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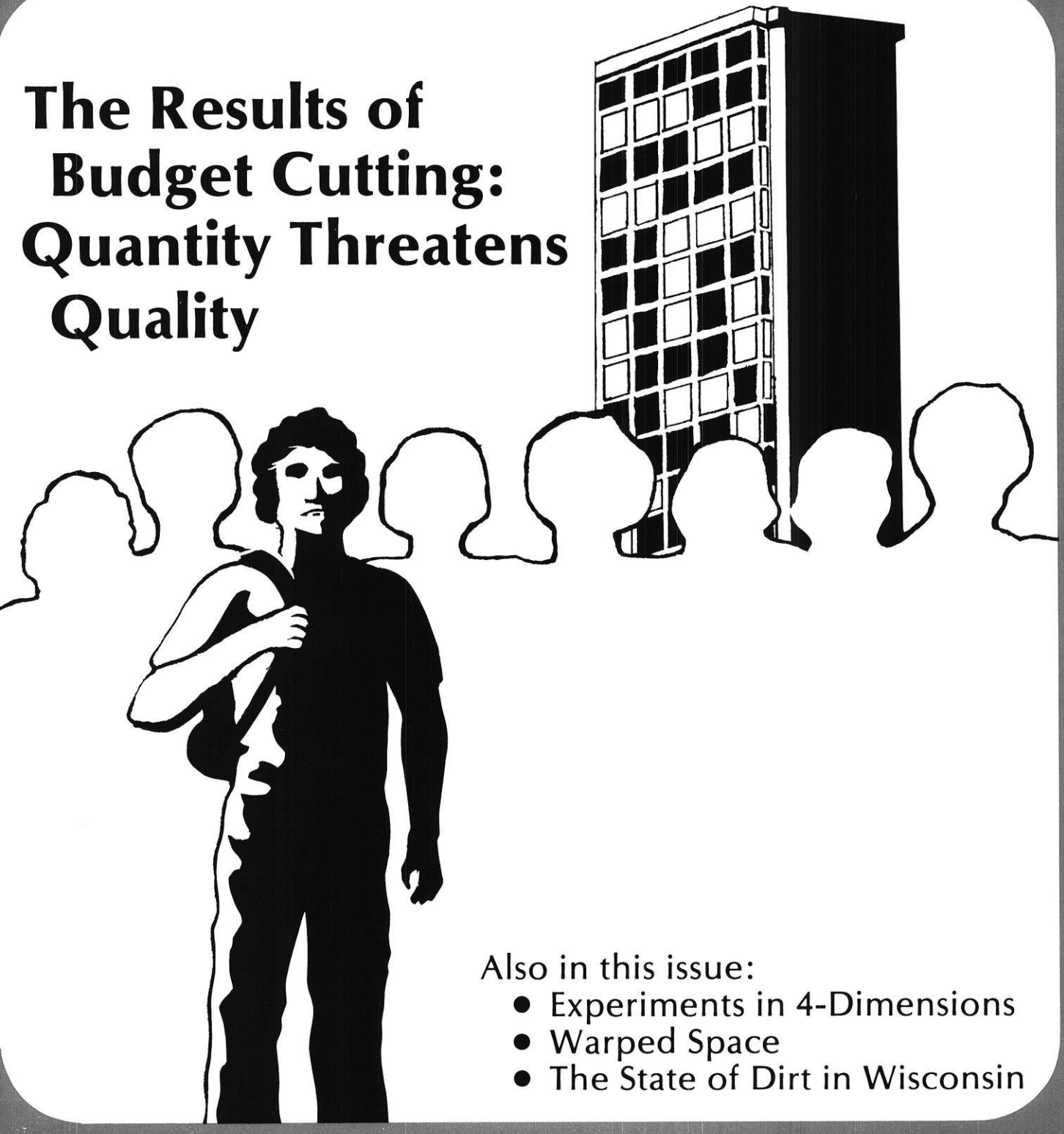
Volume 88, No. 1 October, 1983

wisconsin engineer

The Results of Budget Cutting: Quantity Threatens Quality



Also in this issue:

