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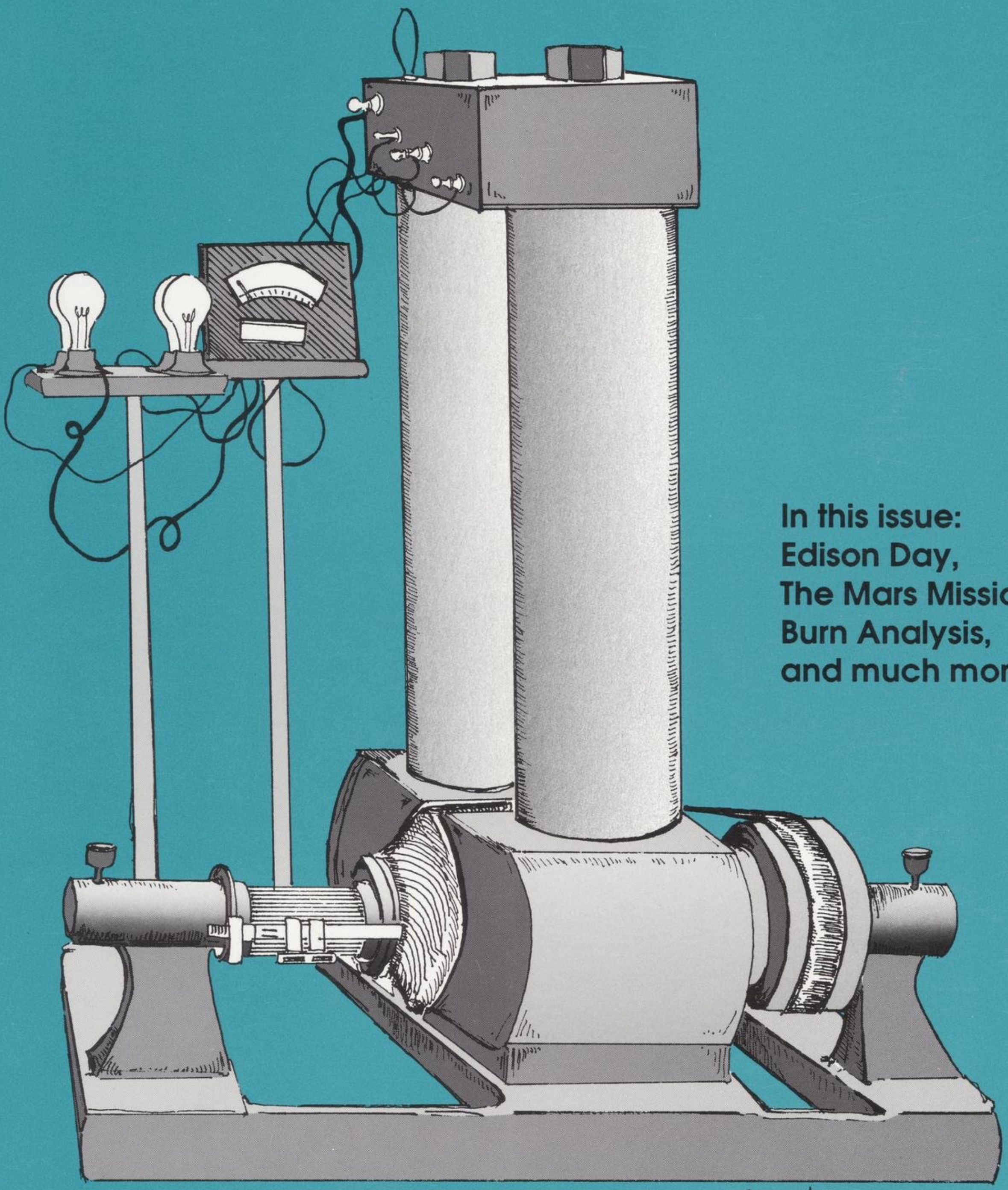
wisconsin engineer



Dawn M. Stanton '90

In this issue:
Edison Day,
The Mars Mission,
Burn Analysis,
and much more

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wisconsin engineer

PUBLISHED BY THE STUDENTS OF THE UNIVERSITY OF WISCONSIN-MADISON, MARCH 1990

Cover by Dawn Stanton:
The *Long-waisted Mary Ann*, an electric generator built by Thomas Edison, in 1880, sits on display in the Electrical and Computer Engineering lobby.

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Board of Directors: Michael Corradini, Gerald Duchon, David Malkus, Evelyn Malkus, Richard Moll, Tom Murray, Kenneth Potter, Thatcher Root.
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The *Wisconsin Engineer* magazine, a charter member of the Engineering College Magazines Associated, is published by and for engineering students at UW-Madison. Philosophies and opinions expressed in this magazine do not necessarily reflect those of the College of Engineering. All interested students have an equal opportunity to contribute to this publication.
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EDITORIAL

We usually do things in our best interests, for example, brushing our teeth. We do it every day to keep from suffering the consequences in the future. Unfortunately, some issues are not as straightforward as brushing our teeth, though they should be.

The environment has become a hot issue, and the media and public have enthusiastically jumped on the environmental bandwagon. Biodegradable plastic garbage bags, and paper and aluminum recycling are just two of a multitude of examples. However, what will happen when, as with most environmental "trends", it is no longer such a hot issue? Some people say that now that the awareness is here, people will protect and cherish their environment from now on. Hogwash.

Most of us are old enough to remember the energy crisis of the late seventies and early eighties. There was a genuine concern for the world's oil supply, primarily because the cost of gasoline had skyrocketed. People were conscientious about energy consumption and did whatever they could to keep from wasting energy. Ten years later, this joint effort no longer seems to be the case. The concern has greatly diminished. We still haven't solved the problem, and we're only a little closer to a solution than we were ten years ago. It seems as if people feel that since gasoline has become less expensive, the energy crisis is no longer important. It's a shame that people don't realize that the next time the energy crisis becomes big news again, it may be too late to do anything about it.

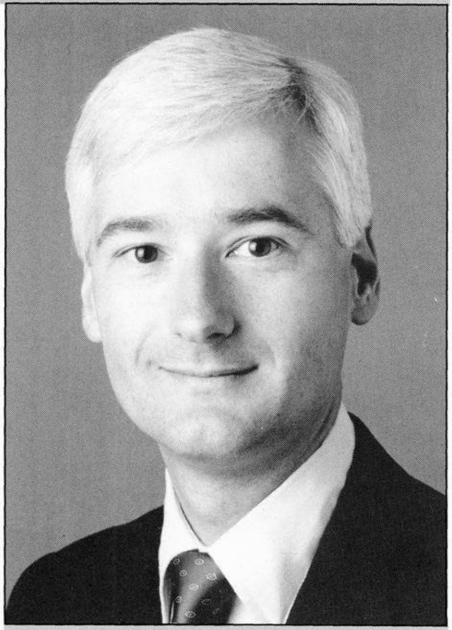
This is just one example of why America is every environmental dentist's nightmare. Why can't people just realize that it takes *daily* and *complete* care to help relieve the problem. This means every day, not just when it becomes fashionable. It means now *and* in the future. It also means you don't just "brush" at certain parts of the problem, but you "brush" at the entire thing. We can no longer stand to draw attention to one problem and neglect everything else. Recycling plastics is not our only problem. Water pollution, air pollution, noise pollution, the ozone layer, acid rain, destruction of forests and animals—these are also our problems. We have to take responsibility for what has been neglected in the past. Only by doing so, can we prevent further destruction.

There is no one to blame but ourselves. There was so much attention drawn to the oil tanker Valdez last spring that it almost seemed as if Exxon became the "environmental enemy." Exxon made many mistakes, but they're not the only ones. Every person who has ever thrown away a styrofoam cup is just as guilty of destroying the environment. The shame of it all is that the extensive media coverage that went into finding the scapegoat could have been better spent informing the public on methods in which they could personally help the environment.

Brushing doesn't always prevent cavities and tooth decay, but it lessens the problem. Recycling and conservation won't prevent shortages and landfill problems, but they will at least relieve some of the problems. We've neglected our environment for so long, there is no remedy. However, we can at least take responsibility and keep ourselves from getting any more cavities, or one day, we might find ourselves with no more teeth with which to survive.

Sharon Chen, Co-editor
Wisconsin Engineer

Dean's Corner



Gregory A. Moses,
Associate Dean–Research

Work hard, have fun, and harbor a healthy skepticism of the establishment. These axioms apply to freshman pre-engineers up through the Deans of your College.

Why engineering? It has been said that the difference between physical scientists and engineers is that physical scientists differentiate a problem to reach their ultimate result and engineers integrate. Physical scientists use deductive reasoning and engineers use inductive reasoning. Physical scientists take things apart to better *understand* them and engineers put things together to better *utilize* them. No matter how it is described, engineering requires a synthesis of ideas and facts. At its best, engineering is more artistry than physics or chemistry. But this artistry comes only with a lot of hard work.

Few students choose engineering because it is the easy ride to a bachelor's degree. Few pre-law majors are found in your classes. Take a poll. College entrance exam scores of our engineering students are higher than the average scores of students across our campus. Only half of our pre-engineers actually receive engineering degrees. Getting in is difficult, staying in is more difficult. In the Engineering College you are in very good company. You make it that way, not the faculty. The faculty sets levels of expected achievement, but you actually do it. That is what counts.

Once you graduate you will be expected to apply your engineering artistry to the creation of wealth. Wealth is not money, by the way. New wealth is new products, processes, and services. It is also new ways to make our environment a healthier and safer place to live. It has been said that society can be divided into two groups, those that create wealth and those that redistribute it. I suppose that there are some members who only consume wealth, but that is best reserved for discussion over a few beers (rootbeers of course). Engineers at their best create wealth. They create a larger, safer, healthier economic pie for all of society. Think about that. I can think of nothing more satisfying, in fact fun, than playing a part in this wealth creation thing (you'd think our President wrote this).

Engineering *is* fun. I think it is. I suspect that you think it is. I happen to like fast computers and fast cars. I suspect that you will like your own particular high technology toys. Don't apologize for that. Cast aside the "gearhead" image. It's not real. It's the uneasy response of people watching their society becoming more dependent upon an accelerating technology base that they do not understand. You have the inside track. But, with this special knowledge comes a special responsibility.

