Wisconsin engineer. Volume 82, No. 2 November 1977

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

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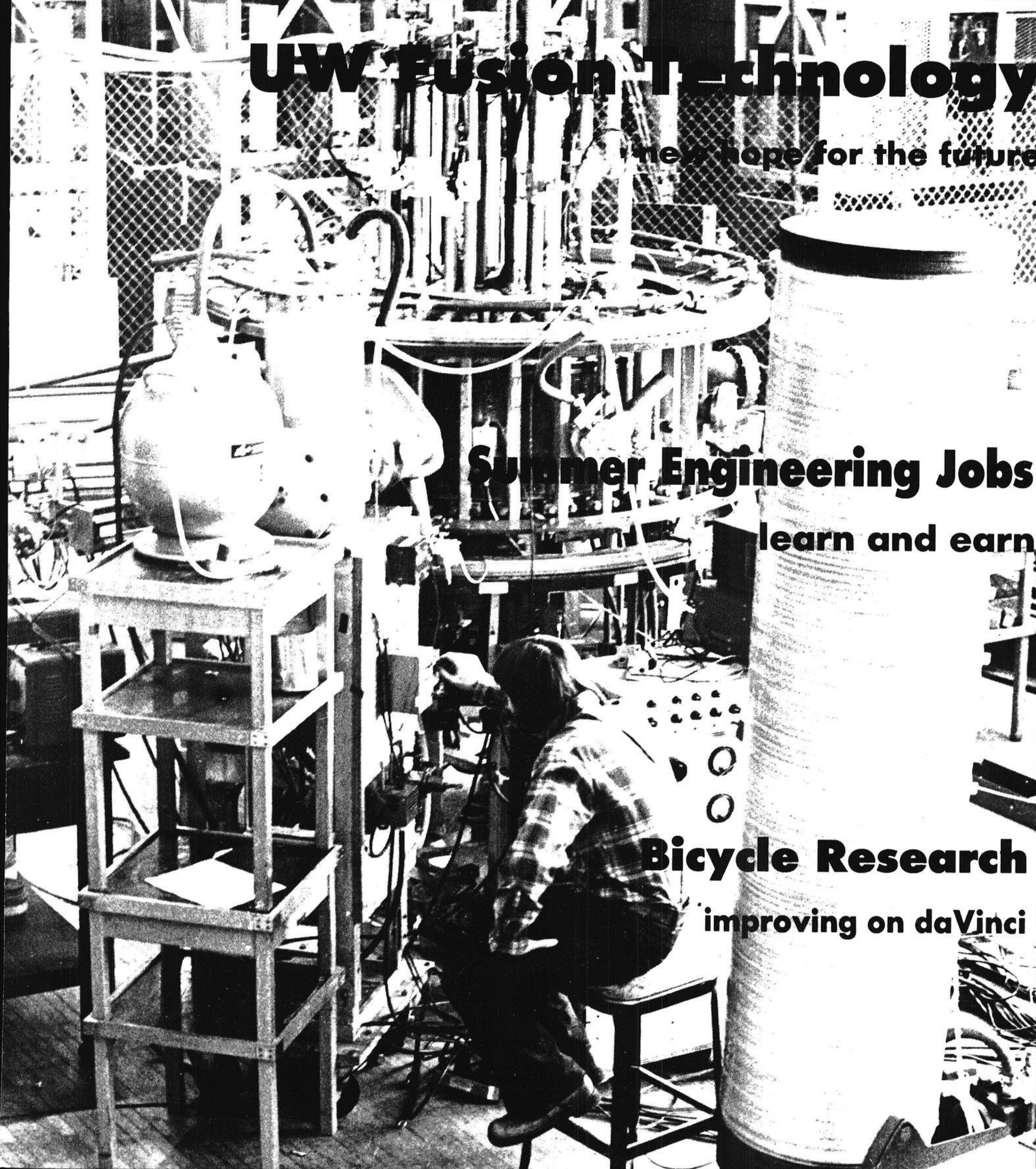
UME 82, NO. 2

NOVEMBER, 1977

visconsin engineer



UW Fusion Technology

new hope for the future

Summer Engineering Jobs

learn and earn

Bicycle Research

improving on daVinci

From the Desk of the Editor

The Capitol Concourse recently opened with much fanfare and hoopla. Madison, it is said, has made a firm commitment to revitalizing its downtown area—to make it "a place for people." This project was completed only after much deliberation and at a great expense to Madison taxpayers.

After surveying the reopened Square, the question needs to be asked: what was really accomplished here? Very little, apparently.

Car traffic is still the dominant feature of the area, with a fifty-foot wide strip of pavement encircling the Capitol. The Square now has a newer, neater appearance; but basically it remains the same.

Plans are supposedly being made to limit traffic on the Capital Concourse. Their effectiveness remains to be seen.

The Capitol Concourse was a great idea, it's too bad it was meekly executed. There is still hope for the State Street Mall if Madison planners will only be persisten their resolution to make a plac people and not cars.

The Wisconsin Engineer *is st desperate need of staff people. office hours are on Tuesday Thursday afternoons from 1 to room 276 Mechanical Enginee Please stop up with your comn and ideas.*

Be It Resolved

The WSA Senate is in the process of rewriting its constitution and by-laws to reduce ambiguity and conflict and to make student government more representative. As a member of the rules committee, I am directly involved in this discussion and would like to inform you of certain proposals currently under consideration.

A number of motions have been presented which shift the emphasis of Senate authority from the traditional district representative to a mass assembly basis. The crux of these various motions all involve extending voting privileges to any student, currently enrolled, who attends a "senate" meeting. This is in response to the criticism that WSA is unrepresentative of the student body. It is hoped that this would increase student representation by allowing every student equal access into government affairs, if they showed up at the meetings.

As a senator from a low-profile, conservative college, I am deeply concerned that a system may evolve which demands a large student population from each district to become actively involved in student government if their interests are to be heard. I contend that these amendments would further remove the students on the western part of campus and increase the already disproportionate influence of those interests who can afford to spend more time in student government.

The engineering students are n campus to administer student a but to obtain an education. concern with a mass assembly sy is that students with a political est would be more active in this of government. The mass asse system is a serious threat to student who, realizing their tim educational constraints, dele their interest to a specific repre ative in the belief that their view receive equal consideration. In re ing the constitution and by-laws WSA must reaffirm that each stu be equitably represented, not each student become a representa My office hours are Thursday a noons, 1 to 3, in the program offi Union South. Discussion of thes any related topics is encouraged.

wisconsin engineer

PUBLISHED BY THE ENGINEERING STUDENTS of the UNIVERSITY OF WISCONSIN

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Charter Member of Engineering College Magazines Associated
Chairman: D. C. WILLIAMS, Ohio State University, Columbus, Ohio 43210.

Publishers Representatives: LITTEL-MURRAY-BARNHILL, INC., 60 East 42nd St., New York, NY 10017 and 221 N. LaSalle St., Chicago IL 60601.

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Second Class Postage Paid at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized Oct. 21, 1918.