- Experiments in 4-Dimensions
- Warped Space
- The State of Dirt in Wisconsin

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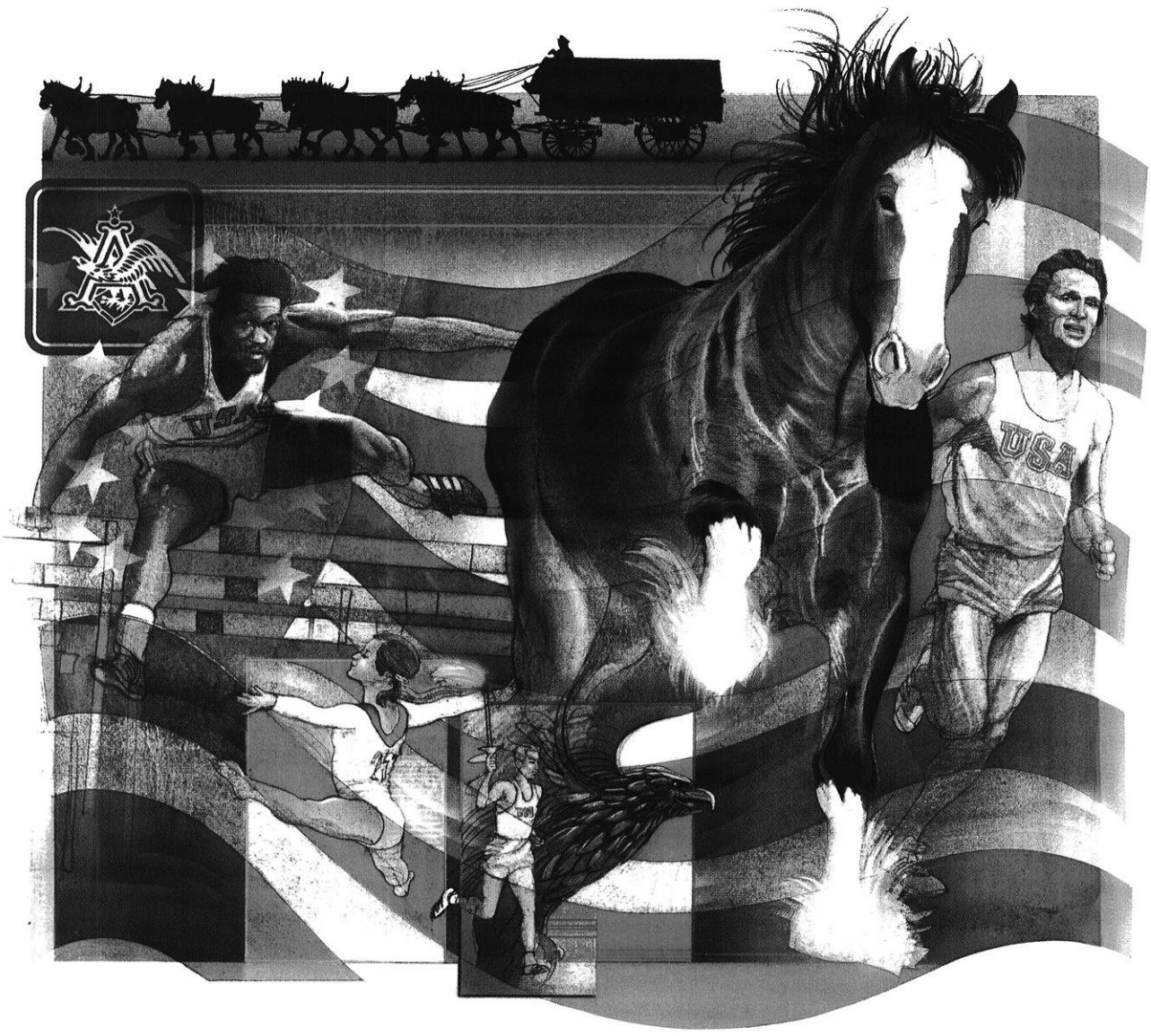

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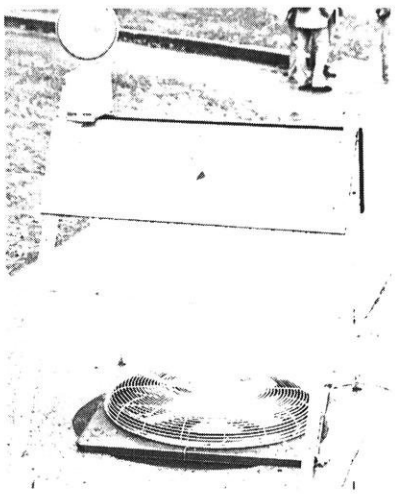
COLUMNS

FEATURES

page 10 photo by Ron Hillman



page 14 photo by Ron Hillman

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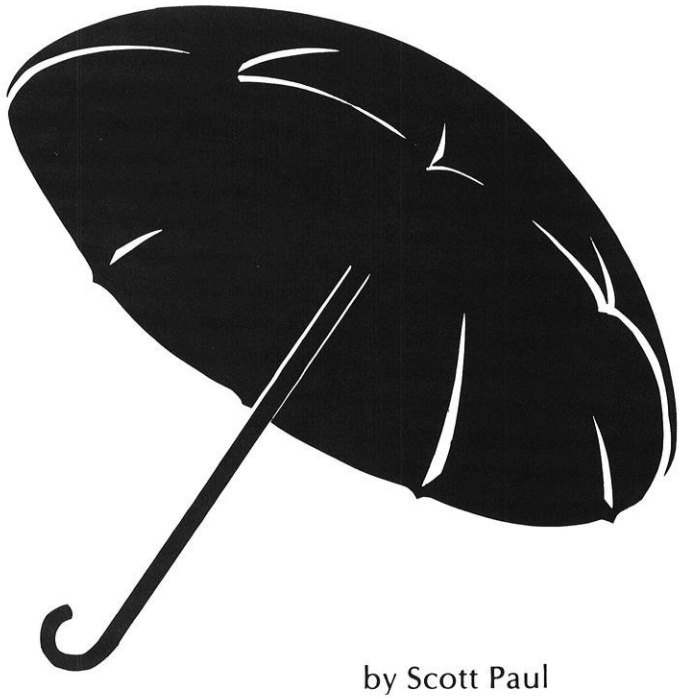
Lake Water

Rainy Days and Nuclear War



by Scott Paul

One day last November the rain came down in buckets. I had wet feet and a runny nose. It was a day where the only place I really belonged was asleep in a warm bed. Instead I was going to class and bravely daring the elements to do their worst to me.