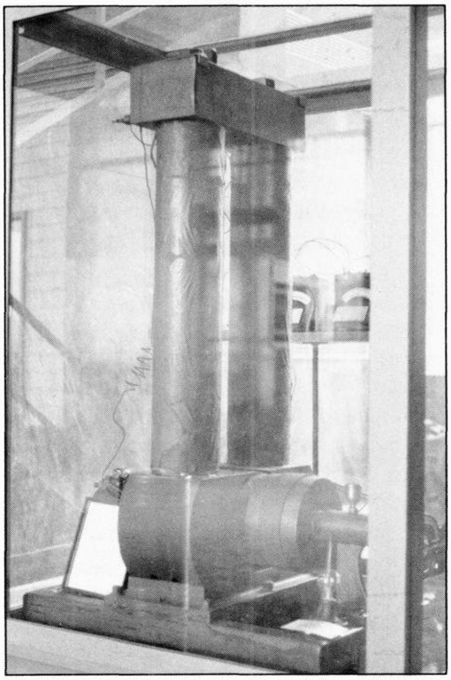
Engineering is a profession with rich traditions. Most of those traditions are good. Some are not. Champion the good ones. Question the others. For example, engineering in the 21st century will be increasingly dominated by environmental impact. Meeting these new constraints will require enormous advances in materials, processes and the idea of what constitutes an optimum design. Engineers must play a lead role in meeting these challenges and not let others dictate how problems will or will not be solved. Advances in technology *do* hold much of the answer and you are the creators and keepers of this technology.

So, there you have it. Try as hard as you can. Have a lighthearted attitude about it. It doesn't get easier. And finally, don't completely trust anyone so old that they actually remember Woodstock as anything other than Snoopy's little yellow friend. ■

THE EDISON DAY CELEBRATION

AND THE LONG-WAISTED MARY ANN

Long-waisted Mary Ann. "She's a beauty!" said one of her admirers. "She sure looks good for her age!" said another onlooker. "And after 110 years, she still runs!" said yet another who was amidst the crowd of spectators gathered to pay homage to her creator.



The Long-waisted Mary Ann, built in 1880 by Edison, sits in the ECE lobby.

Thomas Edison built "Long-waisted Mary Ann" in 1880. After this electrical generator was first exhibited at the Chicago World's Fair in 1892, General Electric donated Mary Ann to the UW's Electrical and Computer Engineering Department. Mary Ann was run annually on Edison's Birthday until the 1940's. From 1955 to 1988 it had rested quietly at the State Historical Society until the "tradition was re-inaugurated," explained Department Chair Professor Leon Shohet at the opening ceremonies of the now annual "Edison Day." This year's celebration on Friday, February 9th was held in the lobby of the electrical engineering building, which houses Mary Ann.

Shohet said, "This Edison Day in 1990 finds us in a period of great change and uncertainty in the nation and the world. But I believe that much of what will happen to us in the future will be based on developments in, and the wise use of, engineering and technology."

"The electrical industry in which Edison began has made major changes in the ways Americans learn, produce, work with one another, compete internationally and provide for the future. Electrical engineering education shares an important part of the solution of our productivity problem and all of us in the department want to be ready to respond to this challenge, " Shohet asserted.

Chancellor Donna Shalala participated in the celebration this year. "This ceremony actually represents a very important link to electrical engineering's past and I'm glad you've decided to re-institute it. It's important for us to be reminded of engineering's roots and our history. By keeping the significant events of the past fresher in our minds, we're better able to shape the future."

Shalala went on to say that Edison had a natural ability to implement elementary ideas and that the capability to translate his ideas into products is "an example that we must hold up to the engineers that we train here at the University of Wisconsin-Madison."

Shalala stated that new programs need to be developed to draw more Americans into the engineering profession. She cited that fewer than six percent of Americans receive undergraduate degrees in engineering as opposed to twenty percent in Japan. She also added that women and minorities "represent an under-utilized source of brain power in this country. "

John O'Keefe from General Electric presented Chancellor Shalala with a check for $100,000 intended for women and minority faculty recruitment, as well as development within the Department of Electrical and Computer Engineering.

"Because of the quality of its programs, its research and its leadership, the University of Wisconsin is viewed by General Electric as a very valuable resource for this country, the business community and for General Electric," O'Keefe said.

The moment symbolizing this important day ensued. Chancellor Shalala was invited to hit the switch that fired up the generator. There were "oohs" and "ahhs" from the admiring audience and already the moment was gone.

Shalala spontaneously teased Engineering Dean John Bollinger, "You can't afford any more electricity, John?"

Dean Bollinger's rejoinder: "We don't want to wear out those bulbs. . . they've got to last another 100 years!"

As this year's ceremonies continued, Reese V. Jenkins, professor of history at

Rutgers University delivered a special slide presentation entitled, "The Power of an Idea, Thomas Edison and the Pearl Street Station." Jenkins, a graduate of the University of Wisconsin, and ten other full-time faculty members at Rutgers are collaborating on a documentary publishing project. Four co-sponsors support this venture: Rutgers State University of New Jersey; New Jersey Historical Commission; National Parks Service of New Jersey; and the Smithsonian Institution.

Jenkins illustrated what the project members face with astounding statistics. According to Jenkins, there are three and one half million pages of Edison-related documents as well as 3000 laboratory notebooks that Edison kept himself.

Ten full-time faculty members in addition to Jenkins have already published two editions of the "Edison Papers," both in microfilm and book versions. Thus far Jenkins and the team at Rutgers have published 400,000 pages and ninety-seven reels of microfilm. The book edition involves fifteen to twenty volumes and includes 70,000 documents. Volume One of the book was published in May, 1989.

UW Chancellor Donna Shalala comments on the significance of the Edison Day Celebration.

Engineering Dean John Bollinger addresses the crowd of celebrators.

Jenkins divulged facts about this successful inventor's life. Thomas Alva Edison (1847-1931) was born in Milan, Ohio. He moved throughout the midwest working as a telegraph operator, and being an experimentor from early on, he consequently lost jobs from tinkering and tampering with equipment. In 1869 he vacated the telegraph industry to expedite progress on his own inventions.

With the successful opening of the Pearl Street Station, Jenkins quoted Edison as having said, "We have proved today that it is a success. I have accomplished all that I promised." In Edison's sixty-three inventive career years, he procured 1093 United States patents.

Jenkins communicated a message that "we must not arrogantly congratulate ourselves on our progress. Too often we see progress as an absolute. . . the technology that we have today is not an inevitable consequence of purely technical design, but (rather) the product of social processes that involves conceivability, resources and values."

Dean Bollinger said, "In spite of rapid change in engineering and technology. . . we have the inspiration to hang onto just this little piece of the past." Long-waisted Mary Ann was unquestionably an inspiration for Thomas Edison, and the University of Wisconsin will continue to honor this pioneer with Edison Day celebrations in years to come.

Photos by Kelly Weisheipl.

AUTHOR

Kelly Weisheipl, a senior in English, loved last summer's hit *When Harry Met Sally*.

The Mars Mission: President Bush Declares America's Goal

"There are many reasons to explore the universe, but 10 very special reasons why America must never stop seeking distant frontiers–the 10 courageous astronauts who made the ultimate sacrifice to further the cause of space exploration. They have taken their place in the heavens, so that America can take its place in the stars.

Like them, and like Columbus, we dream of distant shores we've yet not reached.

Why the moon? Why Mars? Because it's humanity's destiny to strive, to seek, to find. And because it is America's destiny to lead." *- President George Bush, July 20, 1989*

On July 20, 1969, man walked on the moon for the first time. Two decades later, President George Bush addressed an anniversary celebration crowd at the National Air and Space Museum. In his speech , Bush recalled the incredible moon landing and set goals for America's future in space.

The goals involve a commitment to continued space exploration and research, unlike the goal President Kennedy declared when he proposed a manned mission to the moon in 1961. The Apollo 11 moon landing resulted from a political and technological space race between East and West. Kennedy chose to land on the moon to escape America's poor technical and scientific image. He never intended for America to reach the moon to stay, or to venture beyond the moon. But Kennedy's goal won huge public and congressional support. It was after all, a test of American leadership, and after the cold war of the 1950s, Americans eagerly fought to get ahead.

NASA, on the other hand, held different aspirations for America's space program. They wanted to use Apollo and Saturn as serviceable earth/moon transportation systems. NASA proposed 30-90 day visits to the moon, with permanent lunar bases in use by the early 1980s.

To achieve such goals, NASA needed presidential support for its proposed stay in space, space stations, space planes, and trips to Mars. NASA also needed continued funding from Congress.

Governmental support for space exploration never came through. After the moon walk, NASA began to fall apart. Congress cut the NASA budget by $3 billion. In order to save the Shuttle program and Skylab, NASA took the cut out of Apollo. Moreover, the Apollo program lost the public and presidential support that seemed so evident throughout the 1960s. America achieved its goal and did not need to quickly set another.

"In 1961, it took a crisis–the space race–to speed things up. Today we don't have a crisis. We have an opportunity.

To seize this opportunity, I'm not proposing a 10-year plan like Apollo. I'm proposing a long-range, continuing commitment.

First, for the coming decade–for the 1990s–Space Station Freedom–our critical next step in all our space endeavors.

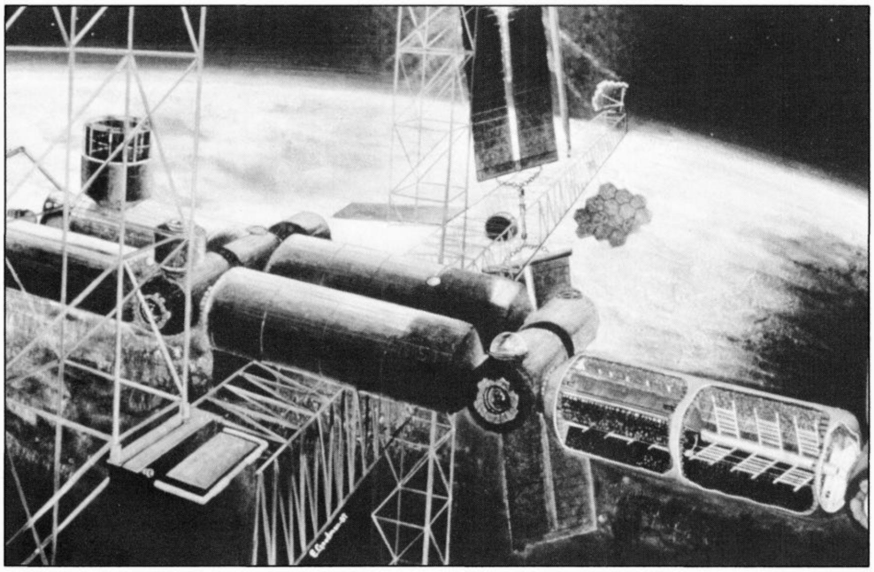
And next–for the new century–back to the moon. Back to the future. And this time, back to stay.

