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EXPO/April 1985

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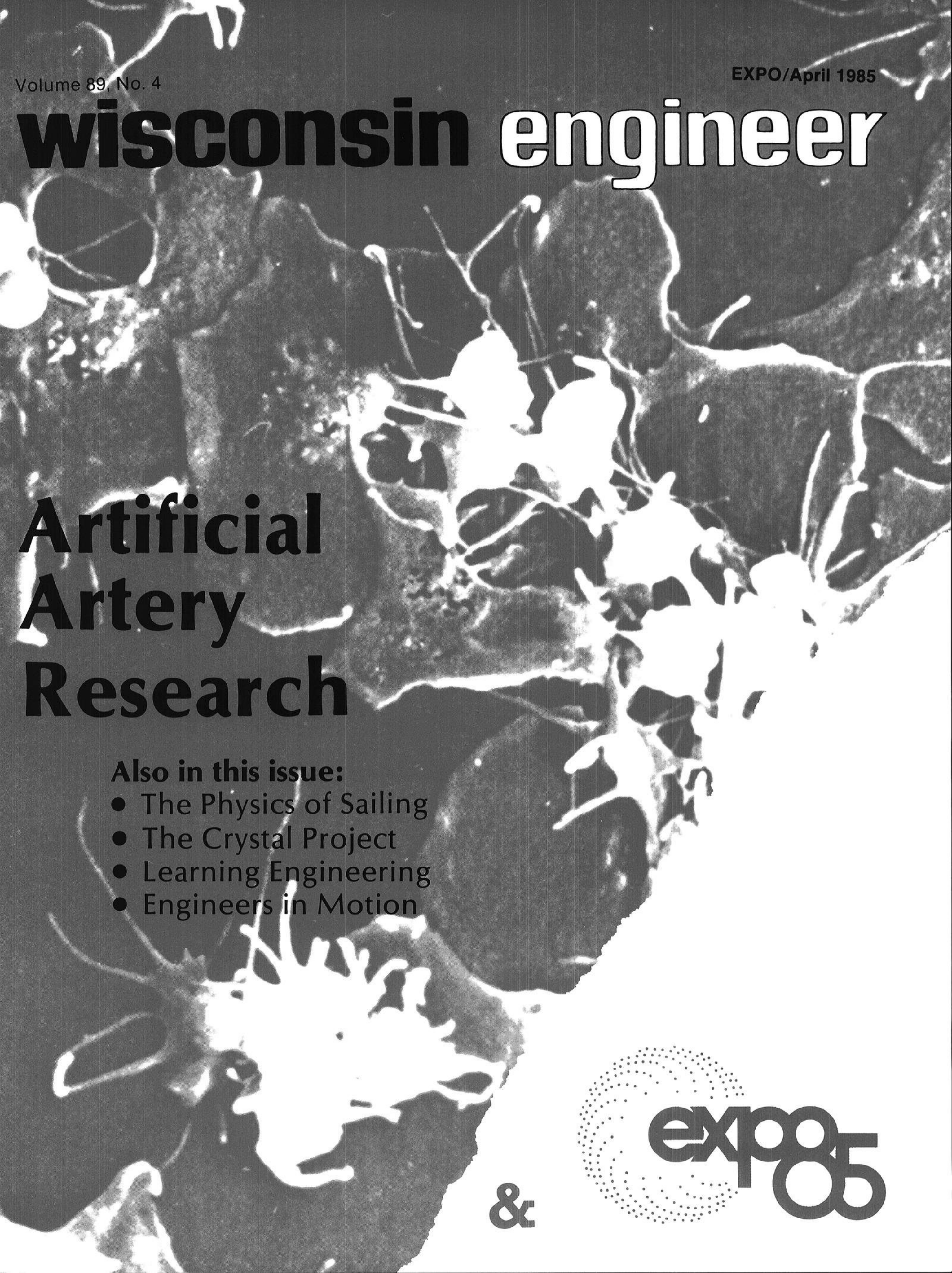

Artificial Artery Research

Also in this issue:

- The Physics of Sailing
- The Crystal Project
- Learning Engineering
- Engineers in Motion

& expo 85

wisconsin engineer

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Features

photo by Carl Birkhalter

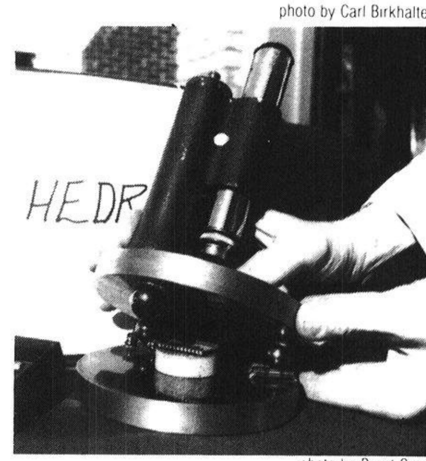

photo by Brent Crary

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Behind the Scenes: Expo '85

by Susan Bogus

It's 1985 and the Engineering Exposition is back! This biennial event is a great way to see what's happening in the College of Engineering as well as in the Engineering profession. Expo '85 will contain many student exhibits as well as many industrial exhibits from leading companies across the country. However, before Expo can actually begin, many hours of planning and preparation must take place to insure that it will run smoothly.

Who are the people responsible for the organization of Expo '85?

Well, to answer this question and

The biggest parts of Expo are student and industrial exhibits.

many others I went undercover as an ordinary student and signed up with the General Committee for Expo '85. The actual planning and organizing of Expo is done by a group of students who form the Executive Committee. These eight students were chosen over a year ago, and have been working ever since preparing for this big event. Each of the eight committee members is in charge of a particular area.

Jim Nejedlo, in charge of publicity, is responsible for getting the general public through the doors. He has been working with the different forms of media trying to generate interest in Expo '85 in hope of drawing the largest crowd ever. In charge of attracting high school students is Linda Johnson. This year Expo is considering a separate contest for high school students in order to get them more involved in the exposition. The biggest part of Expo is the students and industrial exhibits. According to William Monfre, head of students exhibits, the success of Expo depends on student participation. Besides the many student exhibits, there will also be exhibits from leading industries across the U.S. As of now, Expo has commitments from twenty industrial exhibitors with possibly twenty more by Expo time. Toby Thomas has been working hard organizing the industrial exhibits and feels that it is a great way for industries to come into contact with the students and vice versa. The job of building and exhibit organization lies in the hands of Jim Gift.

The person in charge of organizing the actual man-power for Expo weekend is Michelle Janewicz. She has to ensure that there are enough people to set up and clean up for Expo. Overseeing it all are co-chairpersons Sue Guzman and David Franchino. Both are very happy with the hard work and dedication of all the committee members.

Engineering Expo is one of the best ways for students to gain exposure through their exhibits. There are four categories of student exhibits: individual, small group, organizations, and graduate students. Within those groups there will be a variety of different displays. Some students will give demonstrations, others will show processes, and still others will have another type of exhibit. The graduate exhibits have in the past concentrated on research.

Robert Martens, a junior in construction management, has an individual exhibit with a demonstration. His exhibit involves architectural models and model building. He will also have information on engineers and architects of the past and how they used models to solve some of their problems.

Katie Joslyn is also making an individual exhibit for Expo. Katie is a senior in civil engineering whose exhibit consists of a three-dimensional illustration of the factors involved in doing a landfill. She is planning on showing the steps involved, which range from selecting a site to determining what the landfill will be used for.

As for small group projects, Rob Spence, Ardie Khonji, and George Skupniewicz, all mechanical engineers, are planning on building a six-legged walking robot. The robot will be controlled by means of a computer.

As far as organizational projects go, there are many organizations signed up to make exhibits for Expo. Among them the Society of Women Engineers is planning on showing the importance of Wisconsin's paper industry through the use of slides, brochures, and photographs. The Wisconsin Engineer is having our own exhibit on science publications. These are just a few examples of student organization exhibits.

The examples here of some planned student exhibits are just a very small sampling of what is yet to come at Expo '85. To see all of the exhibits you will have to make your way down to Expo on April 12, 13 and 14. The engineering exposition is very important to the College of Engineering in many ways. It allows the general public a

photo by Brent Crary

chance to see what is actually going on in the field of engineering and the Engineering College. It also gives students the opportunity to express their ideas to the public and to leading industries.

Engineering Expo is one of the best ways for students to gain exposure through their exhibits.