Unfortunately the rain was not the worst of my problems. People were running around waving their umbrellas all over the place. These people never watch to see who they are going to hit. I had to keep ducking and dodging to keep from being stuck in the face with one of the metal ribs. Hunched over and moving to their destinations with such single-minded haste, no one noticed how miserable they were making me.

One of the hurriedly passed by while reading a newspaper. The headline said that Brezhnev, the leader of the Soviet Union, had died. I ducked out of the way so that I didn't get poked by his umbrella.

Not many people were fond of Brezhnev. Most were worried that he would start a nuclear war with the United States and bring an end to civilization. People worry an awful lot about nuclear war, and they seemed to breathe a collective sigh of relief now that they wouldn't have to warry about old Brezhnev any more.

Of course they replaced Brezhnev with a new leader and people still worry about nuclear war. And to this day we still haven't had one.

The point is that all the worrying they did made no difference. They worried about something when there was not much they could do to change the situation. People wanted to make the world a safer place to live--but they didn't know how to go about doing it.

If they really wanted to make the world a safer place they could have started right away. They could have been more careful and avoided poking people in the face with the metal ribs of their umbrellas.

You can only improve the things you have control over. That starts with the area immediately around you, then it spreads through the area influenced by your work. Only once in a great while can an individual do anything about a matter of global significance. If you want to lead a useful life you have to always look for the things that need improving, then decide if there is anything you can do about it. If there isn't--don't worry about it. Why waste the time? But if there is anything you can do to make the world a better place, even if only a tiny corner of it, give it your best shot. What might seem to be an insignificant trifle could easily make a great deal of difference to a poor sick college boy with wet feet. □

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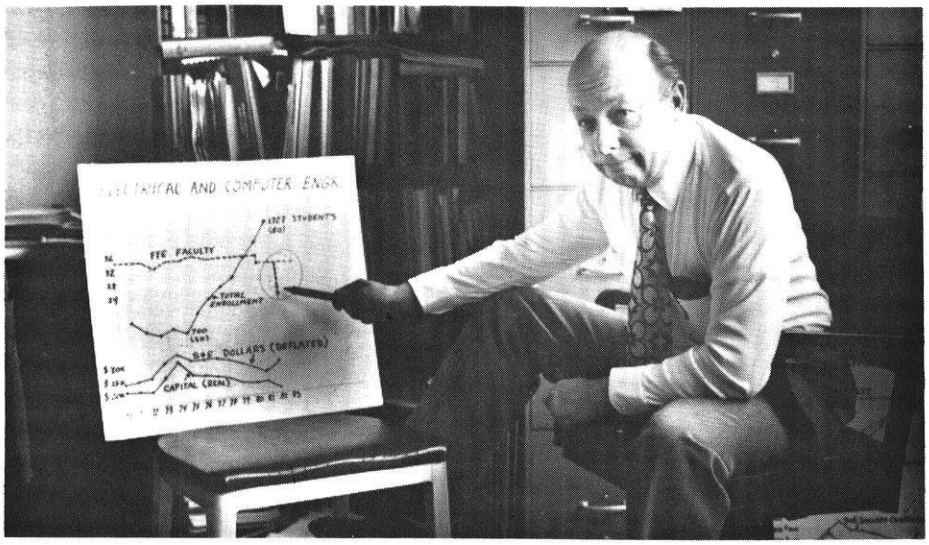
Salary Freeze Threatens Quality of Engineering Dept.



William Birkemeier, Department Chairman of Electrical and Computer Engineering, points out the grim reality of an escalating student/faculty ratio. photo by Ron Hillman

by Bob Zemke

In the past few months there have been numerous articles in the campus and city newspapers on the salary freeze for state employees, including UW faculty. The effect this will have on the UW system and specifically Madison campus may not be readily seen, yet several faculty members fear what UW Madison might be like five to ten years from now if professors continue to leave.

The ratings of specific departments in UW Madison rely heavily on the number of faculty in the department. "Departments are rated by the number of papers the faculty write, the number of graduate students in the department, the number Ph.D.'s awarded and the number of faculty in the department," said William Birkemeier, Department Chairman of Electrical and Computer Engineering. "With a smaller faculty fewer papers are written, and therefore the department's rating goes down," added Birkemeier. ECE's ranking has gone from fifth to thirteenth. "It kills you to be ranked low. We have interviewed seven to eight people and offered several of them jobs but no one has accepted," said Birkemeier. "We have gone from 700 students in 1973 to 1700 students in 1983 and our faculty has dropped from 44 to 34. It is becoming more and more difficult to educate the students that are coming in when you don't have enough professors to teach the classes."

