Godel proposed math as a Strange Loop in itself; for the foundation theorems of math can only be proven by other theorems. Though Godel's proof of his theory is in mathmatical statements too elevated for the average reader, the works of Escher and Bach are used as valuable teaching aids.

ESCHER

Escher's prints of the abstract and perpetual motion are known to most students. His perception of the world is mirrored by the creation of other worlds in his drawings. When matched to Godel's math, Escher's works are worth a thousand words of explanation. In the print, "Drawing Hands", the left hand is drawing the right and the right hand is drawing the left! This is similar to mathmatic's habit of defining itself by itself, creating a very strang loop indeed.

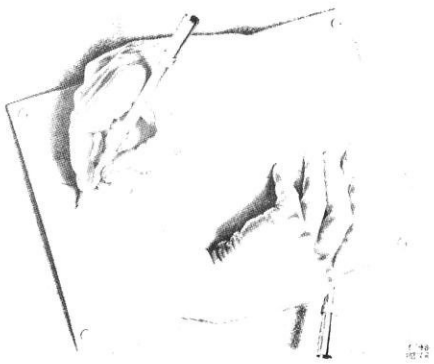
Escher prints are used to illustrate concepts which branch from GEB's "Strange Loop" theme. The print "Crab Cannon" relates to the author's discussion of "figure and ground". In the drawing, the bodies of the black crabs define the bodies of the white crabs. Hofstadter presents this drawing, and then questions whether a letter (the figure) doesn't create a new message with the empty space (the ground) it leaves on the page? This question is taken one step further. It is asked whether incorrect theorems in conventional math don't contain separate mathematical systems within themselves. The connections made between Escher's art and Godel's math are thought-provoking, to say the least.

BACH

J. S. Bach composed some of the world's most beautiful and complex music. He was the master of the fugue, a Strange

Kurt Gödel.

Johann Sebastian Bach



Drawing Hands, by M.C. Escher (lithograph, 1948).

Loop comprised of notes. In a fugue, an initial theme is introduced and then transformed into many variations. A variation would include the theme played backward, inverted, even raising an octive at the completion of each loop. The latter variation was the ultimate loop, for at the composition's finale, the music would be back in the initial octive, with no sudden change in the music. Bach had achieved perpetual musical motion.

GODEL

Mathematics is treated with a philosophical twist in *GEB.* An introduction to abstract logic is made by Hofstadter when he explains Russel's Paradox (a classic Strange Loop) in the following paragraphs:

"Most sets, it would seem, are not members of themselves - for example, the set of walruses is not a walrus, the set containing only Joan of Arc is not Joan of Arc (a set is not a person) - and so on. In this respect, most sets are rather "run-of-the-mill". However, some "selfswallowing" sets do contain themselves as members, such as the set of all sets, or the set of all things except Joan of Arc, and so on. Clearly, every set is either run-of-the-mill or self-swallowing, and no set can be both...

"Now, nothing prevents us from inventing R: *the set of all run-of-the-mill sets.* At first, R might seem a rather run-of-the-mill invention but that opinion must be revised when you ask yourself, 'Is R itself a run-of-the-mill set or a self-swallowing set?' You will find that the answer is: 'R is neither run-of-the-mill nor self-swallowing, for either choice leads to paradox.' Try it!"

Russel's paradox and others like it were not allowed by mathematicians in the early 1900's. The mathematic "rule-book" at that time was called the *Principia Mathematica.* Hofstadter describes the book as "...a mammoth exercise of exorcising Strange Loops from logic, set theory, and number theory...at the cost of disallowing the formation of certain kinds of sets - such as the set of all run-of-the-mill sets. Intuitively, this is not how we imagine sets..." The *Principia Mathematica* had stuffed logic into a box, ignoring common intuition. Only Godel followed this intuition, and published his Incompleteness theorem. Godel proved"...probability is a weaker notion than truth."

ACHILLES AND MR. TORTOISE

Presented at the end of each chapter is a short play called a dialogue. In a dialogue, wacky characters as Achilles and Mr. Tortoise weave Strange Loops with their conversations and wild adventures. The style and casting of these plays were inspired by Lewis Carrol, author of "Alice's Adventures in Wonderland." As it happens, J. S. Bach is Mr. Tortoise's favorite composer and Achilles is very fond of Escher's art. Together, they listen to fugues, take trips into Escher drawings, and lead conversations with definite Godel influences. These dialogues are the icing off each chapter; allowing the reader to have his concept and eat it too.

Rarely does a book encorporate such an entertaining blend of scientific and philosophical though as does **Godel, Escher, Bach.** There are truly no bounds to the book, no rules as to what is right or wrong. It is an intelligent book and to read it is a pleasure and an enlightenment.

John Wengler is a sophomore in Civil Engineering.