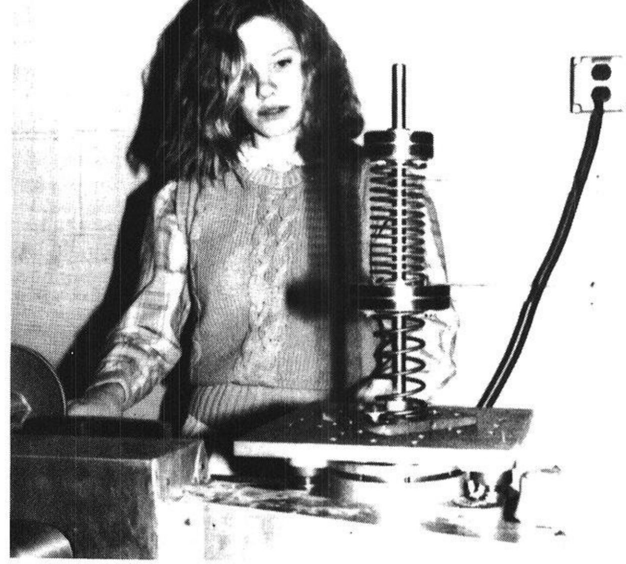
One of the best things about working with or going to Expo is meeting many new people — not just fellow engineering students, but also students from other fields of engineering, as well as students outside of the Engineering College. **I'm sure you will find your experience at Expo to be very enjoyable and provocative, so come and meet the Expo challenge.** □

EXPO Exposed

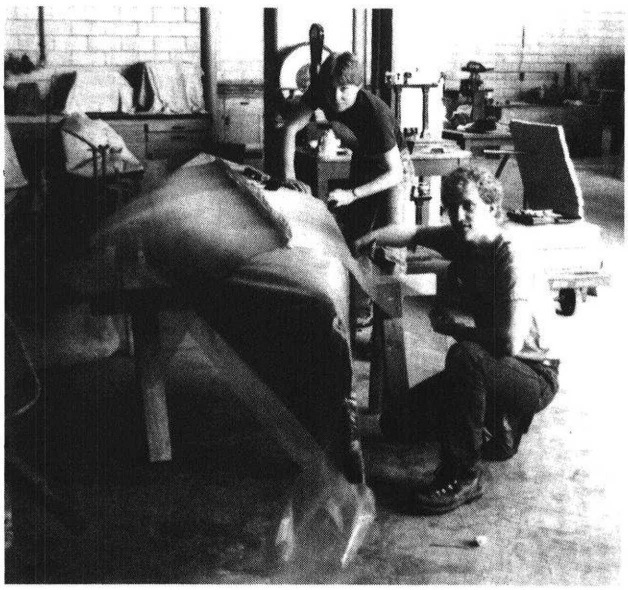
On April 12 we will all be able to walk around the engineering campus and see dozens of exhibits and demonstrations. They will be displayed and presented in their best form. These exhibits are product of human ideas, ambition, effort, and hard work. Brent Crary has caught some of that effort in these photographs. We hope you will enjoy your visit, and learn more about engineering at EXPO '85.

Right: Robert Martens is displaying an architectural model named "Triangulation."

Below: Project A.S.M.U.T.H. Speedway: A.S.M.U.T.H. members present a computer controlled miniture car. Visitors will have a chance to test their skill.



Above: Sandra Wade's EXPO exhibit will Megaron light, demonstrate how to reduce machine vibrations.



Left: A.S.C.E. members prepare their concrete racing canoe for EXPO.

Below: From left to right: Geoff Ludwig, George Villece, and Brian Hornig are working on a voice controlled robot arm.

EXPO: From Birth to Today

EXPO '85: a product of years past at the University of Wisconsin.

by David Franchino

Expo is here once again, to highlight technology and engineering, and to open for you the doors of the UW College of Engineering. The theme chosen for this year is "Engineering: Meeting the Challenges of Tomorrow." Expo '85, like the exposition before it, is a non-profit event and is entirely student organized and run. Welcome!

Over the past 45 years, the UW Engineering Exposition ("Expo") has developed into one of the College of Engineering's finest and most enjoyable traditions. Although the founding of the College preceded the first Expo by more than eighty years, the history of Expo spans the most dramatic period of changes in both the school and the profession. The history of Expo gives a glimpse at the growth of the College of Engineering and also provides a fascinating perspective on the impact that rapidly advancing technology has made on modern society.

The roots of the UW Engineering Expo can be traced to the 1930s and an annual feud between the UW Law and Engineering students. While newspaper headlines of the day were filled with rumors of an impending war abroad, a different type of conflict was stirring at the University of Wisconsin.

Every March, UW Engineering and Law students prepared to rekindle their dispute as to the true vocation of Saint Patrick — the engineers vehemently asserting that Patrick had been a fellow "slide-rule pusher," the lawyers laying claim to Pat as one of their own. Every March, each group held a parade up State Street in the patron saint's honor. From the mid 1920s, these parades had clashed good-naturedly, but by the late 1930s the "shysters" provided feistier opposition.

March 20, 1938 proved to be a day that will live forever in the halls of UW infamy. Throughout the week before St. Patrick's Day, newspapers reported scattered outbreaks of violence, including the kidnapping and hazing of students from both factions as well as some increasingly devilish pranks. By the morning of the day of the parade, the city of Madison was braced for the worst. One look at the engineer's motley parade would have convinced any bystander that trouble was on the way. Nine trucks and a tractor comprised the engineering's thinly disguised regiment, and the grim expressions on the 250 young faces led one Madison newspaper to dub the procession a "cavalcade of death." Over 20,000 Madisonians turned up to watch the parade and were treated instead to one of the most spirited riots in the city's history.

Before the smoke had cleared, the riot's widespread fighting had left a good number of students in the hospital or in jail, six inches of water in the Engineering building, and rotten eggs plastered over much of Madison. With the townspeople angry, city officials aroused, and the University administration aghast, the Engineering faculty desperately sought a means of diverting the students' efforts in a more constructive direction. The result, Engineering Expo, was a new keynote to the St. Patrick's Day celebrations and successor to the traditional, yet unpredictable, parade.

Before the smoke had cleared, the riot's widespread fighting had left a good number of students in the hospital or in jail . . .

The first Expo was held in 1940 and featured about 40 students and 30 industrial exhibits. Admission was set at 25 cents and the April issue of the Wisconsin Engineer magazine served as the complimentary program booklet. Student exhibits included displays on hydraulics, electroplating, welding and casting as well as a mechanical pencil, controlled by a complex mechanism of cams and levers, which would automatically spell "WISCONSIN." After only one more Expo, in 1941, World War Two put a temporary halt to the event.

The Expo was resumed in 1953 on a triennial basis under the guidance of the Polygon Engineering Council, the governing body of student engineering societies. In 1956, the expo began to broaden its purpose under the leadership of a young mechanical engineering student named John Bollinger. He worked at developing four basic objectives for Expo: first, to bring industry to the University and expose the engineering students to practicing engineers; second, to open the College's doors to the public in an effort to illustrate the role of engineering in their lives; third, to offer young people a chance to see the College of Engineering and to learn more about engineering as a profession; and lastly, to provide financial support to student organizations throughout the College. (Bollinger later received his MS and PhD from the UW, and has been Dean of the College of Engineering since 1981.)

1962 found the United States locked in the Cold War, and the Engineering Exposition's theme "Engineering for Peace Power" reflected America's fascination with the potential of modern technology. Industrial exhibits on the "Birth of a Space Craft" launched the Expo visitor's horizon past the atmosphere, and UW students tackled such diverse topics as interplanetary communication, aircraft designs and plans for a proposed universal spoken language. It was also in 1962 that Expo jumped into the computer era with a student exhibit on computer simulation of mechanical vibrations.

After 1965 the Exposition, due to overwhelming student interest, was changed to a biennial event. Also, the Engineering Administration thought that planning the complex event would be easier if the students in charge had had a chance to be involved in the previous Expo.

While the 1967 Expo had taken as its theme "Expanding Horizons Though Engineering," the 1969 Expo reflected young America's concern with what that horizon has revealed. The Expo program booklet became a showcase for anti-establishment rhetoric. The opening article covered the struggle for equality by Black America and was followed by dissertations on civil disobedience, drugs, the ethics of offensive weapons from an engineer's standpoint, water pollution and a variety of urban problems. Conspicuously absent from the Expo were the traditional exhibits by the Army, Navy and Air Force.

In 1971, the College of Engineering worked to recognize the increasing role of women in engineering. There was no longer the traditional "Expo Queen and Her Court," a carryover from the St. Patrick's Day celebrations of old. Also, 1971 marked the first time that a woman served on the Expo Executive Committee when Joanne Depree, an Electrical Engineering student with an interest in computer technology, became the High School Chairperson.

1977 found the United States deep in recession. The make-up of the Expo reflected the hard times. Only six industries were able to exhibit. In contrast, the Expo featured a record number of student exhibits as engineering vied for experience and a dwindling number of jobs.