Published seven times a year, Oct., Nov., (Dec.-Jan.), Feb., Mar., Apr., Summer Issue by the Wisconsin Engineering Journal Assn. Subscriptions: one year–$3.00. Single copies are 50 cents per copy. 276 Mechanical Engineering Bldg., Madison, WI 53706. Office Phone (608) 262-3494.

Wisconsin's Fusion Technology Program

Robert Ebisch

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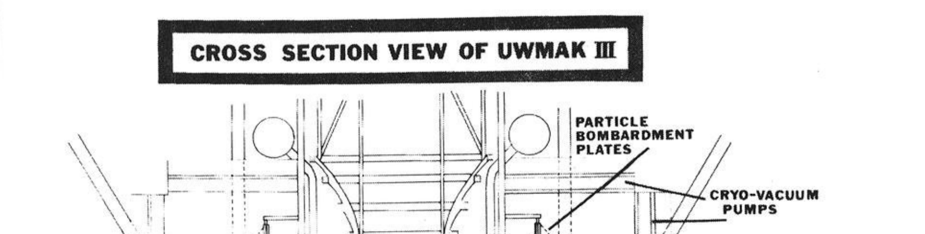


The UWMAK III reactor.

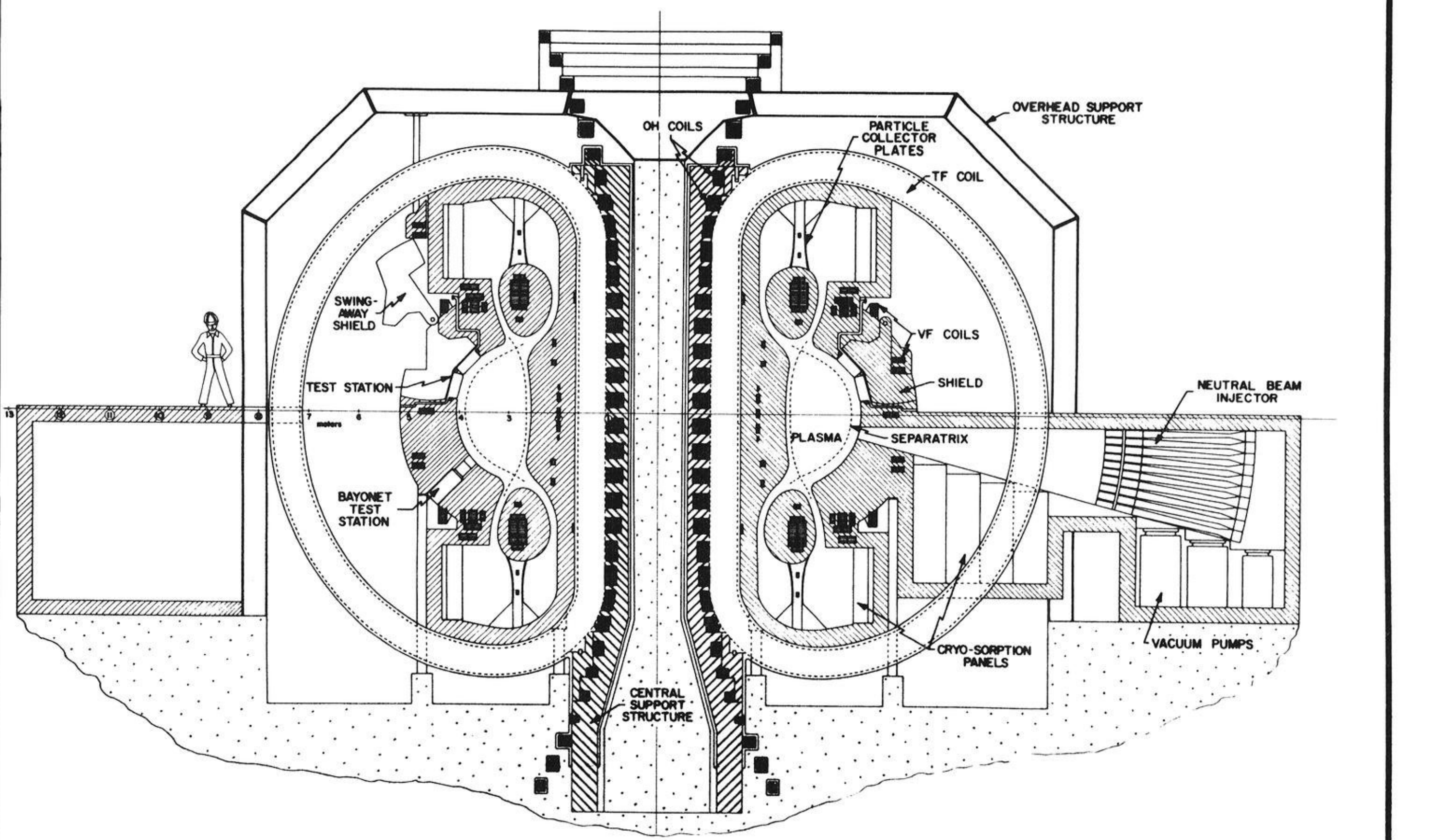
THE FUSION TECHNOLOGY PROGRAM at the University o Wisconsin-Madison is widely re cognized as the foremost pro gram of its kind in the country Started in 1971, it has an annua budget of $1 million, about 50 percent of which is provided by the U. S. Energy Research and Development Administratio (ERDA), 40 percent by the Electric Power Research Insti tute, and the remaining 10 percent by the Wisconsin Electri Utilities Research Foundation.

Thermonuclear fusion, the ener gy source of the sun, is one o the bright lights on the energy horizon.

If man-made stars can be ignited and controlled on earth and if the technical problems o fusion reactor design can be solved, the world will have a endless supply of energy.

Fusion reactions take place when certain light nuclei collide and fuse. The reaction releases much more energy than was required to drive the nucle together.

CROSS SECTION VIEW OF TETR



Cross-sectional view of the Tokamak Engineering Test Reactor (TETR), designed as a test facility for experimental study of reactor problems.

For appreciable amounts of power to emerge from fusion, the fuel—deuterium gas, for example—must be heated until the thermal motion of the atoms becomes so violent that colliding nuclei fuse.

Long before fusion begins, the gas ceases to be a gas. At about 10,000 degrees C the atoms collide so energetically that they are stripped of electrons. The resulting cloud of electrons and nuclei is known as a plasma. Called a fourth state of matter, plasmas are much more difficult to handle than gases. They are wildly energetic and the separation of positive nuclei and negative electrons creates complicated forces still not well understood.

Today, reactors are being designed to burn a mixture of deuterium and tritium, hydrogen isotopes that have one and two additional neutrons respectively. The thermonuclear fusion of deuterium and tritium can be produced more easily and at lower temperatures than other fusion reactions, and consequently it probably will be the first fusion reaction to be used.

Tritium, virtually nonexistent in nature, must be manufactured from lithium. Lithium reserves offer an energy potential equal to that of the world's total fossil fuel reserves, enough to keep things running for several centuries.