And then–a journey into tomorrow–a journey to another planet–a manned mission to Mars." - GB

President Bush specified the difference between the Apollo proposal of 1961 and today's Mars mission–the space race. Mars is a scientific adventure, not a political tool. America is well aware of the Soviet technology and its ability to beat Americans to Mars. But the Soviets have not yet proposed a solid Mars mission. Also, because of cost factors, the idea of international cooperation in space exploration is sweeping through many space-faring nations.

Bush's Mars mission hinges on three basic phases: Space Station *Freedom*, a lunar settlement, and finally , a manned mission to Mars. Bush did not just pull these ideas out of space. Researchers have posed the Mars question for years, and President Reagan proposed *Freedom* in the 1984 State of the Union Address.

NASA agrees with Bush's proposed order of operation and most other experts support the three step process for justifiable reasons. First, Mars is still somewhat of a mystery. More research will give needed data on weather, climate, and surface materials. Second, humans know little about prolonged space flight. The trip to Mars will take eight months–one way– not including a stay on the planet. In addition, a vehicle for transportation to Mars will have to be very large. Currently, there is nothing powerful enough to economically boost the enormous space ship out of earth's atmosphere. It will be easier, NASA believes, to build the vehicle in space. Next, researchers are now finding ways to make a space settlement self-sufficient by producing food and recycling water and oxygen. Finally, economical space fuels may be available on the moon.



This artist's conception shows the Space Station Freedom at an advanced stage. The cut section represents a greenhouse of the type being researched at the Wisconsin Center for Space Automation and Research at the University of Wisconsin.

"...10 years from now–on the 30th anniversary of this extraordinary and astonishing flight–the way to honor the Apollo astronauts...is to have Space Station Freedom up there, operational, and underway..." - GB

A massive orbiting space laboratory, *Freedom* has finally won acceptance by many space experts and members of Congress. Initial designs have been cut back considerably because of a lack of congressional funding for the project. Researchers felt that the Station had no particular scientific applications and would be a great burden to construct and maintain. They were afraid the Station would never develop to its full extent, like the Shuttle failed to do. But NASA revised plans, confirmed the importance of *Freedom*, and now insists that efforts will be concluded on time–provided the required funding comes through.

The main purpose of *Freedom* is to establish technologies that will allow people to live and work in space. *Freedom* will serve as a scientific facility where researchers can build space structures, including lunar habitats and Mars vehicles. They can also gain knowledge on how people adapt to the space environment and study the effects of long term space flight. *Freedom* will be a commercial and industrial research facility, as well as a laboratory for the advancement of science and technology.

Freedom is not just an American effort. NASA has just completed talks with Canada, Japan, and the European Space Agency. Each country will share expenses and usage of the facility.

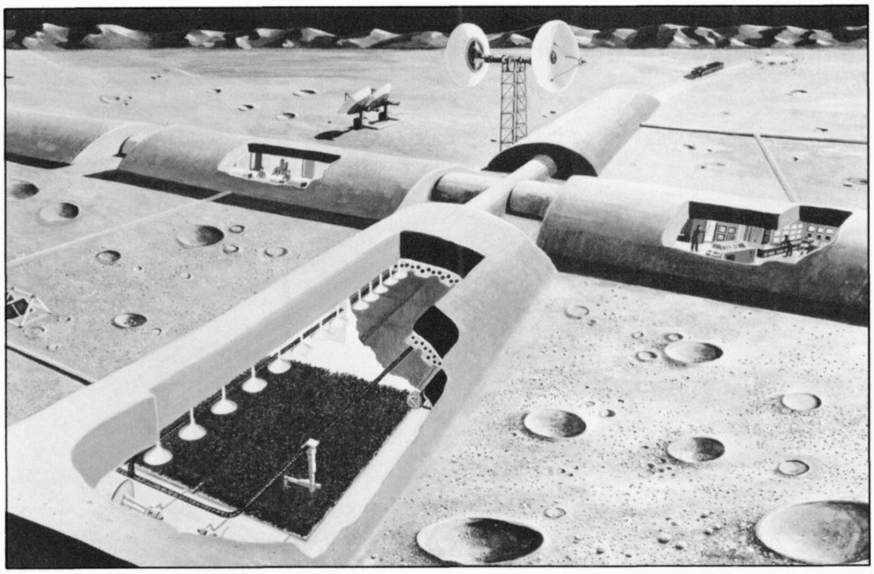
NASA designed *Freedom* with consideration of user requirements, safety, and long term operational costs. *Freedom* will be constructed in space over a five year period and will have an equatorial orbit about 250 miles above earth.

Freedom's design does not reflect the Starship Enterprise. The back-bone is a 500-foot truss composed of graphite and epoxy composite materials. America, Europe, and Japan will have attached laboratory and habitation modules. The modules will be connected by nodes with the same inside "shirt-sleeve" environment as the modules. This closed environment will recycle oxygen and water. Also attached to the truss will be various telescopes and special instruments. Large arrays of solar cells connected at each end of the truss will provide 75,000 Watts of power.

NASA approved four commercial companies–Boeing Aerospace, McDonnell Douglas Astronautics, General Electric Astro-Space Division, and the Rocketdyne division of Rockwell International–to help with the development of *Freedom's* components. The constructed elements will be transported to the Kennedy Space Center in Florida, where each will receive final approval and be integrated into a space shuttle orbiter.

NASA plans to launch the first components in 1995 and use 12 to 20 shuttle flights to complete construction. By the third flight, *Freedom* should be usable. By the fifth flight, astronauts can live in a shuttle docked to the Station to conduct experiments. The habitation module will reach *Freedom* by late 1996. At the same time, two six-passenger vehicles will be moored to the Station for use in an emergency.

Canada's contribution is a mobile servicing center, including an arm that will help assemble the structure. The arm, stronger than the remote manipulator Canada used on the



This artist's conception of a lunar habitat shows sections of laboratory space and an automated plant growth facility.

"To this day, the only footprints on the Moon are American footprints. The only flag on the Moon is an American flag. And the know-how that accomplished these feats is American-know-how. What Americans dream–Americans can do." - GB

The moon seems an attractive goal for permanent space settlement. Not only is it very close–only three days away–but also boasts large quantities of valuable space exploration resources. The lunar soil contains elements such as oxygen, silicon, and aluminum, as well as iron and helium. To avoid the cost of boosting heavy construction materials from earth, lunar soil could serve as a radiation shield for the lunar habitat. The Helium-3 in the soil can be mined for energy sources in the settlement as well as in space vehicles. Glass composites and iron could be used for building and expansion.

Researchers are not certain if water ice exists in craters at the lunar poles. If so, rocket fuels made of hydrogen and oxygen could be produced on the moon, eliminating the need for expensive earth-based supplies. However, if water ice does not exist, hydrogen, nitrogen, and carbon could be extracted and transported from Martian moons to the lunar base. This process would cost less than boosting the fuel from earth.

space shuttle, will provide maintenance after *Freedom* is complete.

Along with a research laboratory, the European Space Agency (ESA) is building a free-flying polar platform and a co-orbiting platform with a pressurized module. The man-tended free-flying platform could be operated by station crew members or by a member from *Hermes* , ESA's proposed space plane.

A Japanese lab module features a robot arm and a "back porch" where experiments can receive direct exposure to space.

Two key features of *Freedom* are the Orbital Maneuvering Vehicle (OMV) and the Space Transfer Vehicle (STV). The OMV serves as a maintenance vehicle to perform utility functions around the space station. The STV serves as a support base for missions to geosynchronous orbit, the moon, and other planets.

Freedom's eight member crew will conduct microgravity research not possible on earth. The gravity on *Freedom* will be one one-millionth of the gravity on earth.

Microgravity allows researchers to separate materials such as ceramics, glass, and chemicals into unique pure and uniform crystals. Such crystals can be used on earth in electronics applications including semiconductors, computers, radiation sensors, and lasers.

The weightlessness also reveals interactions between atoms and molecules. This research will hopefully lead to the development of new products on earth, especially of medicines.

The *Freedom* crew can also observe weather patterns on earth and service satellites such as the Hubble Space Telescope.

These technological developments make up Phase I. But *Freedom* is designed to evolve over time as new needs arise. New labs and telescopes can be attached to enlarge the station. Phase II, though still in the works, focuses on the lunar base.

In an effort to increase an interest and investment in commercial space related activities, NASA established a program called Centers for the Commercial Development of Space (CCDS). Through the program, NASA works with industry and academia to conduct high technology space research.

The Wisconsin Center for Space Automation and Robotics (WCSAR) at UW-Madison is one CCDS program that will have an impact on President Bush's proposed Mars mission. WCSAR researchers concentrate on three major areas: Astrobotics, Astroculture, and Astrofuel.

With Astrobotics, WCSAR is researching the use of robots in hazardous and inaccessible environments. Such devices can be used in robotic arms on the Space Station Freedom and in constructing and maintaining a lunar base.

The balance of the modular environment in Freedom and the lunar base will depend on how efficiently water and oxygen can be recycled, as well as whether or not food can be produced within the habitat. In Astroculture, WCSAR is working to develop automated plant growth facilities that would be part of the habitation.

Another very important aspect of habitation on the moon is the production of fuel as an energy source. At WCSAR researchers are studying Helium-3, an extremely clean and safe

The lunar base, like *Freedom,* will be self-sufficient and recycle oxygen and water. Current research at the University of Wisconsin-Madison involves the development of indoor plant facilities, where inhabitants can grow their own food, thus reducing the costly need for supplies from earth. The settlement generates its own power with Helium-3.

Overall, the lunar base will reduce the cost of space exploration and development, and its facilities will serve as testing grounds for Martian bases. The lunar base will eventually supply products that assist in commercial space manufacturing.