By 1981 the economy had improved and the industries once again returned to Expo. The last Expo, held in 1983, featured 22 industrial and governmental exhibits and 95 student exhibits, and was attended by almost 20,000 people.

Given the vast complex of problems which face mankind today, engineers are more likely than ever to be called upon for solutions. Responding to that challenge will call for skill and intelligence but also a sense of the engineering profession. It is possible that some of the exhibits you see here today will provide the basis for technological advances which will profoundly affect our future. The methods and ideas from coursework, practice and research are not all the College offers. There is also a continuous, encouraging push on the students to become aware, alert and professional, mingling skill with service and responsibility.

Whatever lies ahead for today's society, engineering and UW engineers will play an important part. It is with the theme, Engineering: Meeting the Challenges of Tomorrow, in mind that the University of Wisconsin-Madison College of Engineering presents the 18th Engineering Exposition — EXPO '85. □

Learning Engineering Hands-On

The advantages of hands-on experience far outweigh those of classroom confinement.

by Brett L. Bridgham

Should all engineering students spend some time in their related fields before they graduate? There are many possibilities open to an engineering student who wants to receive hands-on experience. Some of these include the co-op program, internships, and summer work. Merely absorbing material in the classroom is not enough for today's engineering. The student that restricts himself to the classroom environment is coming up short in many other aspects of engineering. A panel of chemical engineering managers at Purdue University noted that new graduates were technically very strong, but were weak in the ability to communicate, in management practice, and in interpersonal relationships.

The gap that exists between classroom theory and practical application is very real.

These abilities can best be attained by doing. The various programs that allow the student to emerge from the classroom setting are those that give much needed hands-on experience.

The gap that exists between classroom theory and practical application is very real. Graduating students void of any prior experience can be in for a big surprise when they land their first job. Ernest Doebelin from the Department of Mechanical Engineering at Ohio State University states,

> ". . . most students' limitations in tackling real engineering problems lie, not in a lack of engineering science tools, but rather in knowing how to apply what they know to unfamiliar situations."

The gap is further widened by the fact that teaching methods are often too theoretical to be applied to everyday engineering problems. However, a student who has previous experience can partially bridge the gap by being exposed to real world engineering problems. Carl Durney and Dr. L. Dale Harris at the University of Utah say that only by doing can learning, in the way an engineer must learn, take place. They also point out that there is all the difference in the world between knowledge and working knowledge. But how is an engineering student supposed to acquire this working knowledge? There are many opportunities for getting hands-on experience.

The co-op programs, internships, and summer work for engineering firms are all viable solutions. Students exposed to the various programs find it easier to fill the gap between theory and application. A student involved in a cooperative educational project at Oklahoma State University summarized his co-op program.

> The project was met with enthusiasm by all involved as a worthwhile and stimulating experience not unlike that which we expect in the future. The problems encountered in meeting deadlines, budgets, and objectives with occasional lack of consideration from others provided an opportunity in practicality . . ."

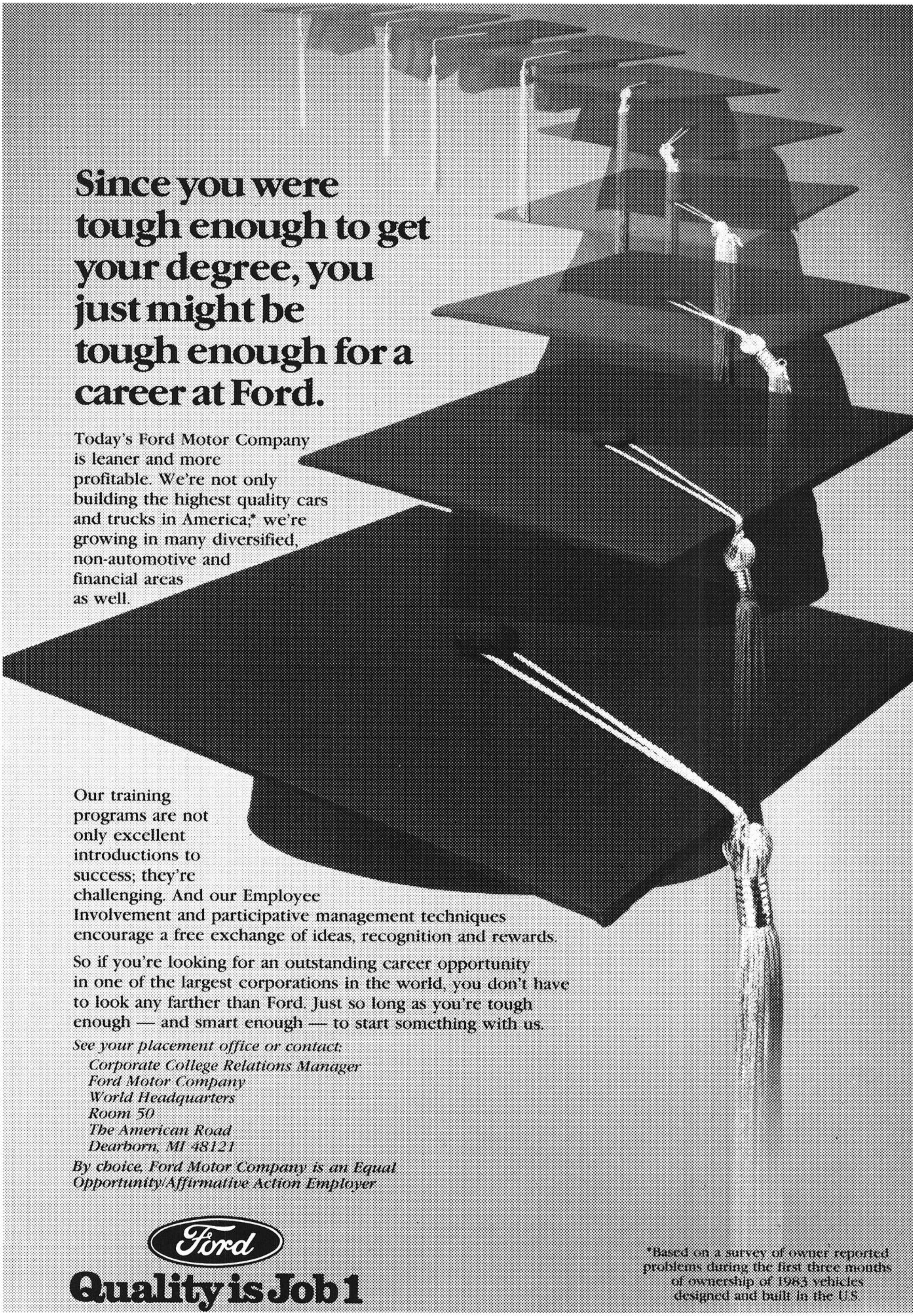
A student from Madison depicts his co-op experience like this:

> The whole attitude about how problems are handled and how co-workers interact and react with each other and management is quite different from college."

Internship and summer work can also fill the gap between textbook and work experience. Any situation that allows the student to get hands-on experience is a plus when he/she is preparing for permanent employment. The ability to confront problems which are of a more general nature best enables a student to cope with a real job setting. David Voltmer of the Department of Electrical Engineering at Pennsylvania State University says that experience in these types of problems reduce the student's awe or sense of being lost when they first face problems in new areas. Instead, they approach them with an increased sense of self-confidence. This self-confidence is very important while job hunting or during actual job procedures. In fact, as far as job hunting is concerned, the panel of chemical engineers at Purdue suggest that interviewers like to see evidence of involvement in related activities and in fact shy away from students who were not involved.

Any hands-on experience is a plus when she/he is looking for employment.

The advantages of hands-on experience in the engineering field far outweigh those of classroom confinement. Co-op programs, internships, and summer employment all provide the engineering student the experience they need. This experience brings the student out of the classroom and into the work atmosphere exposing the students to communication, group involvement and management practices with other individuals. Those who have experienced a work-related program have received immeasurable benefits and those who have not must delve deeper into the possibilities. □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The Reflective Vision

A highly advanced design tool developed at the General Motors Research Laboratories uses computers to generate visual images from mathematical data with such accuracy that, soon, in-depth aesthetic evaluations of new concepts may be made prior to creating a costly physical model.