Yet once the deuterium-tritium (D-T) reaction is tamed, researchers believe, it will be only a matter of time until the deuterium-deuterium (D-D) reaction falls under human control. The (D-D) reaction is essentially an infinite source of power because deuterium is abundant in sea water. The potential fusion energy in one cubic meter of ocean equals the energy content of 2,000 barrels of crude oil. Deuterium extraction is not difficult. Considering the volume of water in the oceans, deuterium fusion offers one billion times as much energy as all the coal and oil and natural gas on earth. If one percent of the deuterium supply were burned at only 10 percent efficiency, it would satisfy world energy needs for three million years.

Pursuit of economical power from fusion has become one of the most awesome scientific undertakings of all time. The United States, Russia, Europe, and Japan have all spent millions of dollars to set up large-scale programs designed to create demonstration power reactors before the end of the century.

The United States is supporting one-third of the world effort, measured in man-years of work. Collaboration among all nations exists and during the past five years a particularly close working relationship has developed between the U.S. and the U.S.S.R. The U.S. is working toward development of a Tokamak Fusion Test Reactor, Russia is developing the Tokamak-20, Europe the Joint European Tokamak, and Japan the Tokamak-60.

So complicated are the problems of making fusion economically and environmentally acceptable, that in the U.S. the research is proceeding along a number of avenues each with special advantages and difficulties.

The four most promising fusion schemes are:

—*the tokamak*, in which a plasma is squeezed by powerful magnetic fields inside a toroidal (doughnut-shaped) vacuum changer; the word "tokamak" comes from the Russian words for toroidal magnetic changer.

—*laser fusion*, in which high-energy laser beams are slammed into a tiny pellet of D-T fuel from all sides, imploding its core to such high temperature and density that fusion occurs.

—*the magnetic mirror*, where the reaction chamber is a straight tube with open ends; the magnetic field is given enormous strength at the ends, and plasma particles that seek to escape are reflected back to the middle of the tube.

—*the theta pinch*, in which a gigantic electrical charge is fired around a cylinder full of plasma, inducing a strong current in the plasma; the current produces its own magnetic field which, in turn, interacts with the fast-moving particles of the plasma and forces them inward, pinching them together in a dense, hot filament along the tube's axis.

Wisconsin Program

Tokamaks and laser fusion devices are being studied at the University of Wisconsin. According to nuclear engineer Robert Conn, director of Wisconsin's Fusion Technology Program, the tokamak is currently the most promising approach.

"Tokamak engineers are closest to achieving a demonstration reactor for commercial application," Conn explains. "The major world-wide effort is devoted to tokamaks. In 1975 it was estimated that 60 percent of the U.S. fusion effort went to tokamak research."

Over the last five years Wisconsin researchers have put together detailed blueprints for three separate tokamak power stations. UWMAK-I, UWMAK-II and UWMAK-III. Created by Conn and Gerald Kulcinski, nuclear engineer and associate director of the program, and their colleagues, the designs are an attempt to understand how fusion reactors can be built using presently available technology.

In the reaction chamber of UWMAK-III, a thermonuclear D-T plasma burns at 100 million degrees. It is suspended in a magnetic cage to prevent disintegration of the chamber wall. Outside the wall, flowing liquid lithium and liquid helium slow neutrons emerging from the reaction, extract heat, and breed new tritium fuel from neutron-lithium collisions. A shield of boron carbide and lead stops most neutrons passing through the blanket, protecting the magnets surrounding the toroid. The whole assemblage is shielded by steel and concrete.

"Research on fusion technology began seriously five or six years ago," Conn says. "We recognized a need to identify the problems demanding most attention. We don't want unpleasant surprises 10 or 20 years down the road."

UWMAK-III

One unique feature of UWMAK-III is the noncircular shape of the plasma, permitting an especially high ratio of plasma pressure to magnetic field pressure. Plasma exerts an outward pressure on its container, the magnetic field. The magnetic field exerts an inward pressure on the plasma. The higher ratio in UWMAK-III means greater power generation with no increase in magnetic field strength.

Size reduction is another important feature. The plasma volume of UWMAK-III is one-third that of UWMAK-I, yet it puts out the same power. This is made possible by the increased power density of UWMAK-III's plasma.

The high power density has, however, increased the flow of neutrons into the plasma chamber wall. Ordinarily this would hasten wall disintegration. But Conn and Kulcinski have covered the wall with a blanket of graphite to slow the neutrons and decrease damage.

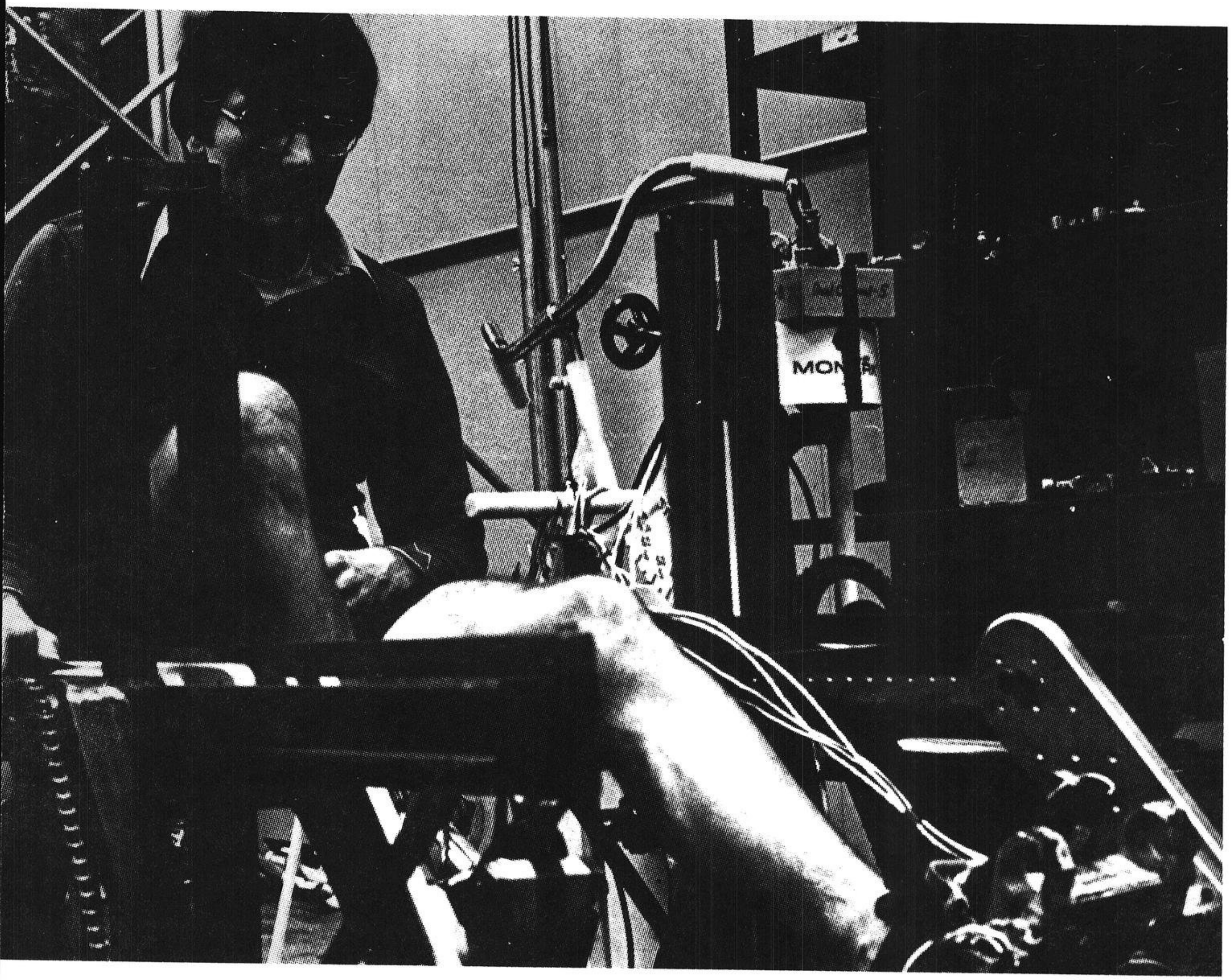
UWMAK-III is also distinguished from other reactors in that the structural material is TZM, a molybdenum-based alloy, instead of stainless steel. TZM can withstand higher temperatures, allowing the reactor to operate at higher efficiency. TZM is resistant to strain, metal fatigue, and neutron damage. It is cheap and the United States has unthreatened access to a good supply.