Find Your Identity

No matter how many years of math a student has, the trigonometric identities never manage to nestle into the memory. Every time the student needs a trig identity, to find it he must fumble through his notes, usually to no avail.

Here is a list of many of the identities needed during the engineer's calculus sequence. Also included are some basic algebraic identities the student will find useful. Cut this page out; put it in your notebook, on your bulletin board, trade them or collect the whole series!

Fundamental Identities

$\sin^2(a) + \cos^2(a) = 1$

$\cos(a) = \cos(-a)$

$\sin(-a) = -\sin(a)$

$\tan(-a) = -\tan(a)$

$\sin^2(a) = \frac{(1-\cos(2a))}{2}$

$\cos^2(a) = \frac{(1+\cos(2a))}{2}$

$\tan(a) = \frac{\sin(a)}{\cos(a)}$

$\csc(a) = \frac{1}{\sin(a)}$

$\cot(a) = \frac{\cos(a)}{\sin(a)}$

$\sec(a) = \frac{1}{\cos(a)}$

Addition and Subtraction Formulas

$\sin[a \pm b] = \sin(a)\cos(b) \pm \cos(a)\sin(b)$

$\cos[a \pm b] = \cos(a)\cos(b) \pm \sin(a)\sin(b)$

$\tan[a \pm b] = \tan(a) \pm \tan(b)$

$\tan[a \pm b] = \frac{\tan(a) \pm \tan(b)}{1 \mp \tan(a)\tan(b)}$

Double-Angle Formulas

$\tan(2a) = \frac{2\tan(a)}{1-\tan^2(a)}$

$\sin(2a) = 2\sin(a)\cos(a)$

$\cos(2a) = 2\cos^2(a)-1 = 1-2\sin^2(a)$

$= \cos^2(a)-\sin^2(a)$

Half-Angle Formulas

$\tan(a/2) = \left[\frac{(1-\cos(a))}{(1+\cos(a))}\right]^{1/2}$

$\sin(a/2) = \left[\frac{(1-\cos(a))}{(2)}\right]^{1/2}$

$\cos(a/2) = \left[\frac{(1+\cos(a))}{(2)}\right]^{1/2}$

Product Formulas

$\sin(a)\sin(b) = \frac{\cos(a-b)}{2} - \frac{\cos(a+b)}{2}$

$\cos(a)\cos(b) = \frac{\cos(a-b)}{2} + \frac{\cos(a+b)}{2}$

$\sin(a)\cos(b) = \frac{\sin(a+b)}{2} + \frac{\sin(a-b)}{2}$

$\cos(a)\sin(b) = \frac{\sin(a+b)}{2} - \frac{\sin(a-b)}{2}$

Other Useful Formulas

Quadratic equation:

If $ax^2 + bx + c = 0$

Then $x = \frac{-b \pm (b^2 - 4ac)^{1/2}}{2a}$

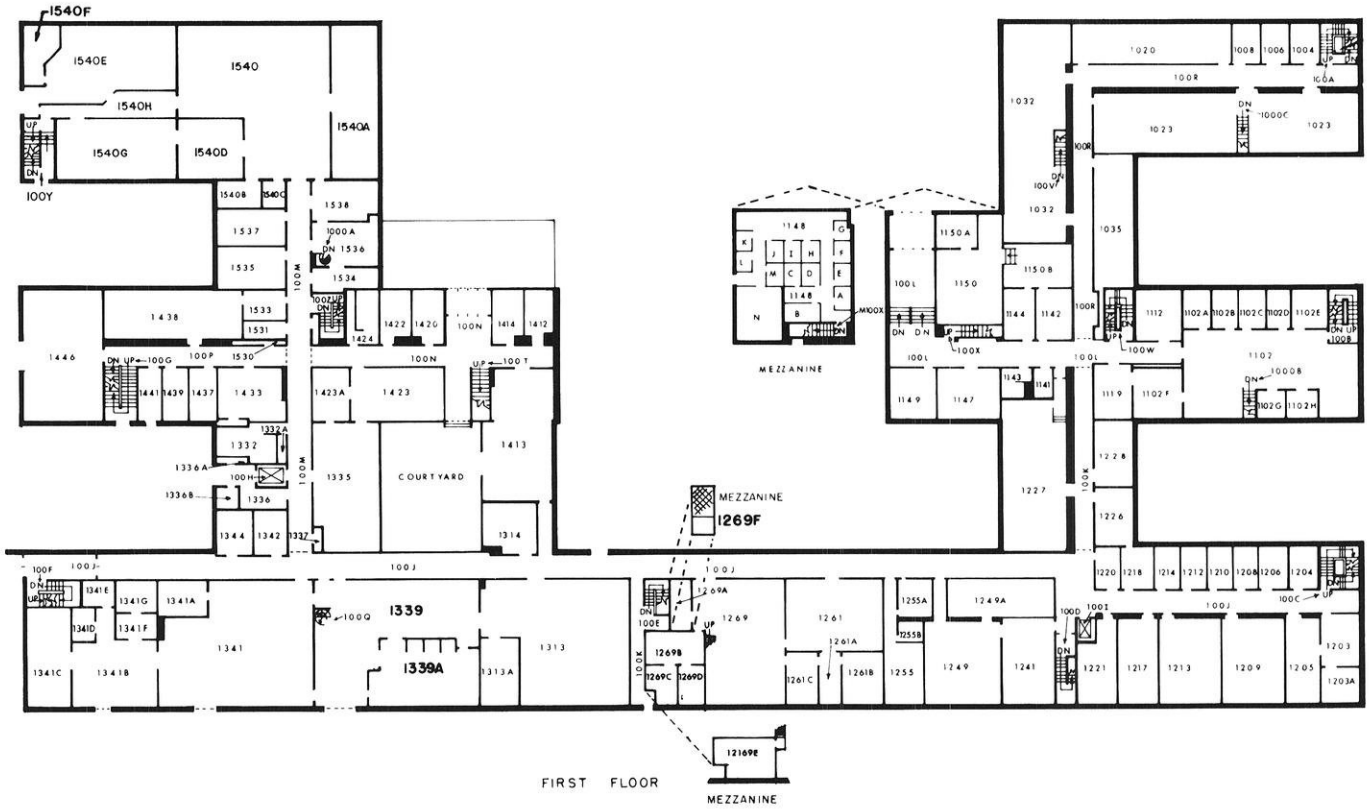
$(a \pm b)^2 = a^2 \pm 2ab + b^2$

$(a \pm b)^3 = a^3 \pm 3a^2b + 3ab^2 \pm b^3$

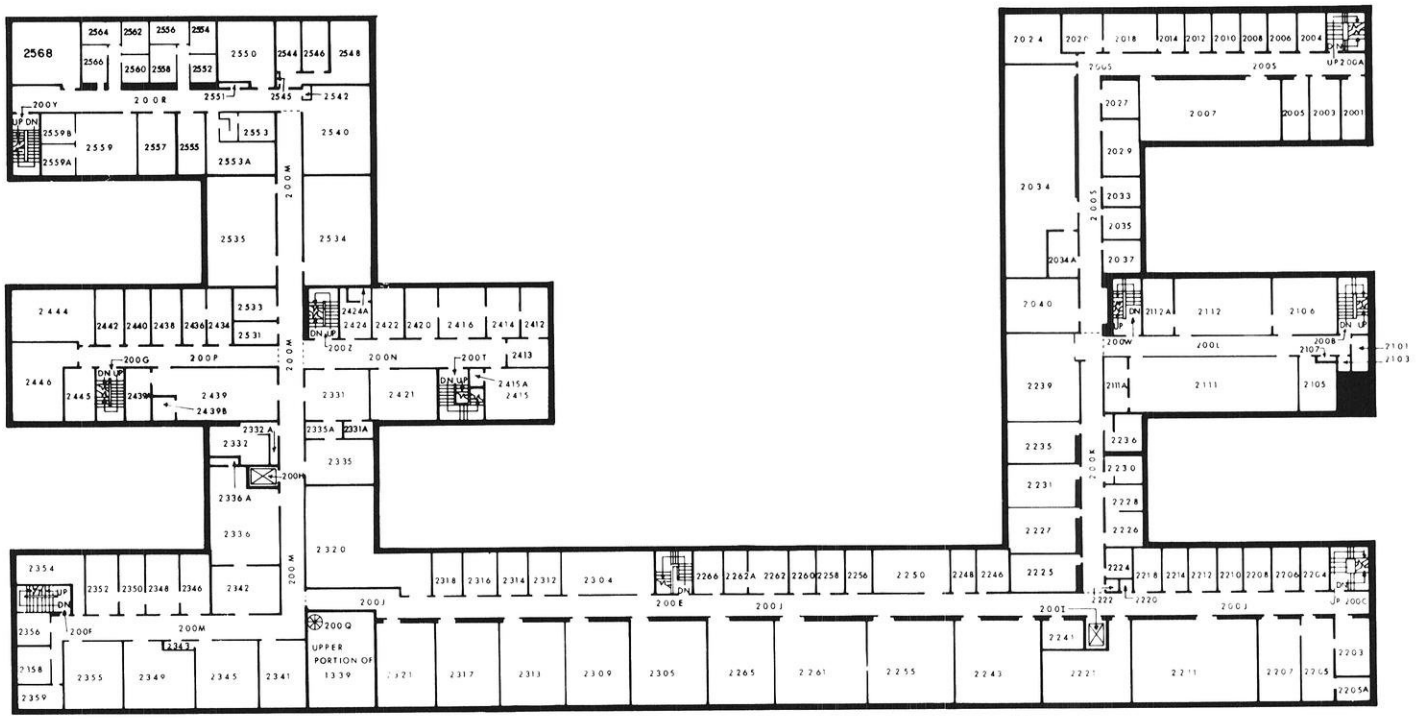
$(a \pm b)^4 = a^4 \pm 4a^3b + 6a^2b^2 \pm 4ab^3 + b^4$