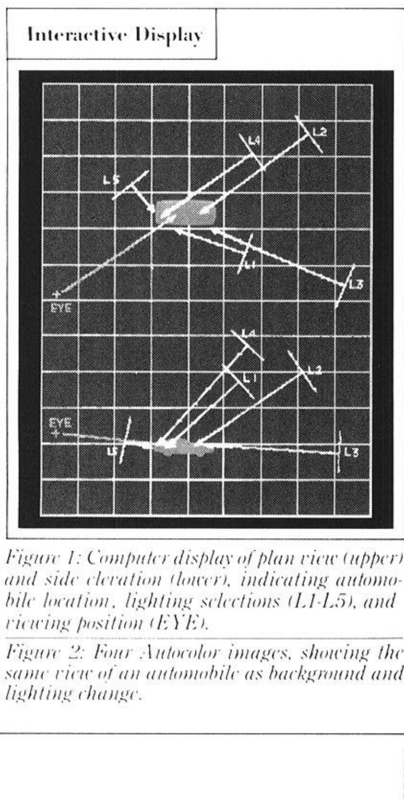
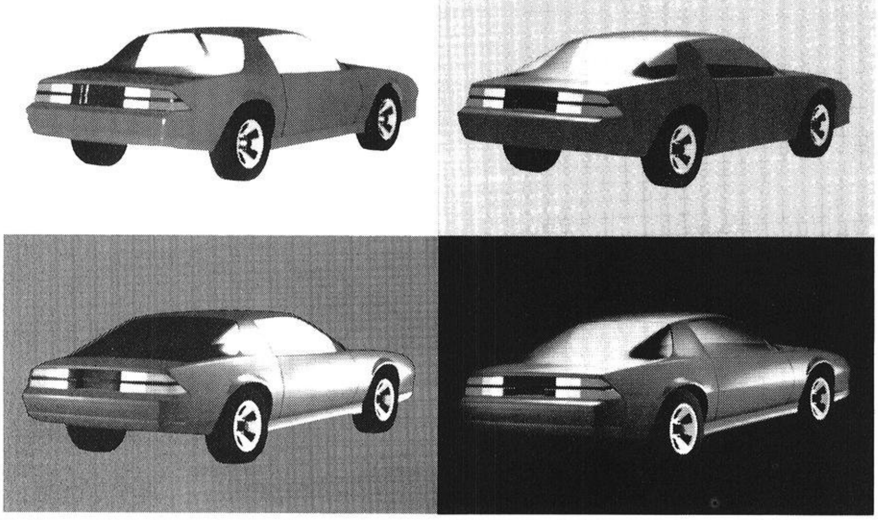


Figure 1: Computer display of plan view (upper) and side elevation (lower), indicating automobile location, lighting selections (L1-L5), and viewing position (EYE).

Figure 2: Four Autocolor images, showing the same view of an automobile as background and lighting change.



WITH AUTOCOLOR, users can synthesize three-dimensional, shaded images of design concepts on a color display and then quickly explore how major or minor changes affect the overall aesthetic impression. The system is completely interactive. By choosing from a menu on the screen, the designer can redefine display parameters, select a viewing orientation, or mix a color. Each part of an object can be assigned a surface type with associated color and reflectance properties. Built-in lighting controls generate realistic "highlights" on simulated surfaces composed of differing materials.

Before developing the system, David Warn, a computer scientist at the General Motors Research Laboratories, observed the complex lighting effects achieved in the studio of a professional photographer. By simulating these effects, Autocolor can produce results unattainable by conventional synthetic image display systems. Previous systems used a point source model of light, which allows adjustments only in position and brightness.

The versatility of the lighting controls constitutes a major advance in Autocolor. An unlimited number of light sources can be independently aimed at an object and the light concentration adjusted to simulate spotlight and floodlight effects. The lighting model even includes the large flaps or "barndoors" found on studio lights. These comprehensive controls permit the user to view the simulation in studio lighting conditions, as well as to make revisions in color, paint type, and materials.

With real lights, direction and concentration are produced by reflectors, lenses, and housings. It would be possible to model these components directly, but that would introduce considerable overhead to the lighting computation. Instead of modeling individual causes, Autocolor models the overall effect, reducing complexity by simulating those aspects needed to produce realistic results.

Autocolor approximates the geometric shape of an object with a mesh of three or four-sided polygons. These polygons are grouped to form parts. For a car body, there might be separate parts for the door, hood, roof, fender, and so on. Each part is assigned a surface type, such as painted metal or glass, and each type of surface has associated color and reflectance properties. The entire data structure is stored in tables using an interactive relational data base developed at the GM Research Laboratories.

THE LIGHTING model determines the intensity of the reflected light that reaches the eye from a given point on the object. It takes into account the reflectance properties of the surface as well as the physics of light reflection. A hidden surface algorithm determines which point on the object is visible at each point on the display. For each of these visible points, the intensity is computed for each light source. The displayed intensity is the sum of the contributions from all the lights plus an ambient term which indicates the general level of illumination.

Using the point source lights of conventional image generation systems, highlighting a particular area of an object can be a difficult task and can result in unwanted highlights in other areas. By contrast, the light direction and concentration controls found in Autocolor make it possible to isolate the effect of a light to a particular area, and achieve a desired highlight easily and quickly (see Figure 2). This is not because Autocolor's lighting model computations are faster, but because its controlled "lights" behave in a more natural way.

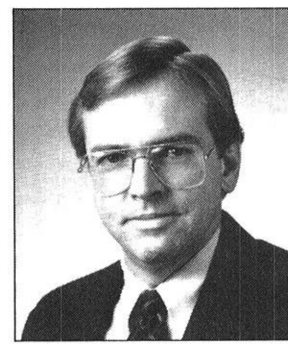
Another unique feature of Autocolor is the ability to portray realistically a variety of different materials and lighting conditions. The color seen from a surface is really a combination of two colors: the color of the surface or material itself (diffuse reflection) and the color of the reflected highlights (specular reflection). The highlight color may be the color of the material, the color of the light, or a color derived from the material and the light.

A different highlight color can be used for each different surface type that is defined. This makes it possible to simulate materials such as plastic, painted metal, and chrome—each of which has different reflectance properties and requires a different highlight color.

The user can interactively adjust the blending of the surface and highlight colors, watching the image change dynamically on the screen until a desired effect is achieved.

"Autocolor will free designers to be more creative," says researcher Warn. "Our goal is to move from controls that show changes in lighting, color, and materials, to software that will let the user change the actual shape, manipulating the image on the screen like a flexible clay model."

THE MAN BEHIND THE WORK



David Warn is a Senior Staff Research Scientist in the Computer Science Department at the General Motors Research Laboratories.

He received his undergraduate degree in mathematics from Carnegie-Mellon University, and his M.S. in computer science from Purdue.

He has done extensive research in relational data management systems with special emphasis on user interfaces and human factors. He also designed the prototype for the network data manager used in the GM Corporate Graphic System. His previous work on other aspects of computer-aided design include system design, file management, and simulation models.

His foremost research interests are in color synthetic image generation and interactive surface design. He joined General Motors in 1968.

Come Sail Away: The Physics of Sailing

by Paul A. Stone

Man, water, and the wind: since the dawn of civilization these three elements of nature have been related to one another through a common link: the sailboat. The first sailboats were rafts or barges equipped with a sail, used primarily for transporting goods. Over time the sailboat developed into many and diverse types, until travel on water became fully practical. Known lands were conquered and new ones were discovered; intercontinental trade became a reality; new cultures evolved from the intermingling of old ones.

Today sailing has become one of the most enjoyable forms of recreation and competition. The experience of the bow wave crashing ahead, spray flying and the wind screaming in from behind is unparalleled. There is, however, another aspect of sailing which is often overlooked or not understood by sailing enthusiasts: that is, the technical aspect. What causes a sailboat to move into the wind? What considerations are important in design improvements? What effect do boats have on each other during a race?

A simple model to describe the fundamental principles of sailing is the "flat world model" (fig. 1). Consider two parallel planes like pieces of paper, one on top of each other. The upper and lower planes represent the "air flat-world" and the "water flat-world", respectively. They can move freely with respect to one another. The sailing vehicle is in the interface between the two planes and has components in each. The water flat-world can serve as the fixed reference frame for the velocity of the boat and wind.

A sailboat moves as a result of the counteracting forces in each world which act on it. These forces are represented as vectors in Figure 2. In the water flat-world the water exerts a force on the hull of the sailboat. This force may be resolved into two components: a side force which acts perpendicular to the true boat velocity and a drag force acting parallel to, but in the opposite direction of the true boat velocity.

In the air flat-world the wind acts

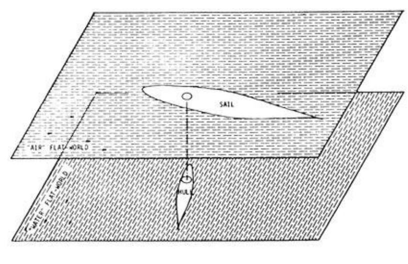


Figure 1: The Flat World Model

upon the sail. As in the water flat-world, the force of the wind is resolved into two components. Note that the direction of the components are perpendicular and parallel to the relative wind velocity, as opposed to the true wind velocity. Relative wind is that which would actually be felt on the boat; it is the direction in which a flag or a tell-tale would go as the boat moves. Expressed in vectors the relative wind is the difference between the true wind velocity and the true boat velocity.