The UWMAK-III power system is a closed-cycle helium gas turbine. Helium coolant carries heat from the reactor directly to helium turbines. The helium turbine system would give a thermal efficiency of 44 percent, as compared with 32 percent for fission reactors. Water would not be required for cooling and there would be no problem of thermal pollution.

Experimental Reactor

Fusion designs will continue to evolve. At some point, however, a tokamak will have to be built to learn if design

—Cont. on p. 16



Pedal Power

by Sue Tyunaitis

The bicycle of the future is currently being developed by Professor Ali Seireg and graduate student Craig Cornelius in the UW Department of Mechanical Engineering.

The two are using a mechanism designed to move bicycle pedals through non-circular paths to examine the forces and velocities the lower leg muscles can produce. They hope to come up with data that will allow them to redesign the bicycle for the most effective use of human "muscle power."

Both long-term, endurance cycling and short-term, speed cycling are being investigated.

The engineers are experimenting with various types of crankshaft paths and their effect on the constant rhythmic leg movement which squeezes the blood vessels and pumps blood to the heart. The most favorable crankshaft path for an endurance cyclist, for example, would allow the cyclist to operate with a maximum amount of power while using the least amount of energy. The speed cyclist, however, would be concerned with producing the maximum amount of power in a given moment.

"There is a particular force and velocity of muscle contraction that provides maximum power," explains Cornelius. "We will test suitable motion cycles and loads to determine the optimum."

For the long or short-term cyclist, there's more to pedaling than mere muscle. Breathing rate and oxygen consumption as well as rate of change of muscle length witll also be monitored during the experimentation.

"The body has different limiting factors," says Cornelius, "and the muscles have a certain amount of energy stored."

"Our ultimate objective is to let the muscles work their hardest at that part of the motion cycle which is most appropriate," Seireg adds.

Don't expect to see Seireg or Cornelius pedaling around the streets of Madison, however. For the purposes of their experiment, the engineers are using a stationary bicycle ergometer. "This type of apparatus," explains Cornelius, "allows us to measure the amount of work done by a group of muscles under controlled conditions."

The device consists of two X-frames which the operator sits between, instead of straddling. A flywheel applies variable loads to the crankshaft. An instrumented pedal, which consists of a force transducer, measures forces perpendicular and horizontal to the sole of the foot.

Cornelius is experimenting with various types of crankshaft curves. They vary from a straight line, to an ellipse, to a teardrop curve. The curves will determine how the muscle contracts in different positions, while stimulating the motion cycle and measuring the maximum amount of power. In addition, link lengths, link orientation and velocity fluctuation are other variables associated with the curves.

The current project is an offshoot of previous work done by Seireg and Norm Miller, now an Assistant Professor at the University of Illinois. Seireg and Miller used a Monarch 850 bicycle ergometer with the right pedal replaced with a force transducer to examine muscle action in the lower leg regions. A hybrid computer was used for data acquisition and analysis. Their instruments allowed for variation of load, speed, muscle load, crank angle and pedal angle. The engineers were then able to examine muscle length and force patterns in relation to these variables with assistance of electromylographic signals.

An electromylogram (EMG), which measures the electrical current produced by muscle fibers, is taken with two electrodes mounted over the muscle of interest. The data signals are then amplified and plotted against the variable conditions. This data yields information about the static and dynamic behavior of the muscles of the lower leg. Motion patterns were produced under varying loads and speeds.

By examining what was occurring among the 29 muscles in the lower leg, Seireg and Miller were able to quantify bicycling in terms of muscle behavior.

In their current experiments, Seireg and Cornelius hope to use this data on the development of power in the human muscle to improve the efficiency of the bicycle.

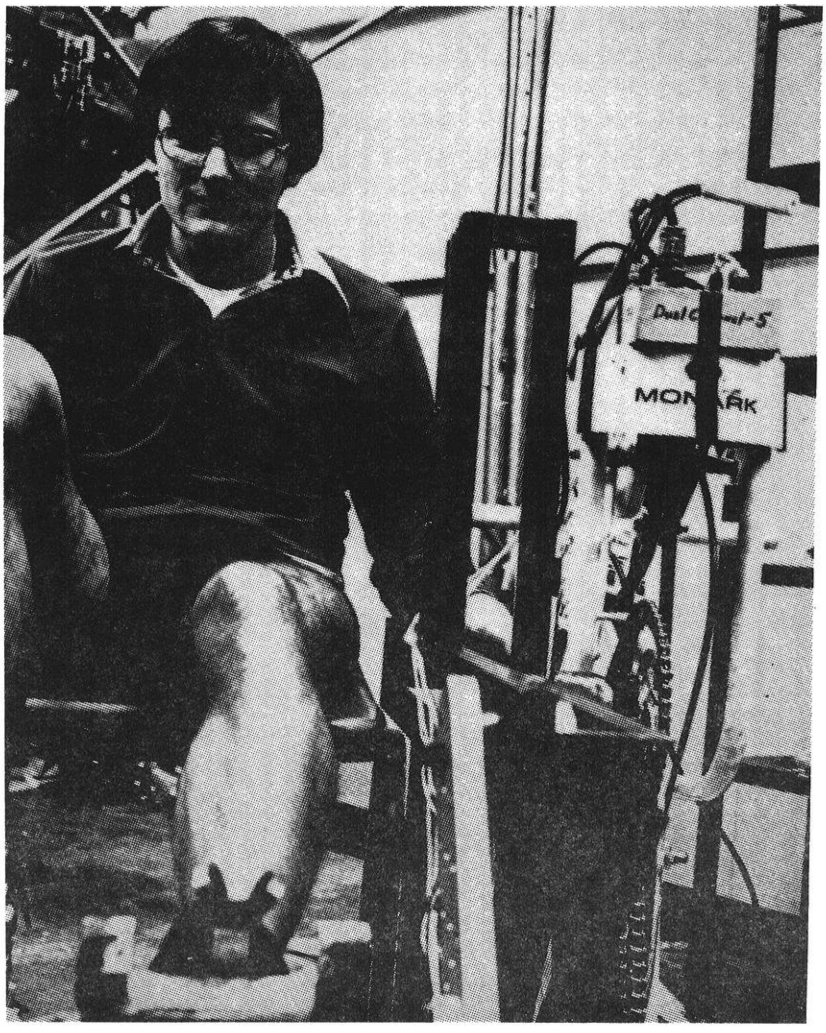
Why the bicycle?