> ***"...the Apollo astronauts left more than flags and footprints on the moon. They also left some unfinished business. For even 20 years ago, we recognized that America's ultimate goal was not simply to go there and go back–but to go there and go on." - GB***

Besides the thrill of setting foot on another planet, a manned mission to Mars can provide better understanding of earth. By comparing the earth to other planets, we can possibly learn where life and our solar system evolved from.

Though questions remain about the Martian soils, climate, and topography, Mars seems the most appropriate planet to shoot for. Venus, for example, is much too hot, with temperatures reaching 900 degrees Fahrenheit. The intense pressure on Jupiter crushes hydrogen and helium gases into metallic states. Any other planet is simply too far away.

Mars is viewed as a scientific mission, not necessarily a permanent settlement. Though the red planet contains elements needed for human self-sufficiency such as carbon, nitrogen, and hydrogen which are scarce on the moon. Costs of repeatedly getting to Mars and setting up camp there would be high. However, industrializing Mars and using its resources for upkeep of the lunar habitation is a possibility.

NASA's idea is to send only a few people and not let them stay long. In the future, though, if space travel and maintenance become less expensive, a permanent Martian base can be considered.

> ***"Each mission should–and will lay the groundwork for the next. And the pathway to the stars begins, as it did 20 years ago, with you–the American people. And it continues just up the road there–to the United States Congress–where the future of the Space Station–and our future as a space faring nation–will be decided." - GB***

Basically, NASA needs money or the entire proposal will fail. Without requested funding, or with late funding, NASA will have to delay the development of each stage of *Freedom,* thus delaying the establishment of a lunar base, and ultimately, a manned mission to Mars. Phase I of *Freedom* should cost around $32 billion. Once even a few components of *Freedom* are in place, Congress cannot deny or delay funding, or America will jeopardize the entire space station program.

> ***"Within one lifetime, the human race traveled from the dunes of Kittyhawk to the dust of another world." - GB***

With construction of *Freedom* beginning in 1995 and ending in 1998-99, experts feel a lunar base can be established and operational by 2010. If all goes well with *Freedom* and the lunar base, a manned mission to Mars is planned for 2020.

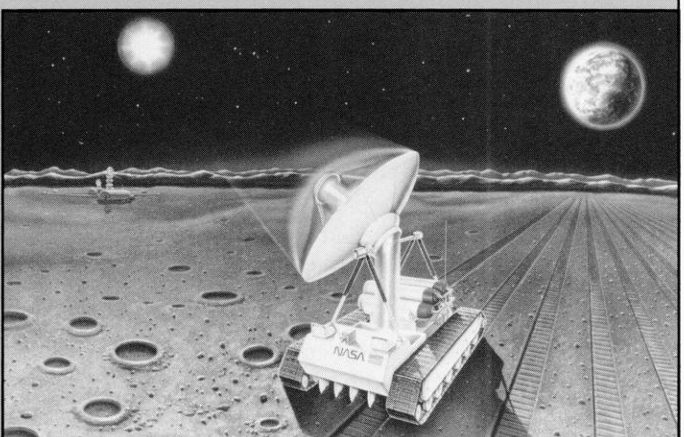
It seems interesting to look back 20 years at the first moon landing and look at what Americans have accomplished in space since. Then consider the future–in only 30 years, Americans (and perhaps others) could land on Mars.

> ***"The time has come to look beyond brief encounters. We must commit ourselves anew to a sustained program of manned exploration of the Solar System–and yes–the permanent settlement of space. We must commit ourselves to a future where Americans and citizens of all nations will live and work in space." - GB***

Special thanks to WCSAR for photos and information. Thank you to Mr. Sanjay Limaye of Space Sciences for the text of President Bush's speech.

fusion fuel that is found in the lunar soil. Helium-3 could be used to power the lunar base, the space station, and even earth.

WCSAR researchers work in a number of UW-Madison labs and with industrial participants. The main field center is the Lyndon B. Johnson Space Center. For more information about WCSAR, see Wisconsin Engineer, December 1988.



An artist depicts a moon rover used in the mining of Heluim-3.

AUTHOR

Shelly Hoffland, a junior in mechanical engineering, claims that she really isn't like any of the characters, but still likes to watch *Real Genius.* It was a classis back in high school.

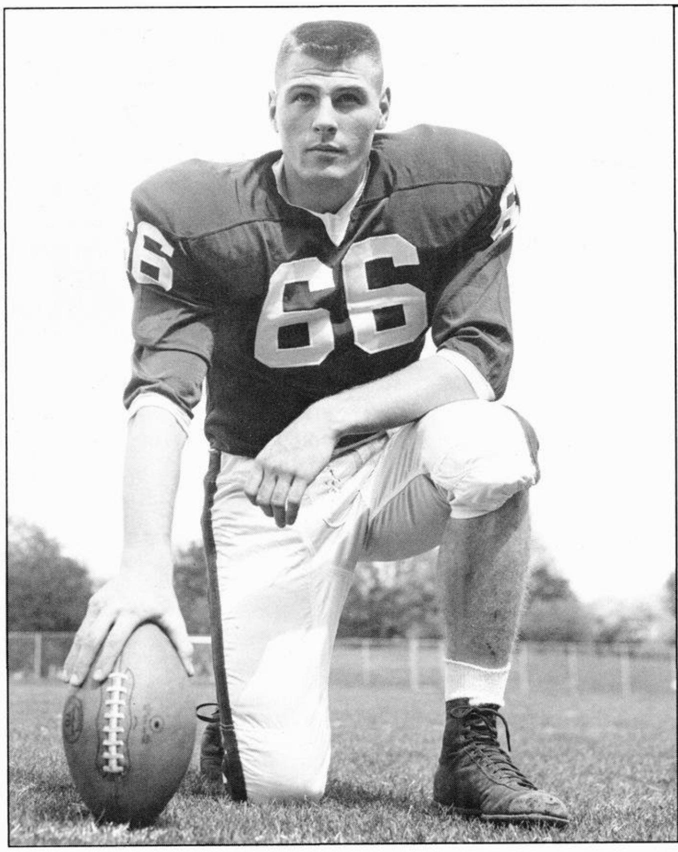
Professor Kulcinski Remembers the *War of the Roses*

Few people can remember the last time our UW football team made it to the Rose Bowl. Undoubtedly, even fewer people are aware that a member of the engineering faculty played on one of only three UW football teams ever to participate in the Rose Bowl. For those of you among the uninformed majority, allow me to introduce you to this faculty member, Dr. Gerald Kulcinski, a professor in the Nuclear Engineering Department.

A native of the LaCrosse area and a graduate of LaCrosse Central High School, Kulcinski came to the University of Wisconsin in 1957. After joining the UW football team as a "walk-on" his freshman year, he played his remaining three seasons on a football scholarship. A high school quarterback, Kulcinski was converted to offensive lineman after dislocating his shoulder. As a starter during the 1959 and 1960 seasons, he was the smallest guard in the Big Ten. In addition to this formidable challenge on offense, Kulcinski was also required to play middle linebacker on defense. He recalls, "In those days, teams were only allowed four substitutions per quarter, so everyone had to play two positions, and on special teams as well." He adds, "Another big difference between those days and now was that we [the players] called our own plays." Kulcinski also assures this reporter that he and his teammates were student-athletes with emphasis on "student," commenting, "It was a whole different group of people that played football in those days. We had law students, medical students and engineering students, simply because the possibility of getting a million-dollar contract [to play professional football] just didn't exist."

The 1959 season proved to be the most memorable one for Kulcinski and his teammates as they became the second UW football team to compete in the Rose Bowl. Unfortunately, these fond memories are clouded by a disappointing post-season loss to the University of Washington. However, one of Kulcinski's fondest memories of his football days at the UW came the year after his final season when he played with former athletic director and Heisman Trophy winner Elroy Hirsh in the annual alumni game.

Scholastically, Kulcinski did not find it extraordinarily difficult to balance football with academics. In fact, he feels that



Kulcinski shows the look of determination that brought him success on the gridiron and in the world of high technology.

Kulcinski holds one of the many "tools of the trade," a proton accelerator used to test the resistance of materials to radiation damage.

the extra obligation may have helped him in his studies, saying, "I think the discipline one learns in sports probably helps because you know you don't have time to fool around." Kulcinski entered the UW with an interest in chemistry and subsequently chose a degree program in chemical engineering because of the department's excellent reputation. At that time, nuclear technology was in the forefront of scientific interest, so after graduating with a bachelor's degree in chemical engineering in 1961, Kulcinski went on to get his M.S. ('62) and his Ph.D. ('65) in nuclear engineering.

After completing his college education and football career at the UW, Kulcinski joined another team–a team of

..."It was a whole different group of people that played football in those days. We had law students, medical students and engineering students, simply because the possibility of getting a million-dollar contract just didn't exist."

scientists and engineers in Los Alamos, New Mexico, to work on the development of nuclear rockets. He later served as one of the leaders of an American delegation of about 100 scientists and engineers in an international effort to study nuclear energy in Vienna, Austria. Regretfully, Kulcinski has watched the United States gradually lose much of its initial superiority in the field of nuclear technology. He attributes this disappointing trend to the federal government's unwillingness to make a long-term commitment to scientific studies.

Dr. Kulcinski returned to the UW in 1972 as an associate professor in the Nuclear Engineering Department. In addition to teaching special topics courses, he has also been the primary leader of the UW Fusion Technology Institute since its inception in 1971. Dr. Kulcinski is currently involved in research on the applications of fusion in space, including the mining of Helium-3, also known as Astrofuel, from the surface of the moon and designing a fusion-propulsion system for future NASA spacecraft.

Away from his demanding responsibilities at the UW, Kulcinski enjoys a relatively quiet home life with his wife, Jan, to whom he has been married for almost thirty years. Perhaps not coincidentally, each of his three children chose to attend the University of Wisconsin. His oldest daughter, Kathy, is now an audiologist. His son, Brian, is a teacher. His youngest daughter, Karen, is currently a senior majoring in geography. While Kulcinski's affiliation with the UW may have influenced his children's decisions to attend college here, he admits that he had no influence on their career decisions.