$a^3 \pm b^3 = (a \pm b)(a^2 \pm ab + b^2)$

MAIN ENGINEERING BUILDING



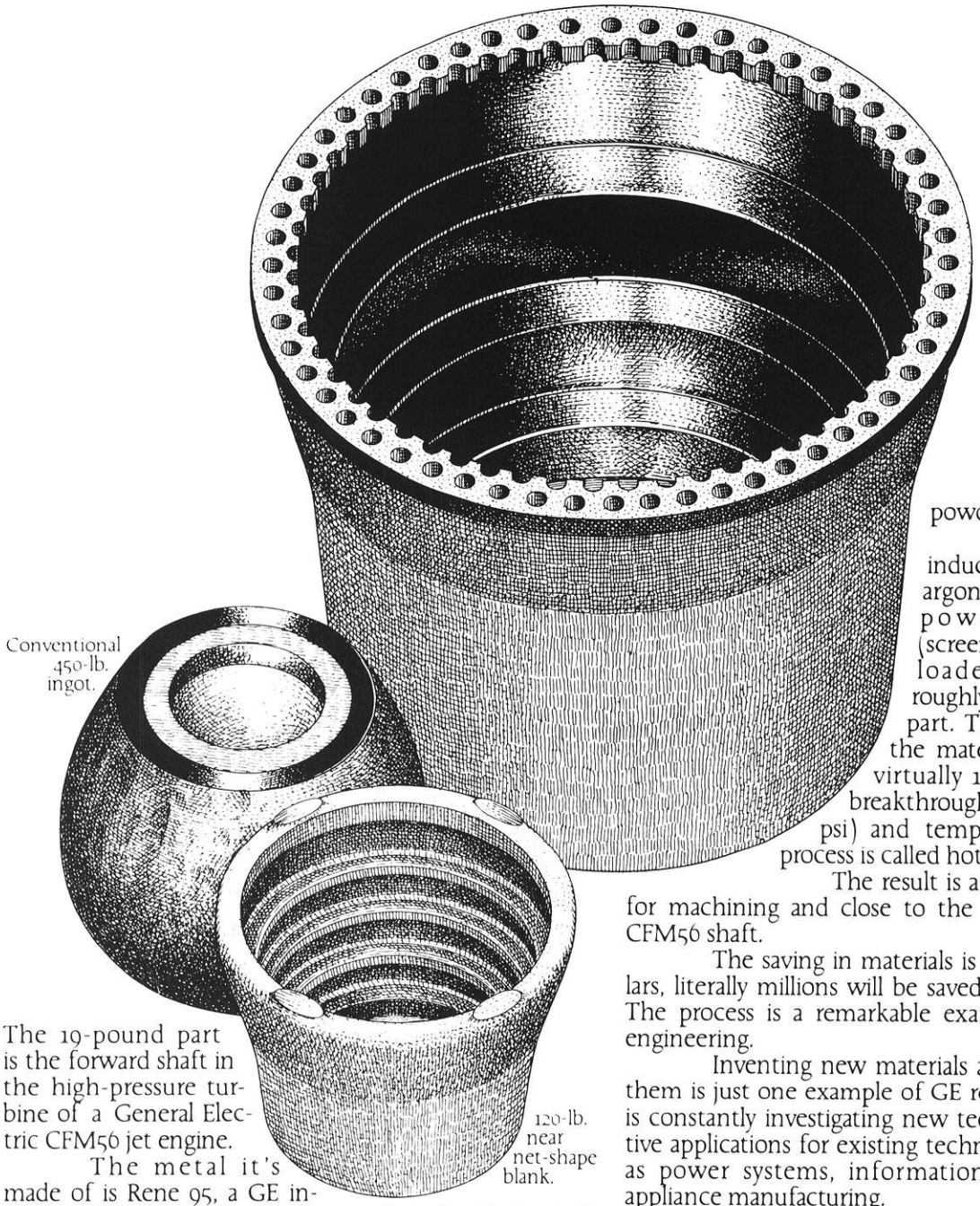
FIRST FLOOR



SECOND FLOOR

N

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



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. 30, General Electric, Schenectady, New York 12345.

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