The fact that more faculty are leaving has brought several harsh and startling comments by prominent educators at Madison. As far as salaries go by 1985 other Big Ten Universities on the average will be paying their faculty 30% more than UW faculty. UW-Madison Chancellor Irving Shain made several comments in the Wisconsin State Journal as to how this would affect UW-Madison if nothing is done.

"If top professors continue to leave UW-Madison, it will hurt Madison's economy because they will take with them several million dollars in research grants," Shain said. "When UW-Madison hires new professors to replace those that retire or leave for better money it takes a while for them to be able to get research grants," said Robert Ratner, an Associate Dean in the College of Engineering. "Two more professors are planning to leave at the end of this semester for better opportunities," he added. Shain also said that early signs of the deteriorating quality of the University may not be readily apparent to those public officials who are in a position to help solve the problem. "By 1985 the salary margin will be so wide, in fact, that the recovery of our competitive position would be both politically and economically improbable for the next 17 years," Shain concluded. Rep. David Clarenbach, D-Madison, commented that many legislators do not see the problems. "The legislature deals in two year increments so they tend not to look at the long-term effects of their actions," said Clarenbach.

Some students feel that they won't be affected by just a few professors leaving. "Unfortunately, the quality of the University is judged mainly by the graduate program," said Birkemeier. "If the graduate continues to slip, undergraduates will find that a degree from UW-graduate program continues to slip, undergraduate will find that a degree from UW-Madison won't be as prestigious as it used to be."

"It is becoming more and more difficult to educate the students when there aren't enough professors to teach the classes."

The problem, as with so many other things, is money. The Governor and legislatures feel that the state is in a depression and those at the University don't understand. Tom Loftus, Speaker of the Assembly, said that the faculty seems to ignore the fact that they had an 8% increase over the past two years. "I don't see where the faculty expects the money to come from. I believe UW-Madison must raise tuition to get the money needed to pay the faculty." Birkemeier feels a possibility for raising money is to go to the alumini. Rep. Clarenbach feels the legislature should reassign its priorities and dedicate itself to solving the UW's financial problems.

Dean Ratner feels the beginning of the decline of the University can be traced back to 1973 when the UW system was formed. "It was better economically, but not for the welfare of UW-Madison. It would be impossible to get rid of the merger, but the Madison campus should be able to be treated differently."

Another way to alleviate the financial situation would be, as Loftus suggested, to raise tuition. Dean Ratner commented that Michigan, a state in deep depression, has put in a tremendous effort to improve the quality of the University. Michigan raised its tuition so that the faculty could receive a 7% salary increase this year.

Other possibilities that might help solve the problem would be to treat the UW faculty as if they were not state employees so that the wage freeze wouldn't apply to them. Another alternative is to admit fewer students to the University so that existing faculty can handle the load.

Rep. Clarenbach concluded that the state is hurting itself by not recognizing the problem at UW-Madison. The legislature and the state need to work together to find a solution. "The problem is that neither the legislature nor anyone else is prepared to accept the responsibility of looking ahead more than two years." □

ME Curriculum: New Accent on Design

by David Eiche
and Greg Gorski

Every six years, the Accredidation Board of Engineering Technology (ABET) reviews the Mechanical Engineering curriculum to ensure that it continues to meet the standards expected of an engineering education. ABET was created by engineering societies (e.g., ASME), and its stamp of approval is crucial for maintaining the reputations of the programs it inspects. Last year, the ME Department underwent an ABET review, and despite a largely positive report, ABET found what it felt was a serious flaw in the ME curriculum -- too little practical design.

The analysis of the department was a fair one, according to Professor John W. Mitchell, chairman of the ME Department. For three to four days, ABET visited the department, talking to the chairman, faculty and staff, and sitting in on classes and studying the curriculum. ABET's only major complaint was that the amount of design credits offered (or mandatory for graduation) was deficient. The examiner found the problem serious enough, however, to recommend that the department solve it within three years.

Budget cuts forced the ME Department to drop ME 216, a specified design course.

Professor Mitchell feels that the recommendation was justified while noting that ABET's action was little more than "a slap on the wrist" which has become very common in ABET reviews across the nation. ABET has recently changed its standards on these types of design problems. Complicating the situation is the ME Department's shortage of staff and budget, which has forced it to change offerings of courses and even drop others. One of the dropped courses was ME 216, which dealt specifically with design problems.

To cure the problem, an ad hoc committee headed by Professor Howard Harrison has recently been named. The committee has just begun to identify the problem and address the specific deficiencies ABET had found.

Professor Harrison stated that exactly what ABET meant by "design" was not clear to anyone, but a few facts did stand out. The ME Department is divided into three sections, with the energy systems section accounting for 5-50% of the curriculum, the design section taking 33%, and the remainder going to the production area. The lack of design-oriented material is not unique to the design section; it is a problem which spans all three sections of the department. ABET apparently feels that the curriculum in all sections has too heavy an emphasis on theory and needs more design content.

The ABET examiner gave a 3-year deadline to add more design content to required courses.

The committee intends to attack the problem first by developing a concrete definition of "design" and then studying the existing curriculum to see where it is necessary to add design-related material. New courses will probably not be offered. Instead, the existing curriculum will be modified to include a heavier design emphasis. For example, a three-credit thermodynamics course could be divided into 2 credits of analysis and 1 credit of design. In the design third of the semester, a student might be asked to solve a problem given certain constraints. A typical problem would be to create a turbine which produces X work with Y heat transfer. Design problems such as this include an element of creativity and synthesis along with analysis and are meant to encourage students to develop a wide variety of skills.