"It's been a good study device," says Cornelius. "You receive useful information about mechanical energy from a bicycle."

Whether or not the team will succeed in improving upon present bicycle design remains to be seen.

"We may find," says Seireg, "that the bicycle, as Da Vinci originally developed it, is still the best."

—Sue Tyunaitis, junior in engineering mechanics from Kenosha.



University Avenue to Close

by John Montgomery

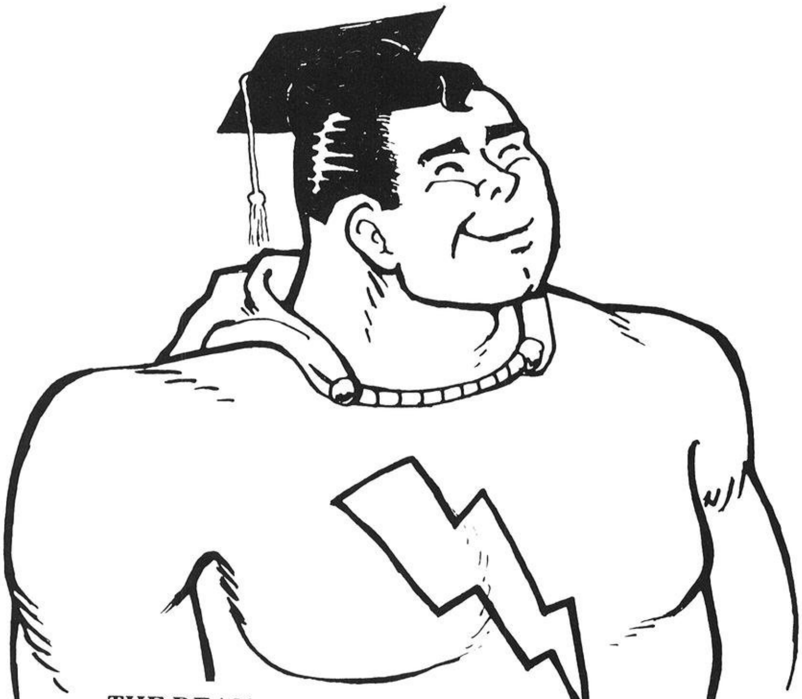
Five years ago, when Paul Soglin first took office as Mayor of Madison, people were complaining about the poor quality of roadways within city limits. Well, people are still complaining but this time around it's because roads are closed due to construction. Every year, the city Department of Transportation undertakes about 25 work projects throughout Madison, including road repair. This article is about one of those projects slated for completion in the future, i.e. the closing of University Avenue on the UW campus.

Early this month I conducted a telephone interview with Mr. Tom Walsh, an engineer with the city Department of Transportation and sometime television personality (I would have driven down and interviewed him in person but the roads surrounding the capitol square were blocked off to traffic due to construction). Mr. Walsh was recently a guest lecturer in Professor Kuhn's CEE 200 class. His comments were extremely helpful in the preparation of this article.

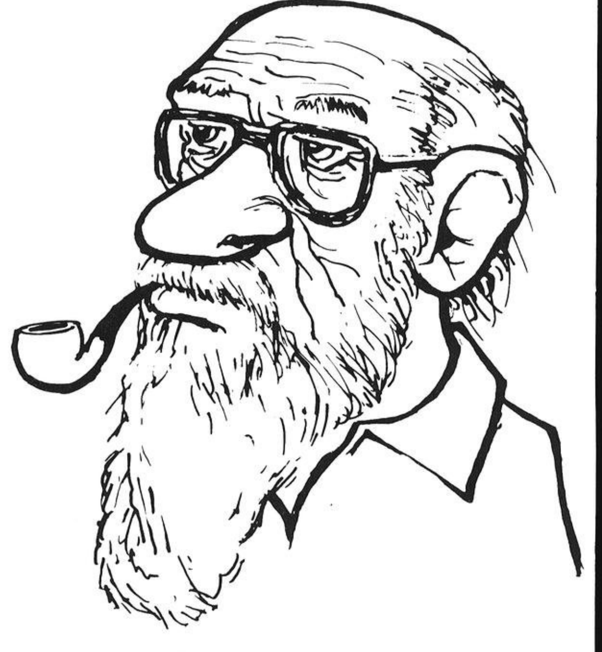
The reconstruction of University Avenue will extend from the intersection of Bassett Street by (IHOP) to the east, and Babcock Drive to the west. While the exact working dates have not yet been set, according to Mr. Walsh it will "definitely happen" within the next two years but probably later than this coming summer. Possible detour routes will probably follow West Johnson and West Dayton Streets, plus, certain sections of University Avenue itself may remain open while construction is underway.

About three years of active planning have already gone into this project by the Madison transportation staff. They've even submitted an investigative report to the federal government, which was approved last January. This was necessary since federal funding will be used to pay for part of the costs involved.

Knowing that a certain amount of inconvenience will occur to all modes of transportation—buses, cars, bicycles and pedestrian, the Transportation Department has already held three public hearings to acquaint citizens with the upcoming changes. Even so, none of the usually informed people who I talked to, who aren't directly associated with the planning, knew anything about it. But for those people who haven't wanted to attend, or who haven't been able to attend those meetings, further information can be obtained by calling the Transportation Department in its offices at the City County building. Also, a handy little pickup for people who don't give up easily is "The Madison Bikeway System" available at the Transportation office.