Superposition and vector addition of the forces exerted in each flat-world yields the overall resultant force which acts on the sailboat (Figure 3). Although the magnitude of the forces varies almost constantly, the resultant force clearly must propel the sailboat forward.

Most of the design improvements in sailing vehicles are aimed at reducing the drag forces acting on the hull and the sail. Sail drag force is an aerodynamic problem, while the hull drag force is hydrodynamic. However, the

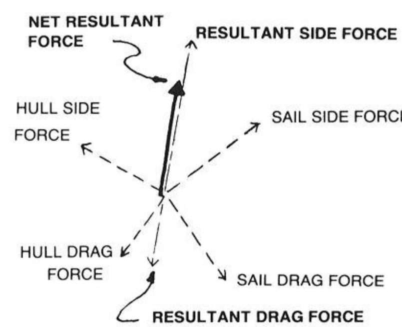


Figure 3: Net Resultant Force

distinction is somewhat arbitrary, as many of the physical phenomenon involved are common to both the hull in the water and the sail in the air, since both water and air are fluid.

In either medium one may divide the fluid flow about an object into two basic flow areas: the boundary layer region and the external region (Figure 4). The boundary layer is that layer of

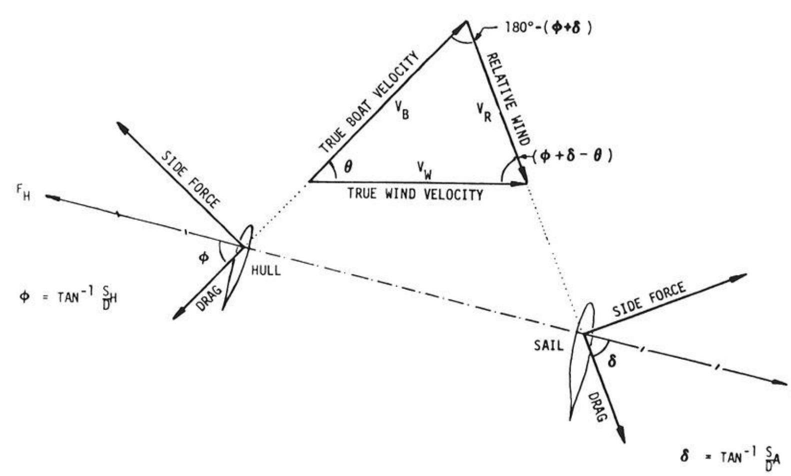


Figure 2: Vector Diagram

air which lies very close to the sail (or hull). Due to viscous effects it is actually carried along with the sail as the boat moves. The flow within the boundary layer itself may be either laminar, turbulent, or both. The remainder of the flow comprises the external region.

Boundary layer flow in the air causes a skin friction which contributes to the drag force acting on the sail. On the hull side a very clean, smooth bottom will result in a more laminar boundary layer, and hence reduced drag force. Another boundary layer phenomena is "separated flow", which results from the boundary layer becoming separated from the surface. The resulting flow is very erratic. Separated flow contributes to the drag force even more significantly than skin friction does. Fortunately, separated flow can be minimized through proper design, and skin friction can be reduced (though not eliminated) through proper manufacture and maintenance of the sail and hull.

The drag forces acting on the sail and hull are also affected by the external flow of the air and water, respectively. The external flow is constantly changing due to the presence of other boats. Air is deflected off of their sails, and waves are created from their hulls. This situation is commonly encountered in racing. The air and water disturbances resulting from the presence of another boat are illustrated in Figure 5. In the figure, the effects of the windward boat become increasingly detrimental to the leeward boat as it goes from position I to position IV. In position I the waves will slow the leeward craft. At II and III the deflected wind becomes increasingly more disturbed (ie, "dirty wind"). In the blanketing zone (position IV) an actual wind shadow exists and the leeward boat will soon be in a no-wind environment. A boat in position I will soon find herself being forced into the more detrimental position.

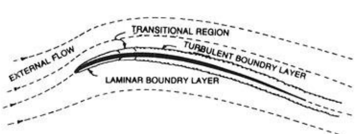


Figure 4a: Definition of Flow Regions

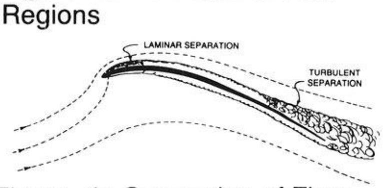


Figure 4b: Separation of Flow Areas

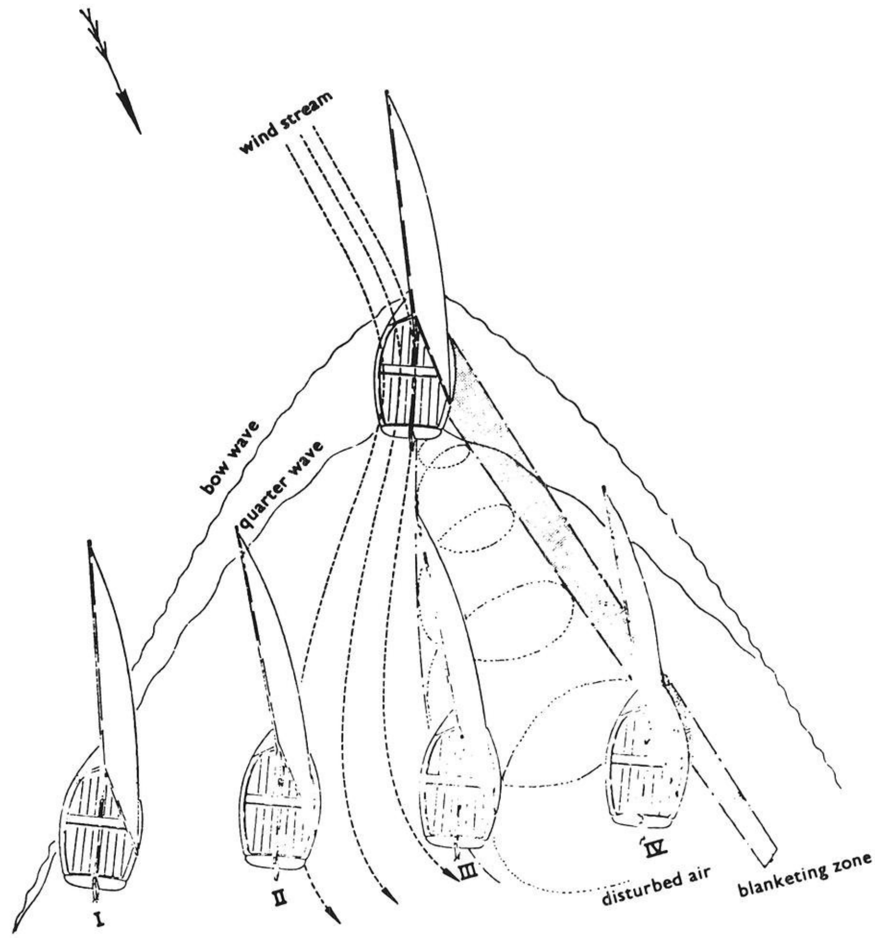


Figure 5: External Flow Disturbances

Another consideration is the drag force on the hull; this is also due in part of the formation of its own bow wave. Consideration of the bow wave phenomena explains a fact known back to the time of Vikings: the speed of boat is directly proportional to the square root of its length. The gravity effect which causes a bow wave may be correllated in terms of a dimmensionless number, the Froude number: Fr = v**2 / Lg, where "v" is the velocity, "L" is a characteristic length, and "g" is the gravitational constant. Hence, v = (Fr)(g)(L)**1/2. This is only true for non-planing displacement type hulls.

Although this discussion about how a sailboat is propelled applies a simple model, it provides a qualitative analysis of the forces which act on a sailboat. The drag forces result from the physical phenomena of boundary layer skin friction and separation; external flow region disruptions, and a boat's own bow wave. Design improvements are aimed at reducing these drag forces. Racing sailor must give careful consideration to the effects of the presence of other boats. Knowledge of these effects can be used to one's advantage both defensively and as an offensive tactic.

Whether you are training to recapture the America's Cup in 1987 or blasting about on a sailboat behind the Memorial Union, the fundamentals of sailing are the same. So, grit your teeth, hang on tight, and GO FOR IT! □

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Artificial Artery Research

by A. C. Diehl

Biomedical engineering is very much a part of our lives today. We have all heard of the new advances in artificial limbs and organs, and in instrumentation. Relatively few of us are aware of research in the area of artificial artery materials that is going on right here at the University of Wisconsin-Madison.