The ME Department's need to include more design is a tricky piece of design work in itself, especially given the constraints of tight budgets and high enrollments. While the present lack of design emphasis is serious, ME students can rest assured that the problem is being addressed and remedies should be forthcoming. □

Eye in the Sky: The Gravitational Lens

Einstein's revelations on the deflection of light may one day allow us to observe distant starts in great detail.

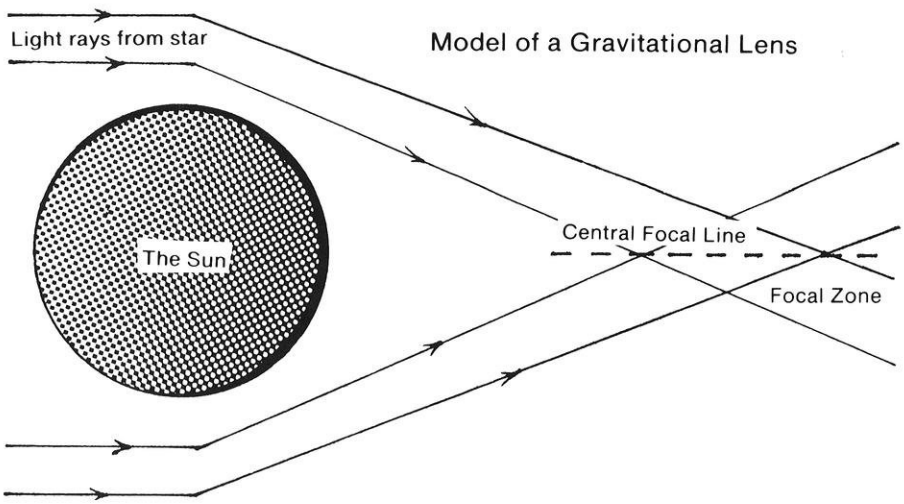
by Scott Paul

A brilliant man named Albert Einstein once predicted that a large mass would have the unusual properties of being able to warp space and slow down time. The idea was so revolutionary that many people thought he was crazy, but he persisted, and in the end he was proved right by an experiment that he designed. The sun has a mass that warps space and slows down time by a measurable amount. This causes light rays to be deflected toward the sun as they pass through its gravitational field. The experiment measured the deflection of the light from a distant star and found it to be in line with Einstein's prediction.

The star's image had been deflected 1.7 seconds of arc. (.00028 degrees). This fact may one day allow us to build a telescope millions of times more powerful than any other telescope built before.

Light rays from a distant star would be essentially parallel as they approach the vicinity of the sun. The rays that skim the outside edge of the sun would be deflected inward. These rays will eventually converge in a focal zone where the star's image could be magnified billions of times.

The major drawback is that this focal zone would be located at a distance of 8.5 x 10^{13} meters from the sun. This is about fourteen times the distance from the sun to Pluto. To say the least, this is not an easy place to get to.



A person at that spot would see a bright ring around a rather dim sun. As he moves further away from the sun he would see the ring get larger. This effect results from the fact that light rays which don't pass quite so close to the sun are not as strongly deflected by the gravitational field. A telescope at a greater distance would have a greater magnification because it would be observing light rays gathered from a larger area.

Such a telescope would most likely be in the form of a circular array of mirrors which would reconstruct the image of the star fom the so-called halo that we would see.

There are many difficulties involved in undertaking such a project. The most significant of these are the great distances involved.

It would also be difficult to locate these focal zones. Each star would have its corresponding focal zone on the opposite side of the sun. What we have is a sphere of these small focal zones surrounding our sun, but they may be tricky to find because of the great volume of space we are working with. To find a particular focal zone we might try using a computer to guide the telescope on its flight so that it will keep the center of the sun in line with where the star should be.

It is interesting to know that there are places out there where the sun appears to have a halo.

It would be most convenient to position the telescope at a distance well beyond the first focal point so that it would be observing light rays that pass at some distance from the surface of the sun. This will reduce the difficulties caused by coronal aberration; that is, it will cut down the distortion that occurs as the light rays pass through the atmosphere of the sun.

It is possible that one day we may even be able to take close-up photographs of a planet orbiting one of those distant stars.

Another possible use of the focal zones is that of harnessing the relatively high energy densities found there. An interstellar probe might be shot out of the solar system in the direction of one of the focal zones. Once it arrived it could operate effectively on ion engines powered by photo-electric panels. It could slowly build up the speeds which would carry it to the stars.

It is interesting to know that, at a distance so great that the sun itself appears as but a dim star, the distant stars can appear as bright as the sun. It is also interesting to know that there are places out there where the sun appears to have a halo. Einstein would have been pleased. He might have smiled. □

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Experiments in 4-Dimensions

by Kurt Worrell

Nearly everyone takes space for granted. Everything we know revolves around 3-dimensional space. What about alternative spaces, those of dimension greater than three. Do they exist? And if they do, how do we represent them in our 3-D world. "Experiments in Four Dimensions", by David L. Heiserman, not only answers these questions about 4-dimensional space, but many more. Incidently, as it stated in the book's introduction, neither he nor the publisher "assume any liability if you use this material carelessly and invent a 4-dimensional object that draws you or any of your personal belongings away into hyperspace."