THE DEAN
Leaps tall buildings in a single bound
Is more powerful than a locomotive
Is faster than a speeding bullet
Walks on water
Gives policy to God

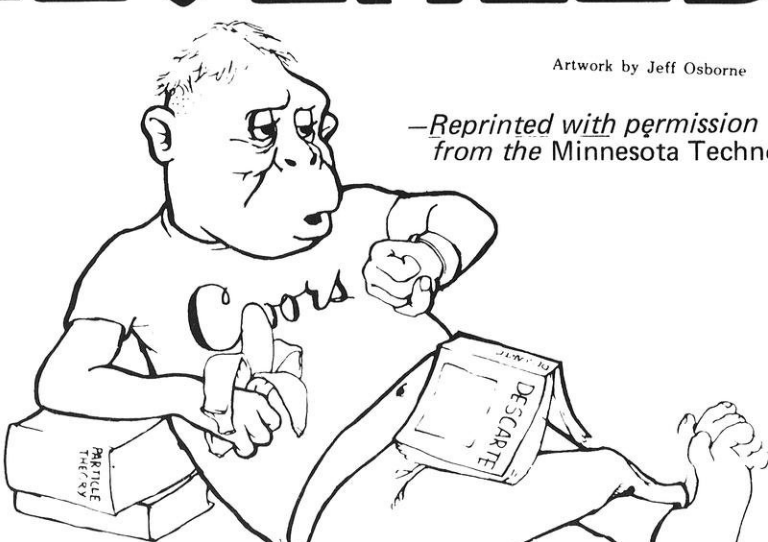


PROFESSOR
Leaps short buildings in a single bound
Is more powerful than a switch engine
Is just as fast as a speeding bullet
Walks on water if the sea is calm
Talks with God

THE SYSTEM REVEALED

Artwork by Jeff Osborne

—*Reprinted with permission from the* Minnesota Technolog.



T.A.
Runs into buildings
Recognizes locomotives two out of three times
Has trouble deciding which end of a gun is dangerous
Can stay afloat with a life jacket
Thinks he is God

UNDERGRADUATE STUDENT
Falls over doorstep when trying to enter buildings
Says "look at the choo-choo"
Wets himself with a water pistol
Plays in mud puddles
Mumbles to himself

ASSOCIATE PROFESSOR
Leaps short buildings with a running start and favorable winds
Is almost as powerful as a switch engine
Is faster than a speeding BB
Walks on water in an indoor swimming pool
Talks with God if special request is approved

ASSISTANT PROFESSOR
Barely clears a quonset hut
Loses tug of war with a locomotive
Can fire a speeding bullet
Swims well
Is occasionally addressed by God

COMPUTER PROGRAMMER
Does not recognize buildings
Trips on tracks, then is run over by locomotive
Gets a kick out of hearing a cap pistol shot
Recognizes "water" as a real variable
Prays to God in Fortran

GRADUATE STUDENT
Makes high stains on walls when trying to leap tall buildings
Is run over by locomotives
Can sometimes handle a gun without inflicting self-injury
Can usually keep his head above the water
Hears strange voices in the night

DEPARTMENT SECRETARY
Lifts buildings and walks under then
Kicks locomotives off the tracks
Catches speeding bullets in her teeth and eats them
Freezes water with a single glance
She is God

Learn and Earn

by Dave McCartney

How does a student become an engineer?

Naturally, a planned four- or five-year schedule of engineering classes at an accredited university. . .which leads to a degree . . .which can lead to an engineering career. Right?

Generally, that's true for most prospective engineers. But for some U.W. engineering undergraduates, the education has extended beyond the Madison campus.

Those other campuses can be in the form of Johnson Wax in Racine or the Hewlett-Packard company in Palo Alto, California.

Johnson Wax and Hewlett-Packard are among the many firms that offer actual work experience to engineering students while they're still in school. The company-sponsored internships are often summer jobs or co-op programs.

While job market observers acknowledge that work experience for engineering graduates isn't as necessary as it is for graduates in other fields, they agree that experience can reinforce a degree when job-hunting time starts.

For Keith Larson, IE-4, of Austin, Minnesota, his work at Johnson Wax was very rewarding. He along with 14 other interns from various engineering fields worked on special projects at Johnson Wax's Racine plant last summer.

"The minute we arrived we were treated as permanent professionals," Larson said. "The people (at Johnson Wax) seemed to go out of their way to make sure the students were socially comfortable. They held special picnics, tours and other social encounters just for the summer interns."

Larson said the working environment was even more beneficial.

"I shared an office with another industrial engineer and was assigned five projects. There was always something to do and some new areas to get involved in," he said.

The projects were quite varied, including material flow, plant layout and warehouse utilization, Larson said. The interns' projects were defined by the company and "the rest was up to the intern," he added.

"The (Johnson Wax) engineers were there to answer questions and offer help if you needed it, but the project design was basically up to the summer intern."

A New Berlin student, Connie Vandermause, ME-4, experienced the same degree of independence while employed as an intern during the summer by Husco, a firm that manufactures hydraulic valves.

"My project for the summer was to develop and design a new test rack for Husco's valves. Their present system was fine until they got a contract in which they would have to ship out many more valves a day than they were capable of doing with their present test rack," she said.

"The engineers and I followed many dead end paths before we found something to work, but (at the end of the summer) we had a small scale model working."

Vandermause said many refinements have to be made on the project yet, but the venture was a self-satisfying one.

The New Berlin senior said her shaft seal design was her best achievement, though.

"For the past few years Husco was trying to design a seal, but they always leaked. I was very proud when after one million cycles my seal had not leaked," she said. The experiment was so successful Husco has applied for a patent on Vandermause's shaft seal design.

Sue Blockstein, ECE-3 of Madison and John Socha, ECE-3 of Marshall, both worked as summer interns for the Hewlett-Packard company, though they worked in different areas at different locations.

Blockstein was employed in the H.P. calculator products division's research and development lab in Loveland, Colorado, "a nice place to spend a summer."

"I gained the 'hands-on' experience I wanted. I saw how industry works. I had contact with engineers and saw what they did day-to-day," she said.

Blockstein worked on two test fixtures for a large scale integrated circuit at H.P.

"One test fixture holds the packaged part onto a computer-controlled chip tester and makes the necessary connections," she said. "The other fixture is for a high temperature reverse bias test. This test causes chips that would fail early to do so before they are installed in calculators.

"This is important for good reliability."

John Socha has completed two summers of work at H.P.'s Stanford Park division in Palo Alto, California. Instead of calculators, the firm's Palo Alto site produces signal generators.

Since Socha was a freshman during his first internship, much of his time was devoted to an introduction of the division's major products.

"Usually I worked with one of the production technicians for the signal generator of interest. Their task is to align the instrument and assure that the specifications are met. If not, then it is their job to correct the problem," he said.

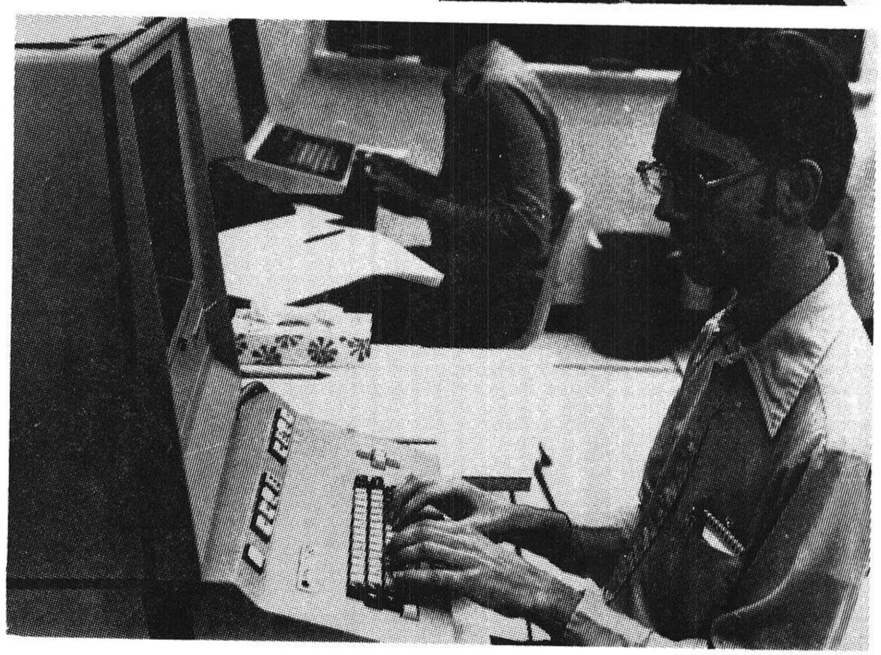
Socha learned of test procedures and observed many of the typical problems lab technicians encounter.