Kulcinski also maintains close ties with UW athletics as a member of the UW Athletic Board and chairman of the personnel committee, which was responsible for reviewing the state of the football program and leading the search to find a new athletic director. [Incidentally, new Athletic Director Pat Richter was a member of the last UW football team to play in the Rose Bowl ('63).] Pushing any potential bias aside, Kulcinski foresees a much brighter future for the UW football program under the direction of Richter and new head coach Barry Alvarez. UW football fans probably won't be packing their bags for Pasadena at the end of the 1990 season, but Kulcinski and many other UW enthusiasts feel that a "War of the Roses-Part IV" within the next decade is a definite possibility.

Proton accelerator photo by Kelly Weisheipl

AUTHOR

Mike Waters, whose favorite film is *The Naked Gun*, plans to major in engineering mechanics.

CHAPTER 17 **HOME BOUND**

SECTION 17.5: TEXTS OF UW-MADISON

If you are an engineering student at the University of Wisconsin-Madison, don't be a bit surprised if the name of your professor matches the name in the front cover of the course textbook. In fact, if you are an engineering student at one of many colleges and universities around the world, you may also use a text written by a professor at UW-Madison. The authorship of texts among UW-Madison educators is a common occurence, and one that gives the College of Engineering a great sense of pride.

Textbooks have been written by many UW professors over the years. There are numerous professors in every department of the College of Engineering who have a book or two credited to their names. As any student walks through the hallways of the engineering buildings, he or she may notice the many displays of these volumes. For example, the showcase honoring the great chemical engineering professor, O.A. Hougen, displays his books written in a myriad of various languages. These exhibits emphasize the pride the University has for its great intellects.

...Transport Phenomena is now in its fortieth printing and can be found all over the globe

Why do professors write textbooks? It might seem obvious that the motives are fame and fortune. However in reality, more practical reasons prevail. For example, some texts are created as new courses are added to the curriculum of a particular department. Such was the case for professors R. Byron Bird, Warren Stewart and Edwin Lightfoot's *Transport Phenomena*, a

On arriving at the end of the text, the reader should be conscious of the key role played by the *equations of change*, as developed in Chapters 3, 10, and 18. These equations provide the starting point for calculation of profiles, dimensional analysis, correlation of transfer rates, and development of the macroscopic balances. One or more of these results may be needed in any given engineering problem.

Needless to say in an introductory text no attempt can be made to go very far into special applications or special techniques. By way of conclusion we consider it appropriate to mention some of the areas that lie beyond the scope of this book.

We have confined ourselves largely to solutions of the equations of change obtainable by simple analytical procedures. It is anticipated that *numerical methods for solving transport phenomena problems* will find increasing use.

In this book we dealt mainly with the continuum aspects of the subject because this viewpoint is of more immediate use to the engineering student. It should be emphasized, however, that the *molecular theory of transport phenomena* complements the continuum theory in several ways: (*a*) the molecular theory can be used to derive the equations of change, (*b*) the molecular theory gives expressions for the transport properties in terms of intermolecular forces, and (*c*) the molecular approach is essential in understanding ultra-low-density gas phenomena.

Some material on *turbulent transport phenomena* has been included because of the practical importance of the subject, in spite of its present unsatisfactory state of development. It is hoped that this introduction will stimulate interest in the rapidly expanding literature of this field.

Certainly the *boundary-layer theory of transport phenomena* has developed well beyond the scope of this introductory text. The rapid growth of this subject was initiated by the aerodynamicists, but numerous recent applications have been made in other areas such as separations processes and applied chemical kinetics.

Of growing importance is the study of *transport phenomena in non-Newtonian flow*. Most large chemical industries are faced with non-Newtonian problems, and to date empirical procedures have been relied upon in design work. It is hoped that some of the non-Newtonian problems in this book will catalyze further interest in the fundamental approach to rheology.

Noteworthy advances have been made in the field of *transport phenomena in compressible flow*, which we have admittedly given less attention than it deserves. This field includes shock waves, sound propagation, supersonics, and aerothermochemistry. Readers interested in these subjects will find that special forms of the equations of change are generally taken as the starting point for the developments.

Some problems that involved *transport phenomena in chemically reacting systems* have been discussed. Usually, for the sake of simplification, we have taken the chemical kinetics to be of rather idealized form. Clearly, for many problems in combustion, detonation, and flame propagation, more realistic expressions for the reaction rates need to be known. Furthermore, much more needs to be known about the various physical properties of fluids containing free radicals and ions, particularly at elevated temperatures.

In this book we have restricted ourselves almost exclusively to systems in which electric and magnetic fields play no role. An important current area of interest is that of *transport phenomena in electrically conducting media*. For such problems we have to modify the equations of change to include electromagnetic forces in the equation of motion, electromagnetic energy terms in the equation of energy, and an additional equation of change for charge. In addition, we need the Maxwell equations of electromagnetism. The field formed by the union of these two subjects is called magnetohydrodynamics.

Numerous examples and problems that illustrate the *application of transport phenomena to engineering* have been given in the text. Most are relatively straightforward examples involving idealized situations. It is hoped that the coming years will see increased application of the principles of transport phenomena to more challenging problems.

R. B. B.
W. E. S.
E. N. L.

The afterword of Bird, Stewart and Lightfoot's text Transport Phenomena pays homage to its alma mater. If you look closely, you can see that the first letter of every paragraph spells out the words ON WISCONSIN.

chemical engineering text. When the chemical engineering curriculum was revised in the mid-1950's, there was a need for a course in transport phenomena. Since there was no existing text on the subject, one was created.

After a professor decides to write a book, he or she then decides how to go about doing so. Most choose to write from notes they have used in teaching the course. Teaching the "book" to students before it is published is a way of getting excellent feedback on the effectiveness of the text in a classroom situation. Once the finishing touches are added, the book is sent to be published.

After a text is published, it often finds itself a home here on the UW-Madison campus. Many texts travel across the U.S. and to other countries, bringing knowledge to foreign ports. A popular text by professors Robert Cook, David Plesha, and Michael Malthus entitled *Concepts and Applications of Finite Element Analysis* has found its way to more than forty colleges and universities in the U.S., including Harvard, Georgia Tech, and UC-Berkeley. Bird, Stewart, and Lightfoot's *Transport Phenomena* is now in its fortieth printing and can be found all over the globe. This text, affectionately dubbed "the Bible" by UW chemical engineering students is *the* textbook for every Transport Phenomena course in the U.S. and is used in every country that teaches chemical engineering. Editions are printed in Spanish, Italian, Czechoslovakian, Russian, and other foreign tongues.

No matter how far a textbook by one of the UW's famous faculty travels, it will not forget its home, UW-Madison. These books pay great homage to their birthplace each time a student sees "University of Wisconsin" printed below the author's name on the title page. Bird, Stewart and Lightfoot take it one step further. In the Afterword of their text, they have spelled it out clearly. The first letters of each paragraph, when placed side-by-side, spell **ON WISCONSIN.** ▮▮

AUTHOR

Amy Damrow is a freshman in engineering. Her favorite film is the well known and always popular *Satisfaction.*

Next issue
Computers!!
May, 1990

Kirk Receives Superior Science Award

On February 5th, 1990 the USDA Forest Service awarded Dr. T. Kent Kirk with its second highest scientific honor, the Superior Science Award. Kirk, who has received several major research awards, directs the Institute for Microbial and Biochemical Technology at the Forest Products Laboratory in Madison, WI. This award recognizes his management of the Institute and his research into how organisms break down the structure of wood.

College Receives GM Grant

The General Motors Corporation awarded the University of Wisconsin Foundation a five-year $750,000 grant. Money from the grant will be used to fund a wide range of programs in the College of Engineering. Such programs include the recruitment of women and minority students and faculty. GM is one of the College's chief corporate supporters.

ENGINEERING BRIEFS

by Dan Grellinger

Engineers in the *Mad House*

On January 27th, nuclear engineering students Wendy Steiner, Laurie Liebo, Steve Silbermann and Mark Rewey represented the University of Wisconsin-Madison as they faced the University of Minnesota on *College Madhouse*. This television game show is a test of mental and physical college superiority. Contestants competed in events such as Three Blind Mice in which blindfolded participants collect sponges covered in Cheez Whiz with their mouths. Other events included the Deli Fish Jerk and rinsing pancake batter off clothes and hanging them to dry. Needless to say UW won the cheese event but was defeated overall 225-150.

Denton Receives Research Award

Professor Denice Denton, electrical and computer engineering, received a Digital Faculty Program Award for her research and teaching in the areas of microelectronics. The grant provides $25,000 in unrestricted funds and $35,000 in equipment to enhance her program of science and engineering education and research.

Vogelsang Appointed Editor

Professor William F. Vogelsang, nuclear engineering and engineering physics, has been appointed editor of the American Nuclear Society Journal *Nuclear Technology* . This is one of the two technical Journals published by the ANS and covers the engineering, operational and waste disposal aspects of commercial nuclear power plants.

wisconsin engineer

ChE Major Represents State in Pageant

Marcille Faye Zietlow represented Wisconsin last fall in the Miss T.E.E.N. (Teens Encouraging Excellence Nationally) Pageant in Kansas City. A freshman in chemical engineering from Berlin, Wisconsin, Zietlow won third runner-up in the national competition. She received a scholarship and trophies for her speech and academic accomplishments.