Most of us can imagine the three mutually perpendicular axes which describe height, width, and depth. Now try to imagine a fourth axis which is perpendicular to all of these. If you can, you either have a high degree of spacial perception or you don't really understand the situation. Human perception is not structured to deal with 4-dimensional space directly.

Heiserman therefore takes an indirect approach in explaining the facets of 4-D space. Starting with a single dimension, he explains the basics for a coordinate system, how to plot figures, and how to analyze these figures. He follows with a discussion of some of the more interesting geometrical aspects of working in different dimensions, these being translations, scalings, and rotations.

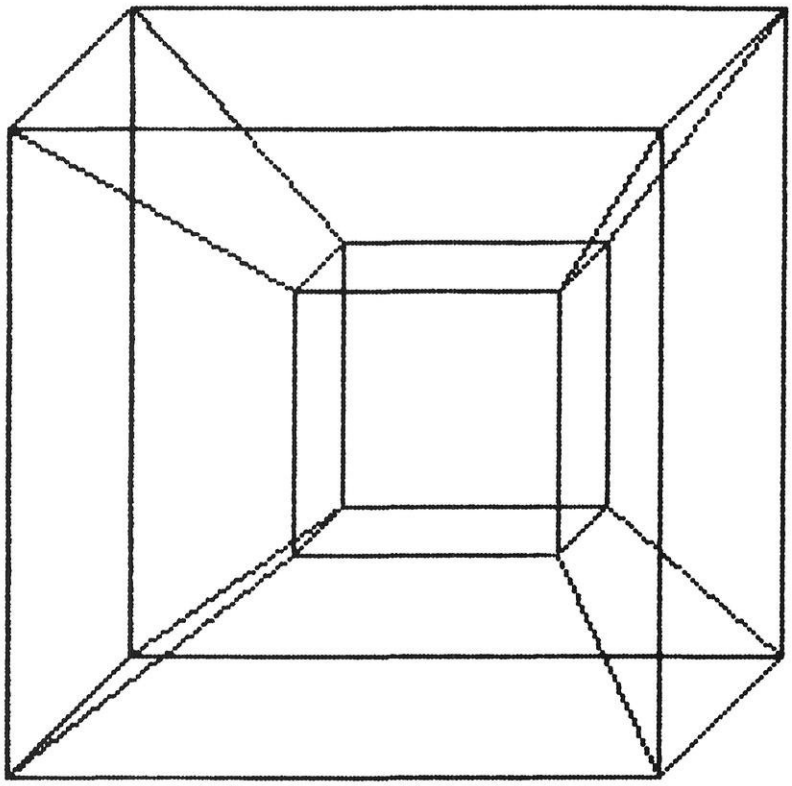

Figure 1. General 4-D view of a hypercube. This object is composed of 16 points, 32 lines, 24 faces and 8 space objects. All the angles are 90 degrees.

Heiserman does an admirable job of portraying the unportrayable.

A translation is an expression which represents displacement, direction and distance, between two coordinate systems. Both geometric and relativistic translations are discussed in the text. Scalings refer to the altering of measuring units causing the figure to be expanded or reduced. Rotations, which are only possible in spaces of two or more dimensions, are those transformations which cause the coordinate system to be turned around a point. Rotations explained by the author include those about the origin and those off the origin.

In all cases, the author provides algebraic equations, proofs, examples, and exercises which, together, provide the reader with a deep understanding of all concepts brought forward.

After giving the background information for each dimension. Heiserman devotes special sections to experiments in that particular dimension. Each of these experiments is designed to com-

pliment your current knowledge of the dimension and, together, these experiments make use of nearly every facet explained in the earlier chapters.

One example of experiments which are given in the sections deals with combinations of translations, scalings, and rotations of 3-dimensional objects. Because these properties are not commutative, that is, the order in which these transformations occur affect the outcome, the experiment directs the reader to see what differences occur when these transformations are performed in different orders. It also suggests that you try different combinations on different axes and analyze the differences that do occur.

photo by Ron Hillman

We cannot assume any liability if you use this material carelessly and invent a 4-dimensional object that draws you or any of your personal belongings away into hyperspace.

Logical approaches to mapping objects in 2, 3, and 4 dimensions are presented in these sections also, including the aspects of perspective and distortion. Prespective is defined as the attempt to produce accurate drawings which lead the viewer to believe that there are more dimensions than there actually are. Distortion refers to certain data which is lost when mapping to lower dimensions. Figure 1 shows one example of distortion, in that both cubes which you see actually are the same size.

Because of the difficulty of visualizing 4-D space, it was necessary for Heiserman to explain the lower dimensions before continuing on to a dimension which has never been "seen" by man. All equations used in later parts of the text were build from 1 or 2-dimensional space and it is this background which is so necessary to understand 4-dimensional space.