Some of the research focuses on the development of new and better materials to use for artificial organs. In particular, current research is concerned with the development of better artificial heart materials and small diameter (less than 5 mm) artificial blood vessels. New polymers must be created, then analyzed. This article reviews not the development of the materials, but the techniques and thrust of research being done on their properties.

The main concern of the investigator in this area is blood compatibility. Will the material under investigation let blood flow efficiently, without clotting? And, do any unwanted chemical reactions occur between the material and the blood?

The importance of these questions is illustrated by the example of heart catheterization, a method in which a tube is inserted directly into the heart. In cases of inborn heart problems, a doctor may wish to determine heart blood pressure and flow rate this way. The catheter tube may be in the heart for only a short time, but the risk of clotting due to its insertion is significant. The risk is increased for patients who require bypass surgery or frequent dialysis. While anticoagulants are helpful, they have associated problems of their own. The ideal solution is a material which has no adverse interactions with the blood.

Two areas of research into blood/polymer compatibility are the engineering approach and the biochemical approach. The more traditional engineering approach is to look at living response on a macroscopic level. On a somewhat more theoretical level are those who look at blood/polymer interaction on a laboratory scale, in a controlled environment.

The traditional engineering approach examines the response of a polymer in a living specimen, such as a dog. The method used is **ex vivo**, which is Latin for "out of body." A tube is placed in an artery in the thigh to divert blood that is returning to the heart. This tube is made up of a series of sections of polymers. The reaction investigated is formation of clots, or thrombi, from platelets and the blood protein fibrinogen. Fibrinogen polymerizes into fibrin, which is fiber-like, and binds clots together.

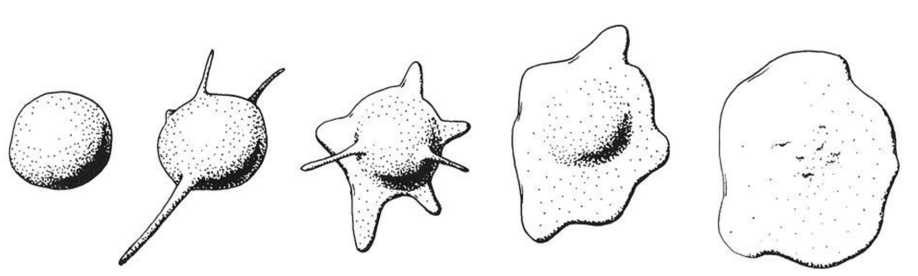
Any one of us may someday need an artificial organ.

An experiment proceeds as follows. First, approximately 100 to 500 milliliters of blood is removed from the dog. The fibrinogen and platelets are differentially labeled radioactively. After labeling, the blood is reinjected to the dog, and allowed to recirculate. Then the tube, or shunt, is inserted in the dog's artery for a measured amount of time. The shunt is flushed with buffer solution, removed, and the extent of clotting determined by the level of radioactivity on the shunt tube. The procedure is repeated for various lengths of time, to determine the functional relationship between clotting and time of contact.

One critical factor is that the average blood flow remain constant, thus ensuring that the average wall shear rate is constant. In the heart, blood circulates with a great deal of force. Therefore, the shear stress at the organ wall is very high, and it is difficult for large clots to adhere. Instead, they shear off the wall and are carried through the blood stream. In the artery, where blood flow is lower, clots adhere and may become relatively large. When one of these larger clots shears off it may lodge and block blood flow. This can cause a stroke, for instance.

To avoid error in this method, the animal is continually monitored to see that coagulation levels throughout his body are constant. In order to avoid systematic error the time lengths may be run in a random sequence, rather than always increasing or decreasing the period.

Ex vivo investigation provides a strictly empirical kinetic model of clotting on a polymer. But, while **ex vivo** experimentation is important, it does not add to knowledge of the clotting process on a molecular scale. On this scale, clotting is studied **in vitro**. This method studies the behavior of



The various stages of platelet spreading on a surface, from round or discoid to completely flat.

platelets and proteins in a controlled medium.

Platelets are about a quarter of the size of red blood cells, but they are not nucleus and therefore are not technically cells. They are large jello-like bodies containing inclusions known as granules. These granules contain mixtures of proteins, calcium, ADT, ATP and other substances.

While floating alone in the blood stream, the platelet is essentially spherical. (see fig. 1). As the platelet comes in contact with another entity, such as a damaged or artificial arterial wall, pseudopods extend and the platelet adheres. Eventually, the platelet looks like a fried egg. While the platelet is flattening out, the contents of the granules are released into the medium. This process is observed in clotting.

The main concern is blood compatibility. Will blood flow efficiently in the artificial organ?

Some of the components in the granules actually catalyze the clotting reaction. Because of this, the process becomes circular. Platelets flatten out during clotting and release these components. This causes further clotting, and so on.

Although this process is readily observed, the reasons behind it are not fully understood. On some surfaces the process stops at psuedopod extension (figure 1.b), and on others the platelets continue to flatten out (figure 1.e). The question is: which factors are critical in speeding up, slowing down, or stopping this reaction.

Studying the reaction **in vitro** reduces the number of variables affecting clotting. Platelets are placed in a saline solution with a sample of the polymer. The clotting process is monitored through a high resolution microscope. A value is assigned to the amount of clotting that has occured, and this value is plotted as a function of time.

Because of the strictly controlled environment, one factor can be varied with a clear result. For instance, fibrin or fibrinogen may be included in the **in vitro** medium. The clotting rate is monitored as before, and the two rates compared. This is a way of determining which blood components are critical.

Shown here is a Scanning Electron Micrograph's view of the adhesion of platelets on a surface.

No research exists in a vacuum, or course. Therefore it is important to look at results that were arrived at by different means. In this case, the results of the **in vitro** and the **ex vivo** experiments agree very well.

Research into artificial arteries is a small part of the vast amount of research going on at the University. It is important as a link between seemingly unrelated fields such as medicine and engineering. But it is especially important in terms of the benefits which may someday be derived from it. Any one of us may someday need an artificial organ, and this is part of the research which promises to fill that need. □

Engineers in Motion: Mining Competition:

Wisconsin engineering students attend mining competition in Denver.

by Jennifer Chalsma

The alarm goes off and blindly I start pawing at the air to find the awful noise and stop it. My brain has emerged from the fog long enough to push the stop button, and the buzzing ceases. I am just about to sink back into the depths of sleep when I hear someone in the next bed start groaning. Groaning? In the next bed? When did I get a roommate? Then it all comes back to me . . . I'm in a hotel room in Denver, Colorado . . . the beer chugging contest we won the night before... the groaning is coming from a teammate who must feel as bad as I. But, why is it so early? I look at the alarm, 7:15! Oh no, we have 45 minutes before the mining competition begins! I'm out of bed and stumbling around the floor before I can finish the thought.

The Mining Compeition, you may ask, what in the world is that? Let me explain. Formally known as the Intercollegiate Mining Competition, it is a chance for colleges with a Mining Engineering program to get together once a year to compete in old time mining events. What do we do? Shovel? Saw? Are we Crazy? Yes, to all questions. We compete in five events including sawing and shoveling and yes, we have to be a little crazy to end the day completely exhausted, bruised, maybe a little bloody, with every muscle aching, and come away telling stories of "the best weekend of our lives" and more in love with mining than ever.

The competition is usually held at one of the western mining schools. Wisconsin has sent teams to Butte, Montana; Denver, Colorado; Reno, Nevada; and Tucson, Arizona. The formal part of the competition is held on one Saturday over the host school's Spring Break. The beer chugging contest is the Friday night before. Some of the colleges didn't know Wisconsin had a mining program, but after the chugging contest we were quite well known. Without fail, long after all the other teams have gone to bed to rest up for the next day's events, the UW teams are still out.

Perhaps it was the lure of the clockless casinos in Reno, the midnight swim in the hotsprings outside of Butte, or the maze of streets and twenty-four hour sites of Tucson and Denver that kept us out. Whatever the case, we never made it back in time to prepare our bodies for the next day.

The events we compete in are swede sawing, hand mucking, jack legging, hand steeling, and rail standing. Recognize any of those events? They aren't exactly NCAA, but to a miner, they are all very important procedures in underground mining.

Swede sawing is the first event of the day and is reminiscent of the old mines where all roof support was through structures made out of timbers. The event requires using a 42 inch bow saw to saw through an 8″ by 8″ timber. Each team member saws one slice and the total time to saw the five slices is the score for this event. Perhaps because it's the first event of the day, this is, without fail, our worst event. We can never quite make our bodies move in a coordinated way to pick up the rhythm needed for sawing quickly. It

photo by Carl Birkhalter

Wisconsin engineering students attend mining competition in Denver.

is an invigorating way to start the morning and a sure way to drive a hangover from your body. This is very important because we need all our strength for the next event.