New Engineering Faculty

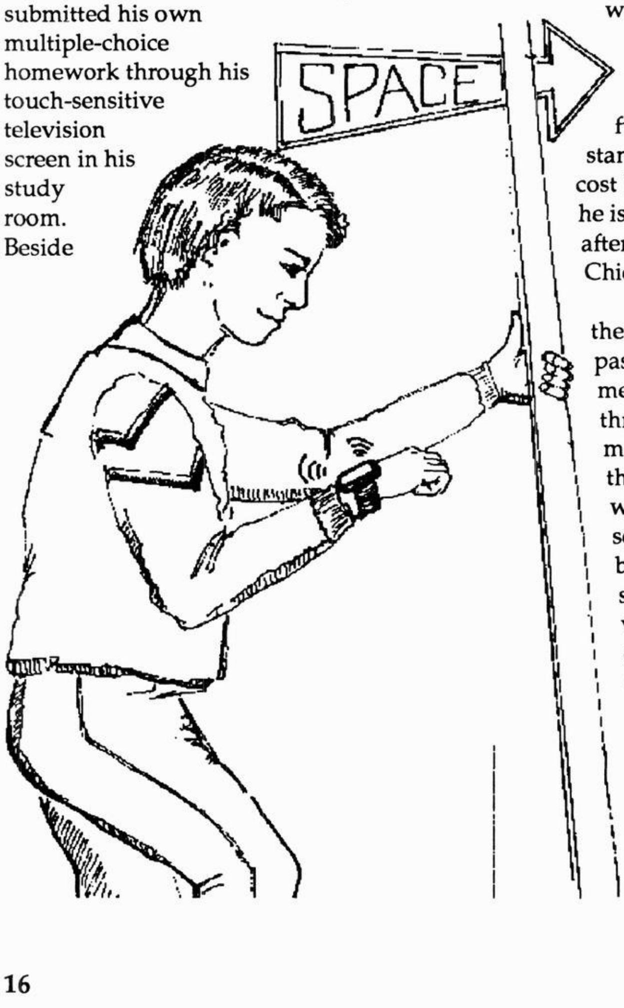
This year proved to be a banner year for faculty recruitment in the College of Engineering. The *Wisconsin Engineer* magazine welcomes the following faculty to the University of Wisconsin-Madison:

Teresa Adams	CEE	Rajiv Jain	ECE
Craig Benson	CEE	Tim Osswald	ME
Vicki Bier	IE	P. Ramanathan	ECE
John Booske	ECE	Rolf Reitz	ME
Ian Dobson	ECE	Jeffrey Russell	CEE
Raymond Fonck	NE	Chris Rutland	ME
Doug Henderson	NE	Pascale Sainfort	IE
Ned Tabatabaie	ECE		

In an Age of New Technology...

The year is 2101. Location: The Museum of Science and Industry, Chicago

Billy and his friends are giggling at the 3-D projected image of what used to be a classroom scene - a teacher waving her hands in front of a bunch of semi-interested students. Earlier, Billy submitted his own multiple-choice homework through his touch-sensitive television screen in his study room. Beside the screen sits Kuji, named after Billy's favorite Japanese rock star. Every day Kuji inputs lesson material from the cable outlet of the TV; he summarizes and prepares only the points Billy will need to learn when he returns from his morning Karate lessons. Kuji has been upgraded to be funnier and more understanding, but the upgrade has cost Billy so much money that he is going to the museum this afternoon instead of his favorite Chicago Bears game.



Billy walks on down the "20th Century" section; he passes by a preserved red-meat watermelon. Today, through years of advancements in genetics and with the help of selective planting, watermelons are now cubic so they can fit in the fridge better. They are much sweeter and come in a variety of colors. Billy cannot figure out why on earth his ancestors would grow a huge round watermelon like that. Maybe people were very weight-conscious then - so after putting in the watermelon they couldn't fit anything else in the fridge.

Further down the aisle, there is a large display of the futile attempts man has made to build robots. These were too cumbersome, too slow and heavy and worst of all, inresponsive. Of course, specialized vision chips were not fully developed then; microprocessor technology was not anything compared to what it is now, and anyway, people did not need robots to guard bank vaults.

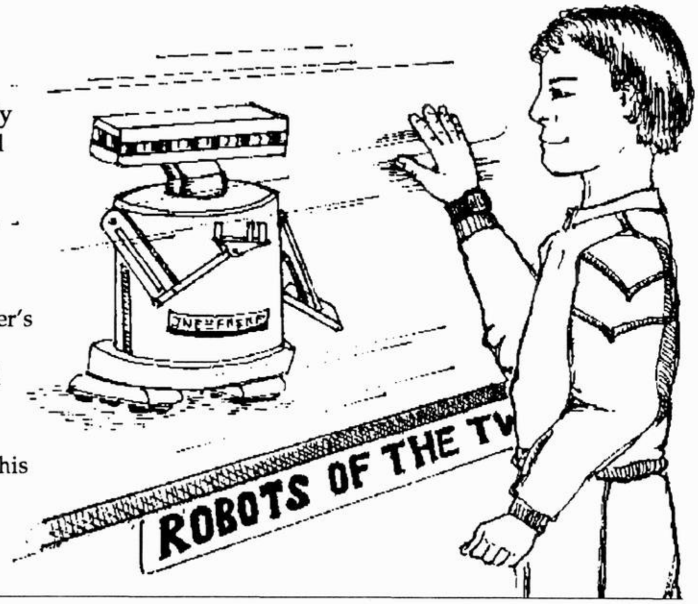
Billy turns right into a room which simulates what was once part of the huge Amazon jungle which unfortunately, is no more. Over twenty-five species of animals have become extinct, three-quarters of the Amazon basin has been reduced to a few national parks. The carbon dioxide content of the air is about .2%, that of the last century. Over 10% of the national budget is now spent on cleaning up the environment - the ocean, the air, the radioactive contaminated water and the orbit. NASA is now working on the painstaking project of removing broken and deteriorated pieces of "space junk" to prevent them from landing on the White House. Through extensive cutting of trees to make room for the factories of today, all the beautiful sounds of the wildlife can only be appreciated through recorded compact disks, which ironically, have been brought about through the same modern technology that has helped to destroy mother nature.

After wandering through the

unrealistic jungle for a while, Billy gets a little tired of rubbing against the synthetic bark of the trees. He exits the room and rejoins his friends who are crowding over a model of the transit system in Chicago. Life-size bullet trains which can reach nearly the speed of sound fly across the sky of Chicago on stilted bridges.

Billy feels excited; he wants to be a mechanical engineer someday. The bridge structures and the train body were so well built that there has not been a single accident since construction finished ten years ago. Through strict city laws on vandalism and regular maintenance, the transit system has been well maintained. Even though it is ten years old, it does not look aged at all. Above the model, statistical data is displayed. The city dwellers have saved billion of hours otherwise spent in traffic jams, as shown by a record 10 billion rides.

Further down is a history chart of man's energy resources. About fifty percent of the world's petroleum resources have been sucked up through continuous mining. A lot of research is done in attempting to tap the energy from the earth's mantle. Most of the current energy supply comes from solar and nuclear plants.



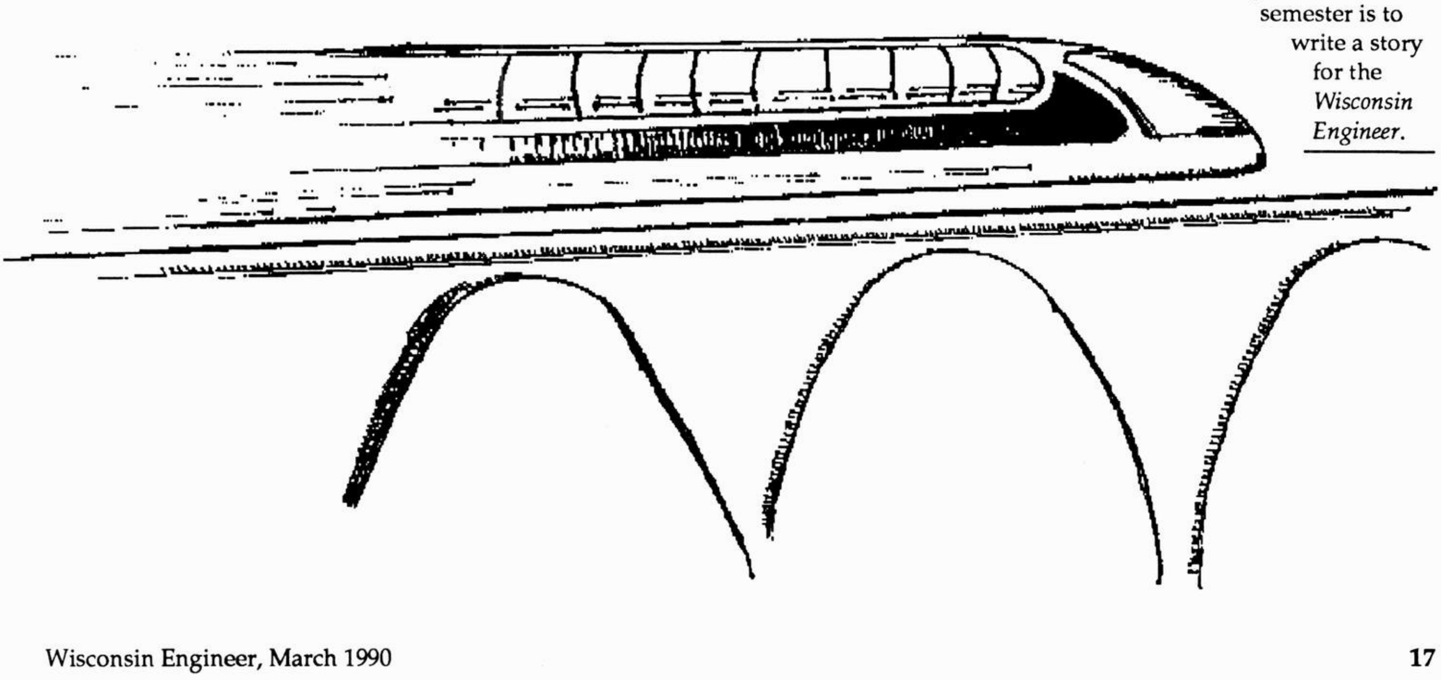
Billy is about to step into the "Space" section when his watch beeps and his kindly-looking mother's face appears on the colored liquid crystal display. "It's almost dinner time; better start coming home," his mother's well-toned voice squeezes through the tiny speaker on his watch. Billy is a little reluctant, but he is getting tired. He says good-bye to his friends and starts toward the train station.

Once home he slams into his favorite chair given to him for his eleventh birthday. This chair is really comfortable; each of the hundreds of micro-sensors underneath the seat detects the pressure on it and exerts the right amount of force to provide maximum comfort. Billy switches his TV to his favorite marine channel which is broadcast through a submarine studio built 100 kilometers off the shore of the East Coast. Illuminated marine life pictures are transmitted live, 24 hours a day. Billy dozes off in his "lazy chair" before waking up for dinner. His dinner tonight is a big surprise, good old home-made sausage and green pepper pizza. ■

Illustrations by Dawn Stanton

AUTHOR

Simon Chu Yew Choo is a guest writer from the ECE 350 class. One assignment each semester is to write a story for the *Wisconsin Engineer.*



Burn Analysis: A Computerized Fire

A match is dropped in the corner of a room. It chars the wood as smoke begins to rise. The temperature around the match increases. The wood ignites and the flames grow. The walls char as the draperies burst into flame. The ceiling heats up along with the supporting structure, charring at first, then igniting. The structural members in the truss begin to sag. Finally, the roof and ceiling cannot be supported any longer and fall crashing to the floor. Is this a reenactment of an actual fire? No, this is a simulation of a fire to be.