During the second summer the Marshall junior was assigned a design project in H.P.'s research and development lab. The task, Socha said, entailed every phase of designing a product up to and including the building of the prototype.

"The real advantage of working on a co-op program is the practical experience to back up the theory," he said. "Experience is also a good way of determining where your interests lie before obtaining a degree so a course of study can be chosen."

Hydraulics, calculators, signal generators and plant management may have little in common. But for students who work as interns in such diverse fields, one clear, common characteristic appears: they'll have a better idea what decision to make when the job-hunting begins.

—Dave McCartney is a junior in journalism from Charles City, Iowa.



You Bet Your Life

Telephone calls from insurance salesmen have become as much a part of the final year in engineering as senior slump and interviews. All three are faced with a certain amount of dread and disdain, due mostly to a lack of knowledge.

This series of articles will provide you with some fundamental background information to help you deal with insurance salesmen. The conclusion will be published next month.

Basically there are two types of life insurance: cash-value and term. Practically all other policies are some form or combination of these two.

Cash-value life insurance (such as whole, or straight, life and endowment policies) is actually a combination of life insurance protection with a savings plan. A uniform premium is usually paid throughout the life of a cash-value policy. Although the face value remains constant, the insurance protection decreases as the cash value of the policy builds up. The insurance protection is the difference between the face value and the cash value. If the policyholder survives until his policy matures, in most cases in twenty years or at age sixty-five, he will receive the full face value of the policy since the cash value is then equal to the face value and there is no insurance protection left.

Term insurance is pure life insurance protection, therefore it has much lower premiums than does cash-value insurance for the same amount of protection.

There are many different varieties of term insurance, two of the most important ones are level renewable term and decreasing term. Level renewable term features a constant face value with a premium which increases at each renewal; usually at one-, five-, or ten-year intervals. A decreasing term policy has a face value that decreases while a fixed premium is payed.

There are many arguments for and against both major types of life insurance. The "forced savings" aspect of cash-value insurance is attractive to many people even though a person with some discipline can do as good or better by saving and investing on their own. Increasing coverage at a future date is usually easier with cash-value than with term. Term, however, allows a person with limited finances to obtain more adequate coverage.

Insurance salesmen almost always try to sell cash-value insurance first—it pays a much larger commission than does term. You should consider whether you can afford to start a savings program at the expense of having sufficient coverage. A combination of term and cash-value insurance is probably advisable in most cases.

Another important aspect of life insurance policies are the "riders," or options available at additional cost.

Almost all policies include an accidental death rider which pays from two to five times the face value of the policy should the policyholder die under particular circumstances. Although the additional premium is small, this rider makes little sense. A policyholder's dependents would stand to lose more financially if he were to die after an extended illness than suddenly. It is probably wiser to spend the additional money on more coverage than on this option.

The "waiver of premium" option is available on nearly every policy. This provides for the payment of premiums by the insurance company should the policyholder become disabled for more than six months. This rider is well worth the extra cost, however, the price does vary greatly from company to company and this should be looked into when comparing prices.

A third important rider is that of guaranteed insurability. Guaranteed insurability allows a policyholder to purchase additional insurance at a later date without having to prove that he is a good risk. This is implicit in a renewable term policy. Since future responsibilities cannot always be predicted, this rider permits flexibility in insurance coverage.

More next month.

engineering holds up under real conditions, then a demonstration reactor could be built with assurance of success.

Scientists at Princeton have developed the basic idea for a breakeven reactor and the Wisconsin team has studied requirements of a Tokamak Engineering Test Reactor (TETR) designed to study radiation damage to materials, blanket design for power conversion and tritium breeding, remote maintenance and handling of radioactive substances, tritium leakage control, and magnet design.

TETR is designed to give a high-energy neutron flux against the inner wall comparable to that expected in a power reactor.

The test reactor should achieve these goals, yet be small, flexible, and as inexpensive as possible, Conn says.

—Robert Ebisch is on the faculty of the University Extension Engineering Department.

To the Editors:

There have been many changes both outer and inner taking place this season. From the eyes of an engineering student the view is stunning. Engineers are masters of change—on the *physical* and *technological* level but are also flesh and blood people who feel and interact and question. In our scholastic experience we are taught to question HOW? But the times are changing and more of us are turning to the question of WHY?