Hand mucking involves shoveling one ton of $1\frac{1}{2}''$ gravel into a rail car and then pushing the rail car down 50 feet of rail and then back without tipping the car over. Back in the days of timbered mines, this was the way the old mining cars were loaded. Nothing will make you appreciate automation more than participating in this event, it is HARD! I've seen incredible atheletes reduced to mush while participating in this event. Once you're done with handmucking the rest of the events seem easy.

Some of the colleges didn't know Wisconsin had a mining program, but after the chugging contest we were quite well known.

Generally, the person who feels the worst after hand mucking is the one who sits out the third event, rail standing. The other four members are timed at their ability to lay one section of small gage rail track. With five rail ties, twenty spikes and two pieces of rail, it's a wonder more people don't die during this event. It is really a test of a team's ability to swing sledge hammers at little tiny spikes while not hitting one of their teammates on the way through. When the section is complete, the clock stops and the judges begin to add on time to the score for everything that is wrong, 10 seconds when the spike is not in all the way, 15 seconds when it is not touching the rail, etc. The clock starts again and we dismantle the track. People still drive spikes by hand in real mines and after this event you can really get a feel for the job, perhaps just enough to know that you'd never want to do it.

The fourth event is hand steeling and involves hammering an 8″ piece of steel into concrete. Crazy? Perhaps now, but back then the miners would use 2 foot steels to drive the holes to place the sticks of dynamite in. Today we use machines called jumbos to hydraulically drive six holes at once. In this event, each team member pounds for two minutes on the same hole and the final score is the total depth driven. One end of the steel is chisel shaped and the trick is to turn it $\frac{1}{8}$ turn after each time you hit it to get a nice smooth hole bottom. Easier said than done because one you pick up the mallet you can't set it down or switch hands. After about a minute or so the light mallet becomes as heavy as the sledge hammers we used for rail standing.

The only event that doesn't come from the days of mining by burro is jacklegging. The jackleg is a drill that is used today in the hard to reach places, where the jumbos can't fit. The jackleg is basically a hydraulic drill for drilling horizontal holes into rock, or in our case, into concrete. The drill bit is a four feet long $1\frac{1}{2}$ inch diameter piece of steel that gets its force for drilling from a hydraulic leg that extends as the hole is drilled. The whole jackleg weighs about ninety pounds and if the leg was allowed to extend quickly while the bit was pointed toward the sky, it could easily shoot the bit thirty feet into the air. While drilling, water and mud, that are used to cool the bit, are pouring out all over the place. The mud and grease that cover you when you're done couldn't even be cleaned on a television commercial.

The competition comes to a close, we head back to the hotel room to get ready for the awards banquet and party. The first people through the door dive for the beds, the last one looks for some open floor space, even the hard hotel rugs feel good right now. We are too tired to even take off our muddy clothes and boots. We lie there staring at nothing and thinking about what we have just been through.

So what are we, crazy? No, not in the least. We have just had a chance to step back in time and, under very ideal conditions, experience what mining used to be like. If it was this hard for us today, imagine what it would have been like underground in the damp air with only a small gas lamp to light the way. You really appreciate how far we have come in mining after experiencing the Mining Competition. By glancing backwards, we gain experience that will be valuable in our future. □

Crystal Project: The Power of Distributive Algorithms

by Fai Chau Hon

Are you familiar with the National Science Foundation (NSF), multi-computers, and distributive algorithms? If you are, do you know how they are related? They are related through a university research program called the Crystal Project, which is being carried out by our Computer Science Department.

In 1981, the Computer Science Department here at the UW received a 4.7 million dollar grant from the NSF Experimental Computer Science Program. This grant is being used to support the 5 year Crystal project. The initiative of the project is to improve the quality of both research and teaching.

Sharing a common memory, but linked together by a communication line.

If you have been studying Computer Science or Electrical and Computer Engineering, you may have heard about the Crystal Project already. But do you really know what is going on? I too had questions concerning the project before I spoke to Professor Finkle, one of the two faculty members involved in the project. At the beginning of our conversation, he described the multi-computer network as a number of computers not sharing a common memory but linked together by a communication line.

At present, there are twenty VAX 11-750 minicomputers in the network located in room B263 of the Computer Science building. Information passes through the network by interconnected hardware, Proteon Pronet, at a rate of 10 megabits per second. In the future, there will be twenty more VAX 11-750 minicomputers passing up to 80 megabits of information per second.

In order to allow different applications to access the network hardware at the same time, a software package called Nugget is employed in each minicomputer. This software package functions as a small operating system to provide a communication link between the user and each minicomputer. It divides the network into several partitions for different applications and governs the job controls.

The magic of the project lies not in the hardware itself, but in the algorithms being developed by this network. Defined by Houghton Mifflin, algorithms are a mechanical or recursive computational procedure. Algorithms play the central role in this project because, having twenty communicative minicomputers, it may be a good idea to have each of them working on part of a problem simultaneously. A distributive algorithm is the means by which this interactive network works to solve problems. The power of these algorithms can be demonstrated by a program which tries to find out the total number of ways to solve an 8-queen problem. (8-queen is a game which asks the player to put 8 queens on a chess board such that there is only one queen in each row and column.) The result of the demonstration is shown below.

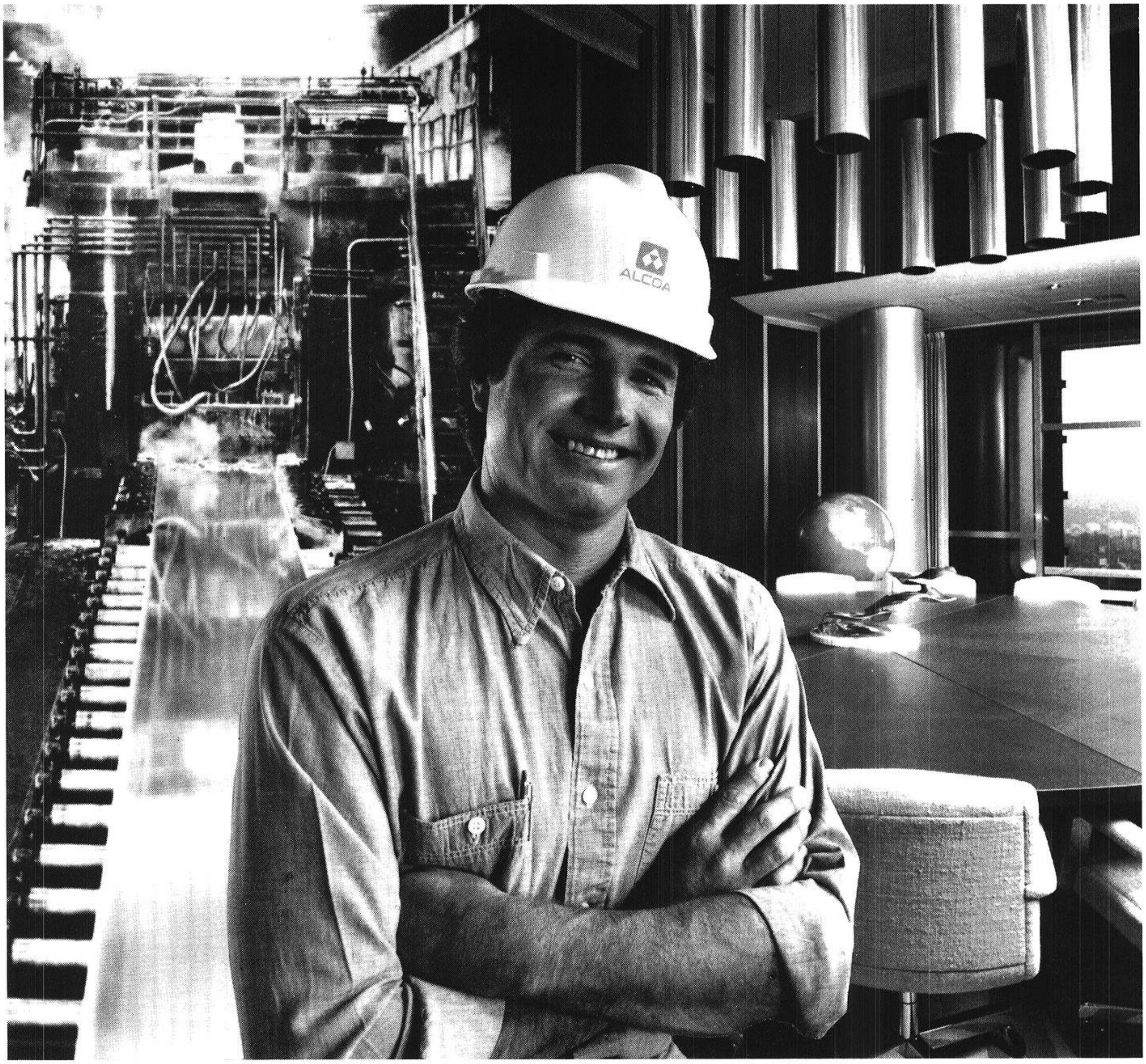
Numbers of computers in use	Time taken to solve the problem per unit of time
1	24
2	12
3	8

As we can see, the time taken to solve the problem is inversely proportional to the number of computers in use. In other words, the more computers used, the less the time spent.