Currently, many new larger structures are being built of wood. Wood trusses keep the cost of structures low and allow for greater spans to be met than when using beams and joists. Trusses allow for faster completion time, lower building costs, and more flexible room designs. This seems great if one is a homeowner or a builder, but to the firefighter it is something else.

Most firefighters are skeptical of entering a burning building with a truss system overhead or underfoot. This is due to the small members which are used in the construction of the trusses. When wood is heated in a fire, the wood begins to char. Char is wood's natural mechanism for protection. The char acts as an insulation between the wood and the heat. For the wood to burn, it must reach a certain temperature where a chemical reaction occurs called pyrolysis. It is at this point that the wood begins to release highly flammable gases. The gases burn hot and the fire begins to feed on itself. The key is that wood will burn only under certain conditions, one being that it must be hot enough. Trusses have a large surface area/mass ratio compared to joists or beams and heat up rather quickly. Thus they fail sooner and with less warning.

UW-Madison Civil Engineering Professor Steve Cramer is currently working on a team research project that will simulate a fire within a given building. Other team researchers include the U.S. Forest Products Laboratories' scientists and technicians as well as many staff people from North America's wood industries.

The research project has two different areas. One is the data collection. Industry and the U.S. Forest Products Laboratory are deeply involved with data collection of many different materials. Cramer and the University are involved with integrating the data into a useable computer program that could be used on a PC such as an IBM-386 or an Apple Macintosh.

Testing can be done on individual materials allowing better procedures and reducing the cost of the process

Data from lab tests will be fed to a large data bank. The data bank will need to be updated as new materials are developed in the design process for improving trusses. Some of the different variables from industry will include types of wood, effects of sheathing in protection of structural members and types of fire retardant treated lumber. Variables that the designer inputs at the PC include the geometry of the structure, the size of the room, the size of the structural members, and the type of materials used in the construction. The integration of the data needs to include how different types of materials behave in fire, how the metal truss plates behave in fire and how material properties change with temperature.

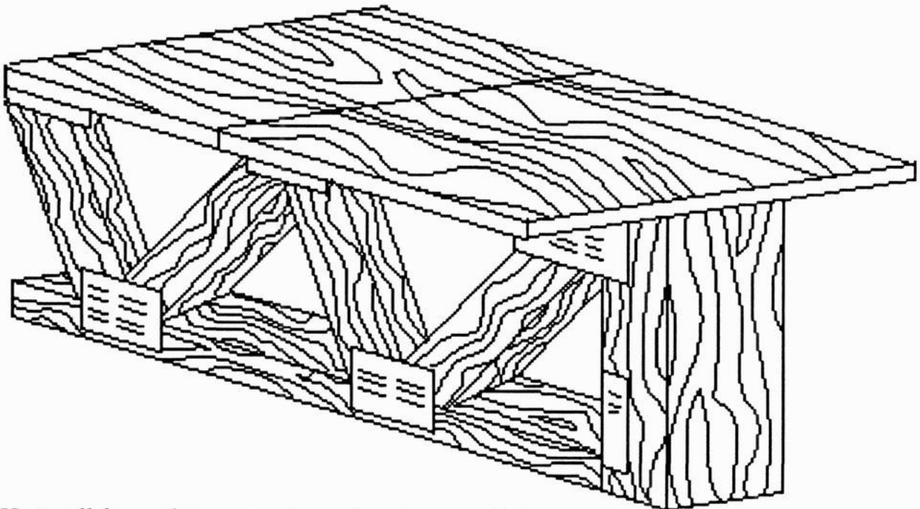
The current methods of determining the fire endurance of trusses involve large tests. One of the most important conditions of the test is that it must be repeatable. Therefore, a standard fire has been adopted. To obtain a standard fire, a standard burner and furnace is used. The ASTM-E119 test covers these specific requirements.

The test is basically as follows: a truss type system is built over the furnace which is contained in a 16 ft. x 16 ft. basement-like structure. Monitors are placed throughout the structure. A load (usually containers of water) is placed on the structure. A hood and an exhaust system are placed over the loaded system to eliminate the smoke from the testing building during the test period. The furnace is regulated as the structure is monitored by temperature gauges to meet the test requirements. Failure of the test can occur 1) when flames come through the structure, 2) when the top side of the structure exceeds temperature specifications of the test, or 3) the trusses collapse. For measuring performances of truss systems, only the third type of failure is used in determining the failure time of the structural system.

A program for determining the fire endurance of structural designs enables more testing to be done since it is faster and more economical. Testing can be done on individual materials allowing better procedures and reducing the cost of the process. More information can be obtained in this way than through one large composite test. According to Cramer, there are only five ASTM-E119 furnaces in the country. However, there are many smaller furnaces that can sit on top of a desk for performing the individual material tests.

Cramer says the key to the program is that, "It is much, much easier to take a small amount of that material and put it in a furnace and learn about its characteristics than it is to take that whole room into a furnace and learn how the whole room behaves. It is very easy and inexpensive to put a little piece of material in a small furnace that fits on top of a desk."

Cramer's idealized version of the program is as follows. A designer sits at the computer screen. After entering the design criteria entered into the PC, a match is dropped into a corner of the three dimensional design room. The program indicates a fire has started, and graphics show smoke billowing up. Through calculations of parameters within the code of the computer, the fire grows. Fire climbs the walls and heats up the supporting structure of the ceiling. Material properties change. The computer calculates the degradation of the wood. The trusses sag and the ceiling collapses. The clock in the upper window indicates the elapsed time from ignition to failure. This is important to the occupants of the room trying to escape, as well as to the firefighters trying to get in to put the fire out.



How well do wood trusses really perform during a fire?
This is a typical one-hour-rated protected wood-webbed truss floor-ceiling assembly having a double layer ceiling of Type X gypsum wallboard directly applied to trusses.
(From Erwin L. Schaffer, P.E., PhD.) Computer graphic by Dawn Stanton

This program will be used in two ways to help protect lives. First, it will be used by industry to discover better fire resistant designs and materials. Second, it will be used in building codes as an alternative to the large ASTM-E119 test in the determination of fire resistance of a building as designers will be able to test the safety of a design based on results of the program. ■

AUTHOR

Fred Hegeman is a senior in civil and environmental engineering. Fred's favorite movie classis is *9 1/2 Weeks*.

John F. Hinrichs: Winner of the International Golden Robot Award

On October 4, 1989 in Tokyo, Japan, John F. Hinrichs, manager of the Manufacturing Technology Laboratory at A. O. Smith Automotive Products Company in Milwaukee, became the first American to win the International Golden Robot Award for his work in the field of industrial robot technology with a special focus on automated welding applications.

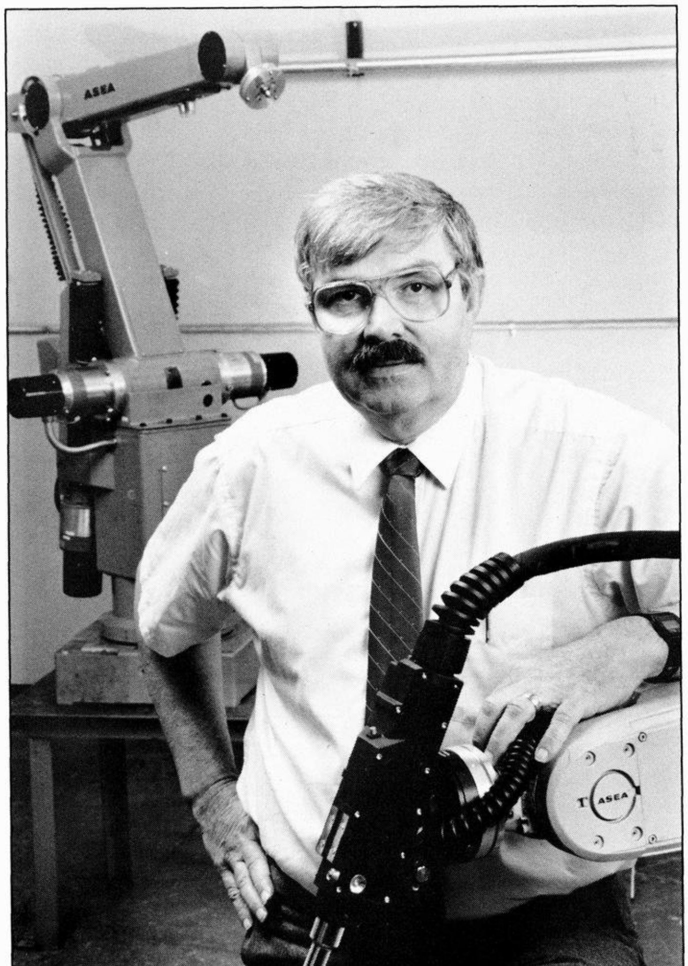
Begun in 1983, the Golden Robot Award was designed to recognize and promote high level research, development and implementation in the field of industrial robotics.

As a nominee for this award, Hinrichs was evaluated on the significance of his work in increasing industrial robot technology, on the verification of this work by an advanced educational institute or a robot user, and on the submission of documents detailing his accomplishments in this field. Professors from prominent Swedish educational institutions and representatives from various Swedish robotics corporations served on the five-man judging panel for this year's award.

Hinrichs' remarkable robotics accomplishments include the design, development and implementation of electronic interfaces between robot and welding equipment, multi-task capability robots for increased machine efficiency, out-of-position, spatter-free pulse arc welding procedures, sensitive seam tracking techniques, and world class weld quality.

Hinrichs began working for A. O. Smith, a major producer of automotive frames, in 1954. He became a project engineer in the mid-1960's and began supervising the development of the robot applications for welding and other manufacturing processes in the early 1970's. As manager of the Manufacturing Technology Laboratory, Hinrichs currently directs a team of engineers and technicians who work with him on various advanced robotics projects. Hinrichs and his team are credited with installing over 150 robots for A. O. Smith in welding and material handling applications.

A. O. Smith's initial work with automated welding systems began in the mid-1960's. After successfully implementing an automated riveting process, the company next turned to automated welding. Under the guidance of Dean John G.