Heiserman has portrayed an unportrayable concept and has done an admirable job. Not only does he explain how to display 4-D objects, but he shows you how to manipulate them as well. He "sparks your imagination and sets your sights beyond our universe...into the fourth dimension. □

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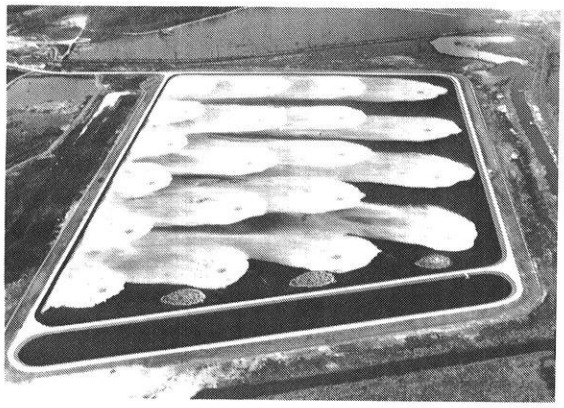

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Bits and Threads

photo by Ron Hillman

Big Park on Campus

The UW engineering campus has become more of a cultural center now that the Robert W. Marshall Memorial Park is open to the public. The park, which provides a visual conclusion to the Henry Mall and extended flower bed in front of the Engineering Building, was rapidly adopted as a location where one might hold discussions on relevant social issues. It's also not a bad place to have lunch.

The Cube With A Twist

Remember all those frustrating hours you spent futzing around with Rubik's Cube? Well, a group of Madison entrepeneurs have developed a cheap rip-off of the original which is advertised as "The World's Easiest Cube Puzzle." No longer will you have to strain your brain while trying to get all the little colored squares on the right sides: these guys have a cube that is the same color on all six sides. In addition to being very easy to solve, it is also rather difficult to mess up.

You can purchase one of these marvels by sending $5.99 to: The Triamox Corporation, 613 Sellery B, Madison, WI 53706. For $1.50 more you will receive a detailed instruction manual which would certainly be a nice thing to have if you like such things. Get yours today.

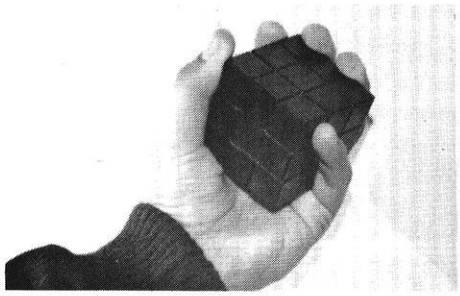
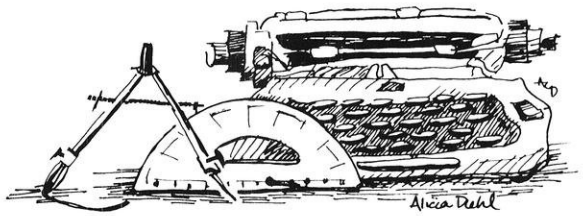


photo by Ron Hillman



Low Orbit Probes

Close-up photographs of airless worlds may one day be taken by probes placed into stable orbits only a few feet above the ground.

Researchers at the University of Wisconsin point out that on planets that have no atmosphere, the only limit to how low a satellite may be placed is the elevation of the highest part of the plant. A probe placed in such an orbit would be able to provide scientists on earth with a long series of extremely detailed pictures of features on the planet's surface.

This would be an improvement over landers, such as the Viking, which can only photograph one location. And a low orbit probe would be able to take much more detailed pictures than a satellite positioned so as to map the entire planet.

The researchers recommend that low orbit probes be a part of any future exploration of airless bodies in space, but they advise that "placing a satellite in an exceedingly low orbit is a tricky business requiring the most advanced guidance technology we have today."

High Mileage

Nowadays it costs a lot of money to "fill her up," especially if you happen to be driving a space shuttle to work.

The shuttle's main tank holds about 140,000 gallons of liquid oxygen and 380,000 gallons of liquid hydrogen. This is entirely used up during the first few minutes of a shuttle mission.

Although the space shuttle might be termed a gas guzzler by anyone's standards, you might be surprised by the kind of mileage the shuttle actually does make. On a typical seven-day mission the shuttle will travel approximately 2.9 million miles. The shuttle will be making an estimated 5.6 miles per gallon.

Actual mileage may vary depending on individual driving habits and conditions.

photo by Ron Hillman

No Place to Pedal

A shortage of parking space for bicycles has become a severe problem on campus. Cyclists are forced to chain their bikes to practically any fixture that is nailed down. Finding a space is unnecessarily time-consuming, and students are forced to risk having their bikes stolen because they must sometimes chain them to objects that are not physically secure.

The State of Dirt in Wisconsin

After a decade of pressure, the state finally recognizes an official state soil.