The power of the distributive algorithm can be further demonstrated in a second example. If a single computer can predict the weather in two days, we could use 48 computers of the same kind with a distributive algorithm to do the job in just one hour!! Amazing? Again, the speed of a computer is not critical. For such applications, the idea of division of labor works wonderfully.

However, what is this idea? At this time, the idea described above is true in some cases only. Yet the amazing power of these algorithms are obvious. For this reason, the UW has many Computer Scientists working on the distributive algorithms. In the Crystal Project, current research areas include Distributed Operating System, Programming Languages for Distributed System, Tools for Debugging Distributed System, Multiprocessor Database Machines, and Paralled Algorithms for Mathematics Programming and Numerical Analysis and Computer Vision.

The potential power of distributive algorithms is great, although it is still in a beginning state. There is much optimism that both software and hardware developments can support each other in harmony so that we can get the most out of our computers. □


ALCOA

Engineer's Library
Choice Sci-fi in Review

by John Hilgers

There are secret societies out there trying to control the world. This is the message of THE ILLUMINATUS! TRILOGY (Dell 1975) by Robert Shea and Robert Anton Wilson. ILLUMINATUS! is the combined version of THE EYE IN THE PYRAMID, THE GOLDEN APPLE and LEVIATHAN.

The main characters are (originally) normal people who discover the conspiracy. These poor souls are then launched on a journey into the unknown helping one of several secret conspiracies against the nefarious Bavarian Illuminati, the strongest group who plans to kill thousands of teens at a European Woodstock to achieve immortality.

The book is loaded with puns, inside jokes, and comic situations that make the book hilarious. Every time I read it I seem to uncover a few more jokes that I missed the first time through.

As the book reviews itself (a book review inside of a book reviewing itself), "It's a dreadfully long monster of a book. The authors are utterly incompetent — no sense of style or structure at all. It starts out as a detective story, switches to science fiction, then goes off into the supernatural."

The story does occasionally jump around in time and space incoherently and it is long, 732 pages in fact. But it makes great reading once you get started.

The story starts with the bombing of a small magazine, CONFRONTATION. Then the police arrive, the most interesting clue that they find is a file of memos labled ILLUMINATI PROJECT. Each memo contains some evidence or theory about a secret society that has throughout history, manipulated people and governments to their own ends.

Next, we find the ace reporter of CONFRONTATION locked up in a jail in Mad Dog, Texas. He is rescued by a group wearing trench coats and carrying machine guns. They take him from the jail to the golden (yellow) submarine the Lief Erikson. There they "illuminize" him.

Slowly he decides to help the owner of the submarine, Hagbard Celine leader of the Discordian Society, to stop the evil Illuminati.

The rest of the story is the recruitment of new members and the continuing education of these converts in mysticism.

Eventually the final battle takes form and is met with a typical Discordian fashion. (The Discordians are in favor of freedom, discord, and chaos.)

All in all, this was one of my favorite stories of all time. □

The Halls of Engineering

by Kurt Worrell and Scott Knox

Scott: Kurt I think the program is going to run this time.

Kurt: How many pages is it. Now that it's fixed.

Scott: About twenty three not including the library functions I still have to copy.

Kurt: Do you down all the systems in MACC when you run it?

Scott: Yea, that's why I called it SYSTEMDOWN. It gets almost all of them. I let the hackers pick off the rest.

Scott: Did you see the posters on the wall of the operator room?

Kurt: Are those the kids on the milk cartons?

Scott: No, these kids are hackers. They have rap-sheets longer than your arm.

Kurt: Maybe those are the guys that overloaded the log-in last year and sent the VAX into computer heaven.

Scott: Could be, . . . it said on the poster they're wanted in four states, by Ma Bell, and the folks in the Silicone Valley.

Kurt: Do you think they're using the campus system?

Scott: The authorities claim to have traced them to either Madison or Ann Arbor!

Kurt: I don't think Ann Arbor has the facilities. Besides, we have all these shifty characters around here. You know, guys like that guy over there; walkmans mounted to their bodies, computer cables for connecting a commador to a VAX.

Scott: What about that guy in the corner?

Kurt: No, he's just into games. You can tell by the way he flips his fingers.

Scott: I don't know, he's always working with the monitor off!?

Kurt: What's that box sticking out of his pocket? It looks alot like one of those three line modems.

Scott: Yea, he was in here last night working on that PC next to the phone.

Kurt: He can't hook-up through those lines, they're restricted.

Scott: A **good** hacker could break a restricted line.

Kurt: Check him out! Looks like he hit the jackpot.

Scott: Yea, look at the grin on his face.

Kurt: Scott, what's happening to your screen? It's scrambling?!?

Scott: Damn! I haven't saved my program yet.

Kurt: Wait . . . there it's stopped. There's the prompt.

Scott: The keyboard is still frozen.

Kurt: Let me check the remote switch. I've heard it can cause problems.

Scott: Wait . . . its booting something up. I hope it's my program.

Kurt: What? . . . "Good Morning, Captain!". □

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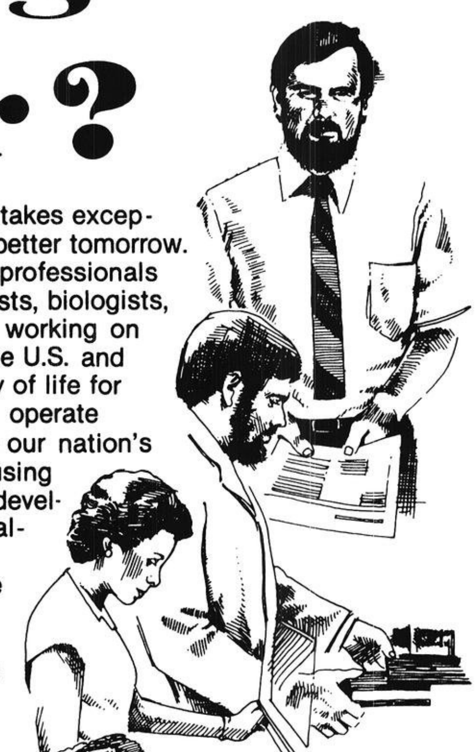

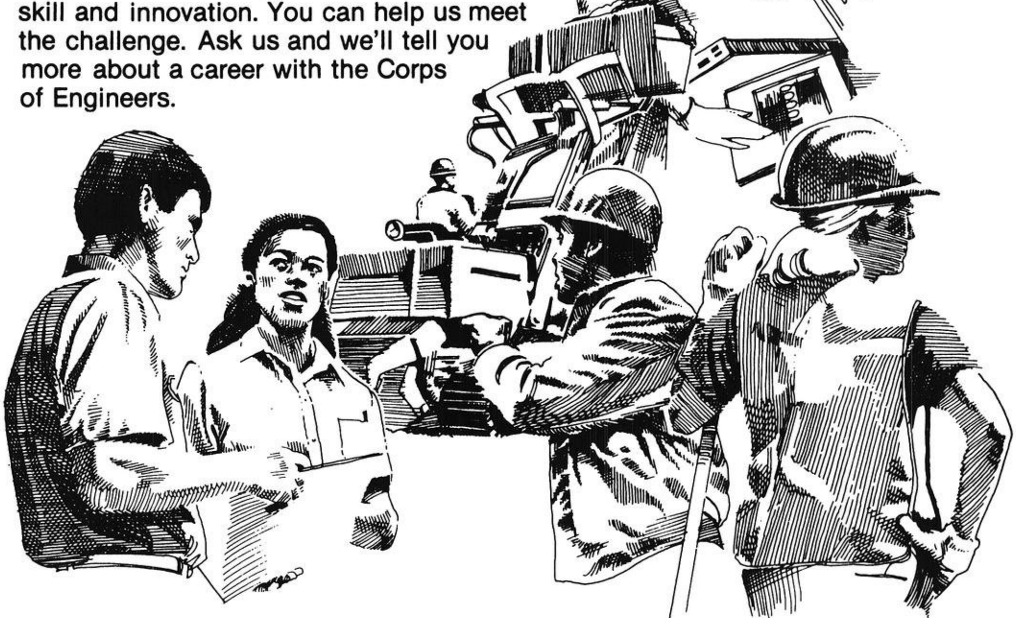

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