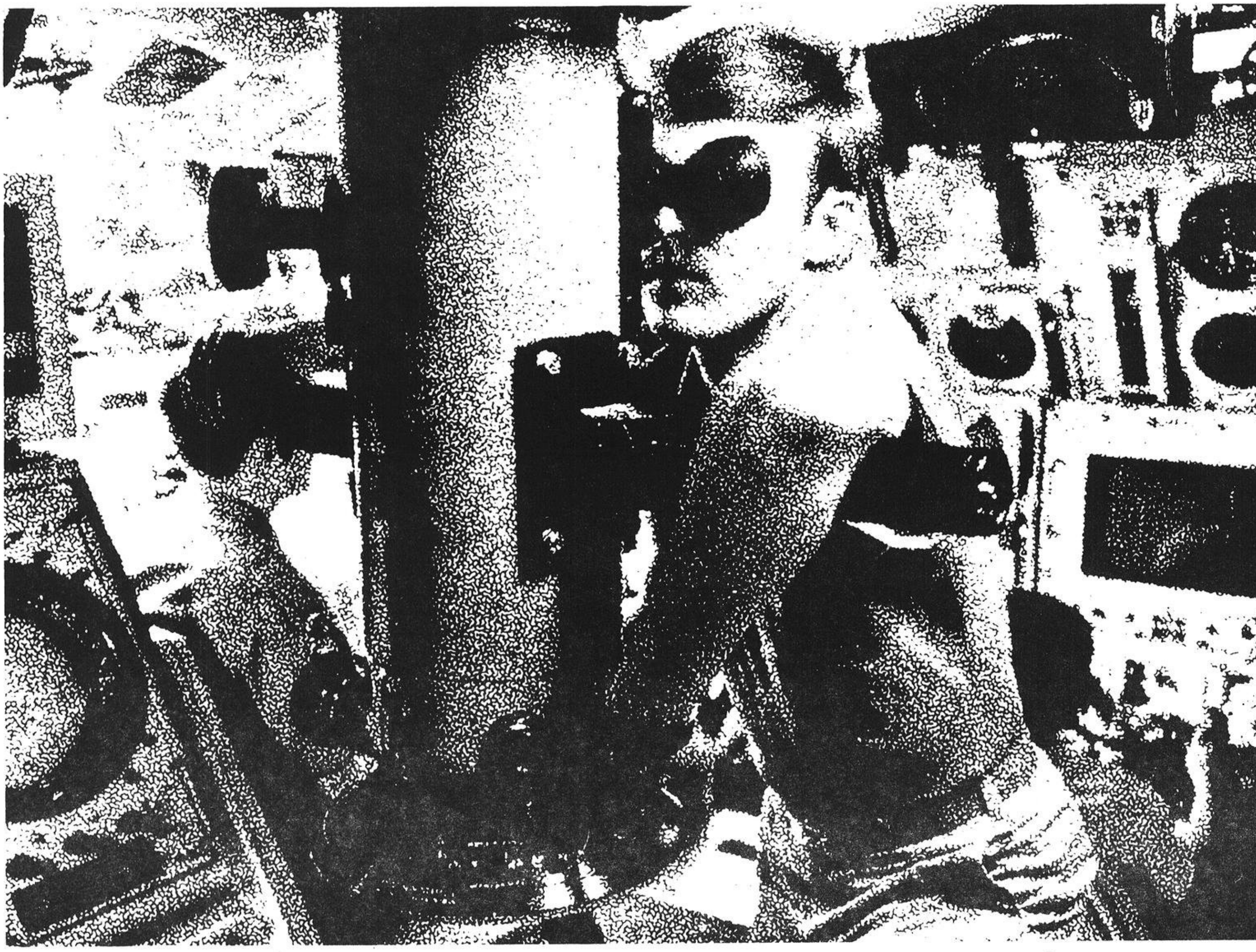
The stresses and strains of the routine seem to take over as our primary motivational factor. The deadlines are met, but with enthusiasm? We are not animals who live by instinct. We are not machines (programmable) that compute or feedback data. Learning is a means to an end. There is a challenge to find that end and in doing so find yourself.

Many will never appreciate the beauty of our work. All of the efforts, the concentration, the creation of each piece (masterpiece) of engineering science is like a dynamic channeling of rapid flowing waters, yet it rushes by leaving heads unturned and thoughts undisturbed. Can anyone see the magnificence in that box of tubes (circuits) which stares us in the face during prime time?

Engineering has come a long way in such a short time and has passed so many by intellectually that we as engineers have a duty to keep up with our monster, tame it, train it, LOVE it and in doing so love ourselves. We must realize what is behind and what is to come, noting the tremendous amount of progress we can achieve if energies are directed instead of scattered and diffused. Imagine the difference in our world if our thoughts could all be harnessed—Can we be that clearheaded?

All of us are playing a small part in the total production so as the changes are taking place inside of you, the effects will float to the surface producing a unique outcome. It is impossible to separate ourselves from our work so take pride in it and do it well. Since science is infinite our work will never be done.

—Jo Ann Chang



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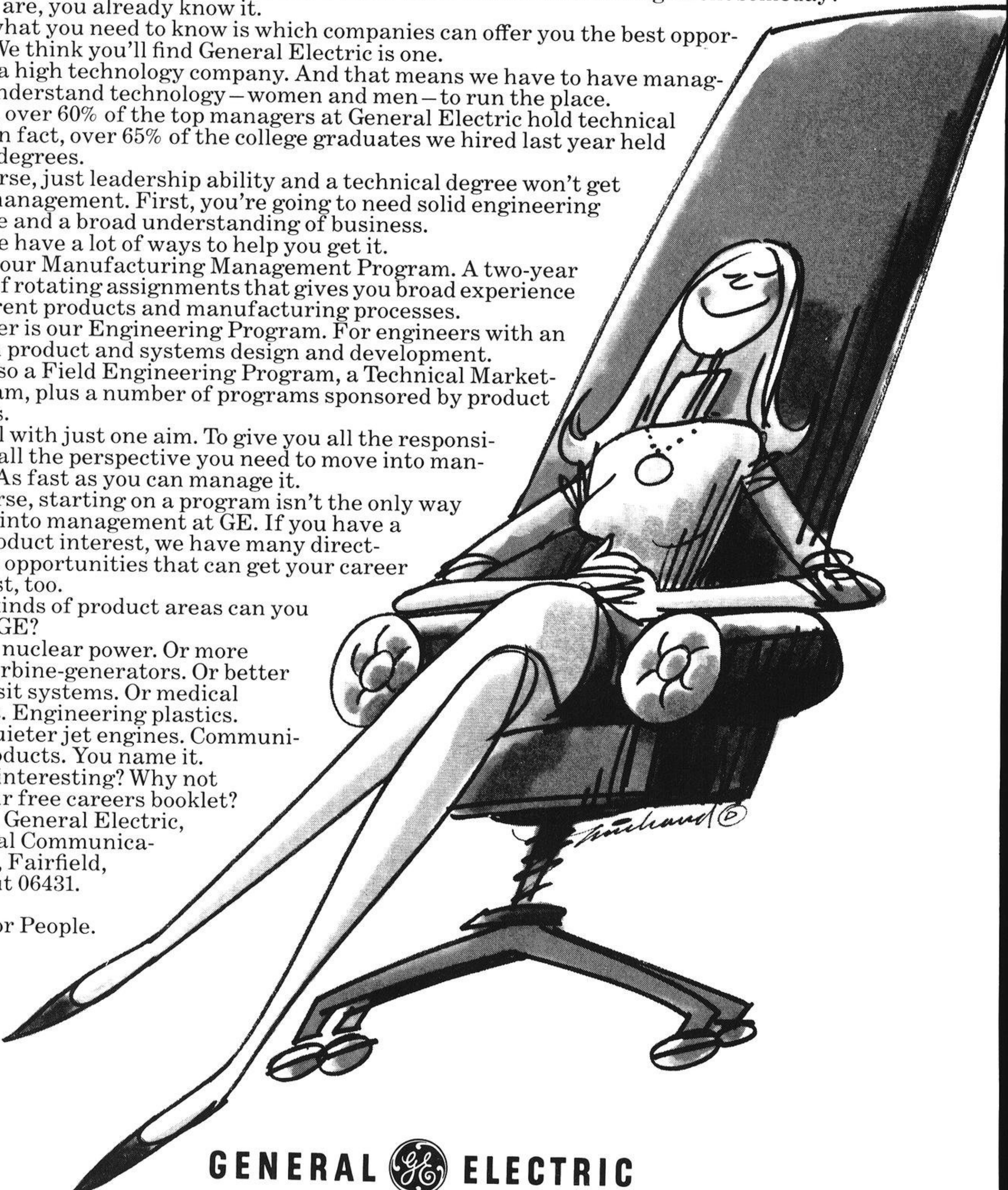

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