John F. Hinrichs is the first American to receive the International Golden Robot Award. Hinrichs is an engineer at A. O. Smith in Milwaukee.

Bollinger of the University of Wisconsin-Madison, then professor of electrical and industrial engineering, A. O. Smith began its long but productive journey into the world of welding robotics.

With funding from A. O. Smith, Bollinger, Professor Howard Harrison (also from UW-Madison), and several UW graduate students began a project which was to last almost 15 years. Initially working on a one-plane welding machine with an analog computer system, the work eventually progressed to a more complex and effective machine with five degrees of axial freedom guided by a digital computer system.

At that point in the development, the machines were known as automated welding systems, but they have since been labeled "robots" with the definition of "reprogrammable pieces of welding equipment."

"The success of introducing robots has been not because of one person, but because we have a team of people... a team effort made it successful."

Looking back on the robotics projects, Hinrichs notes that because of A. O. Smith's collaboration with the University." A number of grads received their masters' degrees as a result of working on various facets of robot welding equipment."

In 1980, with the advent of commercially available jointed-arm robots, the company no longer needed the University's help. By working from the past efforts of the university and the valuable experiences of Hinrichs and his team members, A. O. Smith can now simply communicate directly with a robot company and outline particular specifications.

With the implementation of the welding robots Hinrichs claims, "We get consistent results every day." He explains that this consistency is not always present in manual welding systems because a worker may not be feeling well on any given day , and that discomfort may show through in the quality of his welding work. However, once trained, a robot can do the same thing every time. "If the robots are made correctly, they will produce good, high quality parts every time," claims the 1989 Golden Robot Award winner.

In addition to designing and integrating robot systems, Hinrichs and his team are also responsible for developing and conducting training sessions that deal with programming and electronic and mechanical maintenance of the systems. The sessions typically involve about 80 hours of employee training, but the philosophy behind this method, according to Hinrichs, is that "well-informed people do a good job."

Stressing the importance of the participants in all aspects of this automated welding process from Hinrichs' core group of engineers to the workers on the shop floor, this manager declares, "The success of introducing robots has been not because of one person, but because we have a team of people...a team effort has made it successful."

He goes on to say, "People who run robots make suggestions. We [the Manufacturing Technology Lab] listen to them and try to implement the information we get from the shop floor."

Hinrichs received his undergraduate degree in mechanical engineering in 1956 from Marquette University and then, by attending classes at both UW-Madison and UW-Milwaukee, went on to achieve his master's degree in metallurgical engineering from the University of Wisconsin in 1964.

Regarding the Golden Robot Award Hinrichs says, "It was really quite a thrill and quite a surprise." Hinrichs received

The International Golden Robot is awarded for excellence in the field of industrial robotics

the award during the 20th International Symposium on Industrial Robots in Tokyo, Japan. Following this October ceremony, A. O. Smith conducted its own congratulatory ceremony for Hinrichs in Milwaukee. Emphasizing the importance of his co-workers, Hinrichs reiterates, "The success is a team success and not just a personal thing."

Looking back on the automated welding project Dean Bollinger says, "The whole thing started with an industry-sponsored research project...twenty-five years later, he [John Hinrichs] won the award."

Dean Bollinger attended the recognition ceremony in Milwaukee and comments, "It was really a pleasure for me to be a part of it and to see him get that award because he has done a good job in the welding business."

Photographs are courtesy of A. O. Smith.

AUTHOR

Nancy Hromadka, a sophomore in electrical engineering, is a *Wisconsin Engineer* co-editor. Her favorite fantasy film is *Princess Bride*.

Lab Safety: Are You at Risk?

Safety is a serious and significant subject, especially when dealing with dangerous chemicals and materials as most students do in a laboratory. There is much literature written on the subject, much of it repetitious, although important. However, as engineers and human beings, there are times when we all throw caution to the wind and do something wild, something impetuous—like going through half a lab without safety goggles, or chewing gum while working with chemicals. Are you one of these people? How safe are you in the laboratory?

Below is a self-examination on that all-mportant, understressed issue of laboratory safety. Pick the phrase that you feel best fits the paragraph. (Note: There are no written answers to this quiz.)

For anyone that has ever taken a laboratory course, safety is a very (a) important (b) overstressed (c) boring part of the course. This is due in part to the nature of the course. A person is always in iminent danger of seriously (a) injuring themselves (b) killing themselves (c) learning something in a lab course. When working with hazardous materials and machines, it is always important to protect oneself against these unforeseen dangers. (a) Knowledge (b) avoidance of a drunken stupor (c) not showing up to lab is the major factor in prevention of accidents.

Whether dealing with chemicals or machinery, several rules apply with all lab courses. Probably the most common is the use of safety goggles . These come in a variety of forms. There are those which offer the least amount of effectiveness to the (a) full-covering plexiglass goggles (b) bullet-proof glass goggles (c) full-body, hardened steel suit which offers the fullest effectiveness. When working with any chemicals that may splatter or explode, or when working with machines that may create a great amount of debris, it is advised that a person wear safety goggles. What can happen to you if you don't wear goggles? In most cases, serious injury does not occur, but by wearing goggles, a person can (a) prevent blindness (b) look like Luke Skywalker (c) get permanent "raccoon scars" around the eyes. Safety goggles are a good example of the "better safe than (a) sorry (b) flunking (c) dead" rule.

Other rules that usually apply in a laboratory deal with the type of clothing a person wears to the laboratory. Long, flowing clothing, and loose ties are not advised for several reasons. When wearing loose clothing, there is always the possibility of (a) setting onself on fire (b) catching the clothing in a piece of machinery (c) being mistaken for a hippy from the sixties. Catching one's clothes in a machine usually results in (a) the loss of an arm or leg (b) the impossibility of an 'A' in the course (c) utter and absolute humiliation. In more extreme cases, it may even result in death.

When an accident does happen what should you do? Depending on the nature of the accident, there are a variety of different things that can be done. If the accident deals with a fire, the nearest fire extinguisher should (a) be located and directed towards the fire (b) be read for directions (c) be salvaged from some corner of the room. In the case of a person on fire, a person should direct themselves (a) calmly (b) quickly (c) wildly and madly like a person on fire to the nearest shower and douse themselves with an adequate amount of water to extinguish the fire.

If the accident deals with any sort of object in the eyes, such as a douse of chemical in the eye, the person should proceed to (a) the nearest eyewash (b) the sink (c) the closest faucet, which is usually a block closer than the eyewash and rinse the eye out with copious amounts of water for several minutes.

For accidents that cause any sort of bleeding, a person should consult the first aid manual on what to do. In general, unless it is a case of severe bleeding, (a) tourniquets are not advised (b) cookies and milk will make the boo-boo feel better (c) buckets are not needed. A good example of this is the amputation of an arm. The arm should be kept as cool and clean as possible, and the bleeding at the place of origin should be stopped. There is always the possibility of reattachment of an amputated limb.

Safety and knowledge are very important in the prevention of serious injury due to laboratory accidents. A person should always be aware and alert when working in a laboratory. Failure to do so may have disasterous consequences.

AUTHOR

Sharon Chen is a sophomore in chemical engineering and favors *It's a Wonderful Life* over other flicks.

Engineering Mechanics Sets a Trend:

Astronautical Engineering

In the last State of the Union Address, President Bush called for a renewed American interest in space exploration. This renewed interest may take the form of a permanently-manned orbiting space station, a mission to Mars, and perhaps even a return to the moon. However, many of the problems associated with space exploration are unique unto themselves and are not generally addressed in many of the classical engineering disciplines. Because of the need for a specialized type of engineering to deal with these problems, the Department of Engineering Mechanics is requesting a preliminary entitlement to develop a proposal for a bachelor of science degree in astronautical engineering.

The proposed new degree will comprise two major components: a required sequence of basic science, mathematics and engineering fundamentals plus liberal studies electives, and a program of required electives in advanced mathematics, science and engineering with an emphasis on astronautics. The proposed curriculum would include courses in orbital mechanics, satellite dynamics, spacecraft propulsion and satellite and aerospace vehicle design to name a few. Many of these courses are already available within the Department of Engineering Mechanics for those students seeking the bachelor of science degree in engineering mechanics with the astronautics option.

UW-Madison has been offering selected courses in aerospace-related areas since 1948 and has offered courses in astrodynamics since 1965 when Professor A. L. Schlack, Jr. first offered a graduate course in Space Dynamics (EM 742) and then started teaching Celestial Mechanics (EM/Astronomy 550) in 1966. In April of 1987 the Department of Engineering Mechanics voted to request the approval of an Astronautics Option to the bachelor of science engineering mechanics degree. This plan received final approval from the University of Wisconsin System in April of 1989. In this brief period interest in the program has rapidly accelerated. Out of the 200 undergraduates majoring in engineering mechanics, 70 have declared the Astronautics Option, and 24 out of 39 of the pre-engineering students interested in engineering mechanics have selected the astronautics option.

According to Professor Kessel, Chairman of the Department of Engineering Mechanics, the employment outlook for engineers with a background in astronautics looks promising. Kessel points out that with the radical changes which are occurring in world politics today, reduced military spending may become a reality. With this reduction, the economic re-direction of America's defense industry's resources towards the peaceful exploration of space is a possibility. In fact, some UW-Madison engineering graduates have already procured jobs in the astronautics industry with firms such as McDonnell Douglas, Hughes, Lockheed, Boeing, and even NASA.

If this program is approved UW-Madison would be joining a very exclusive family of universities who have taken the initiative in this relatively new area of engineering technology. Several universities offer programs in aerospace engineering, aeronautics and astronautics, and aeronautical engineering. However, almost all of these programs grew out of an established aeronautical program, and offer few courses in astronautics, with the primary focus of their curriculum being devoted to aircraft rather the spacecraft studies. Currently, the U.S. Air Force Academy offers the only accredited degree in astronautical engineering. Meanwhile, the University of Texas at Austin and Ohio State University offer as of yet unaccredited undergraduate degree programs in this area.

If everything goes as planned, the Department of Engineering Mechanics would change its name to the Department of Engineering Mechanics and Astronautics. Pending final University approval, the College of Engineering would be able to offer the degree for the fall 1992 semester and perhaps have an accredited program by 1996. ▮▮

AUTHOR

Glenn Ruskaup is a junior in engineering mechanics. This is Glenn's first semester on staff. In the past, he was too busy watching *Blazing Saddles*.

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