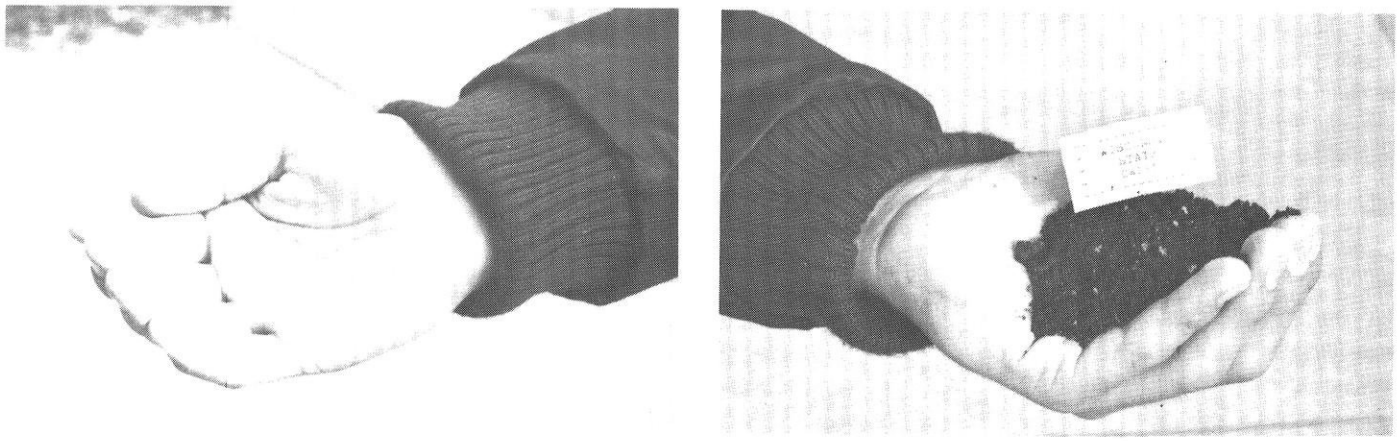


photo by Ron Hillman

by Solveig Christenson

Until Friday, September 10, 1983, there was no soil for the state bird to hop on, the state tree to root in, and the state mammals to roam over. On that day, Gov. Anthony Earl signed a bill making Antigo silt loam Wisconsin's official state soil.

University of Wisconsin-Madison soils professor emeritus Francis Hole witnessed the signing after his ten-year campaign to stimulate public interest in the soil. In view of the relative youth of soil science (it's approximately one hundred years old) Hole said he wasn't surprised at the absence of a soil in the state "official symbols" listing. Hole was concerned with the public's ignorance of important signs of soil neglect and erosion. The promotion of a state soil was hoped to spark interest.

Three years after Hole started discussing the silt loam issue, newspapers and magazines picked up reports of his talks. The light humor with which the idea was presented by the press increased "grass roots" popular support. Students and teachers became involved through numerous signed petitions in favor of the measure. State senator Tiny Kruger called Hole in 1982 asking for information to draw up a bill to set before the State Legislature. In the fall of 1982, Senator Fred Risser reintroduced the bill. Finally, after extensive debate, the bill was passed by both the Senate and Assembly.

Since there are over 500 soils in the state, debate over the choice of Antigo silt loam above other state soils intensified into rivalries between various sections of the state. In the light of this competitive dispute, one lawmaker stated that since the state tree, sugar maple, and state bird, robin, are both found in every part of Wisconsin only a soil found everywhere in the state should be made a state symbol.

"I suppose that this is a dirty job that someone has to do," commented Gov. Earl, while signing the soil proclamation.

There is, however, no one soil representative of Wisconsin, because of the diversity of the state's glacially dependent geography. Antigo silt loam is found in a 200-mile belt through twelve counties north of central Wisconsin's large sand deposits.

Antigo silt loam was formed from the gravel plains left by meltwaters from the retreating glaciers. The soil is a product of 3-foot deposits of this gravel covered with a 3-foot loess covering blown in over time. In Wisconsin, the silt loam's natural erosion is not as problematic because of organic matter enriching the soil. Still, Hole says, the farmers in North Central Wisconsin take care to ensure an adequate covering of vegetation to prevent possible wind erosion.

Where many Wisconsin soils are sandy or gummy, causing difficulties in vegetation growth, Antigo silt loam provides a positive foundation for many state industries; particularly dairy farming, lumbering and potato farming. To those who contend that Antigo silt loam was not a representative choice, Hole says that potatoes grown in Antigo silt loam are sold in every part of the state. Antigo, as opposed to the regional names of other suggested soils, is a town name found only in Wisconsin. Many common state trees also grow well in Antigo silt loam.

Antigo silt loam does pose a problem to engineers who build on it. Its tendency to accumulate water, while good for crops, makes it subject to frost heaves, thus calling for bearing considerations. In areas covered by Antigo silt loam, the groundwater is only twenty feet down.

Perhaps the most encouraging point in this state soil debate, Hole says, is the fact that a natural material most people take for granted is now being recognized and discussed. It has increased public awareness of soil aspects and issues that face people who work with the soil every day. It has brought dirt to the attention of the common man. □

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We are also looking at parallel processing, a method that divides problems into parts and attacks them simultaneously, rather than sequentially, the way the human brain might.

While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception. At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams. As one young employee said, "At GE, we're not just shaping machines and technology. We're shaping opportunity."

Thinking about the possibilities is the first step to making things happen. And it all starts with an eagerness to dream, a willingness to dare and the determination to make visions, reality.

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