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Volume 87, No. 4 April, 1983

wisconsin engineer

INVESTIGATING KIRLIAN PHOTOGRAPHY:

The Human Aura

THE CHALLENGE

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On the cover:
This Kirlian photograph (electrophotograph) of a human hand subject was exposed to a voltage of 30,000 V through a dielectric oh photographic film. The envelope frequency was 150 Hz and the high voltage frequency was 10,000,000 Hz for an exposure time of 20 seconds. Electrophotography by Russell Wasserman and Ed Jassin.

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COLUMNS

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FEATURES

Correspondence: *Wisconsin Engineer Magazine, Room 460, Mechanical Engineering Building, 1513 University Avenue, Madison, WI 53706. Telephone: (608) 264-2394.* ***Letters to the editor are encouraged.***

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Editorial

Remember all of those great things we heard about engineering when we were deciding to major in it? "Engineering is for those who want to apply science, to solve problems, to CREATE!" That's what intrigued many of us enough to choose this field as a major.

Few of us, however, as we study for an exam or work on a problem set, find ourselves thinking how much we enjoy what we're doing and looking forward to a career filled with duties such as these. It is obvious that the work we do in school, at least for the first few years, is not what we expect to do on the job after we graduate. We trudge through these assignments waiting for the day when all of our calculus, physics, circuits, dynamics and heat transfer coursework will merge into one fascinating whole and make contact with the real world.

One way to get a glimpse of how things all fit together is to attend the biannual Engineering Exposition. The exhibits at EXPO 83 are based on some of the engineering principles that we learn in class but never really appreciate for their practical applications. EXPO brings us back to engineering as a creative science.

At EXPO 83, you can see a model railroad system that's controlled by a computer to keep it running on schedule and prevent collisions between trains. A computer simplifies structural analysis by displaying a full visual image of how any object will deform under stress. Yet another EXPO project shows how high voltage photography can produce some amazing images on film.

Projects like these bring the creativity and usefulness back into our view of engineering. EXPO 83 reminds us that there's a reason for learning the equations and doing the calculations. In school, we never see any tangible results. It's easy to forget that our primary interest actually is to apply science, to solve problems, to create! □

Betsy Priem

Lake Water

345 East 47th Street

by John Wengler

Kitty corner from New York's United Nations Building stands the mecca of professional engineering societies: the United Engineering Center. This building houses the national headquarters for the ASME, ASCE, IEEE and other societies. Many a student has seen the UEC's address on official pamphlets and secretly yearned to visit there one day.

Last vacation I was in New York and was able to visit the UEC. As any good pilgrim would, I expected nothing less than a grand structural palace with throngs of trumpeteers and wreath bearers welcoming college students. But the only reception party proved to be a watchman and assorted floor plants. There were also three glass cases containing gifts from nations and dignitaries in honor of the UEC's opening. It was a consolation to know that others had also held high hopes for the building.

Though not my primary objective, the first order of business was to locate a washroom. If the lobby didn't entirely shatter my expectations, the washroom did. The same artist who decorated the walls of every UW facility had left similar graffiti on the UEC's walls. "ASCE STINKS!" was the only publishable quote. Although he criticized other societies, the outhouse poet seemed especially interested in the ASCE. Ironically, I was planning to visit the ASCE office to submit an entry for their student essay contest. So I quickly passed the graffiti off as written by another entrant who couldn't type.

Actually, I hadn't finished typing the essay either and it **was** already a day past the deadline. I had planned to finish typing while visiting my sister (the reason for my trip to New York in the first place). But neither she nor her neighbors had a typewriter. Upon entering the UEC, I was prepared to beg ASCE's mercy -- for the use of one of their machines.

If the lobby guard wasn't going to welcome me, the ASCE most certainly would. Wrong. The poet must have already met the receptionist, for she was not friendly. She didn't even try. In fact, the job description is closer to rejectionist. It seemed the deeper I travelled into the UEC, the more menacing it became.

But then ASCE's student affairs coordinator arrived to save the day. His name was Mike and he would fix everything. Though he had no trumpets or wreaths, he must have played the coronet in high school and liked gardening. Mike quickly bought my sob story and I was soon placed before a typewriter. A long story made short would include the fact that I broke one of ASCE's typewriters. The carriage return cable had reached its elastic limit and snapped. It could have happened to anyone. Mike ushered me to another machine, at which the essay was finally completed.

On my way out of the office, I passed a number of brown-suited gentlemen smoking pipes. When seen through a misty veil of white smoke, these national officers seemed god-like to me. I circumvented the group on my way to the elevator wondering how many other mortals have ever seen them.

The guard was locking up the building as my elevator reached the lobby. I was uncertain whether he was locking someone out or locking me in. Anticlimatically I realized it was the UEC's closing time. Across the street, tourists were leaving the United Nations Building. They looked at me and then at the UEC. Then I looked at the UEC and crossed 47th Street to the UN to see what the rest of the world had done that day. □

Letter to the Editor

Dear Editor:

I found it appalling to hear that signing up for interviews for engineering jobs can begin at 4:00 p.m. the night before the Engineering Placement Office opens at 7:00 a.m. The prime spots in line can be taken even before midnight. This goes on during weekdays in the hallway outside the placement office, which becomes a beer-drinking, card-playing study hall while waiting for an interview.

The University of Illinois offers one solution to this crisis. Once a week, students sign up for interviews in an order based on the results of a lottery. It allows students time to sleep. I would recommend our College of Engineering consider such a lottery system.

Sincerely Yours,
David Barnas, CEE-4

Luis Castellanos mines copper with software.

Most copper is found deep underground. But the Bell System's 100 million miles of copper cable have tons of it above and below ground. That copper provides vital circuit paths to transmit customer voice, data and video signals for today's Information Age needs.

And Luis Castellanos, seven years out of undergraduate school, supervises one of the groups that helps Bell System companies "mine" all that copper. He works with one of the largest computer hardware and software systems in the world—the Trunks Integrated Record Keeping System (TIRKS). Every day it "mines" the vast Bell network for available circuits and equipment. As a result of efficient use of network facilities, the Bell System saves millions by eliminating the need for certain capital expenditures.

Plus, there's more to TIRKS than "mining copper." It also configures circuits and assigns components needed for each circuit path. That allows Bell companies to respond faster to customer requests for complex services like video and data transmission. Employees are more productive too, because TIRKS helps them set up circuits and forecast facility needs.

Before TIRKS was available, keeping track of communications circuits and facilities required enormous amounts of paperwork and manual calculation. Every day, the average Bell System company handles orders involving 1500 circuits and up to 7500 individual components associated with them. Each detail has to be specified and accounted for.

Now, thanks to people like Luis, TIRKS keeps track of all that information instantaneously using computers. Information is up-to-date. It's instantly available. And it's more accurate.

According to computer scientists like Luis, the benefits from TIRKS are just beginning. He believes that, as more computer hardware and software systems like TIRKS interact, new benefits for customers may be possible, as well as additional productivity increases for employees.

Luis joined Bell Labs with a B.S. in computer science from Pratt Institute. Under a company-sponsored graduate study program, he attended Stevens Institute of Technology for his M.S. in computer science. At the same time, he worked part-time assuming responsibility for a large piece of TIRKS software. Working with design teams, he gained valuable insight from experienced members. Now, his technical performance has earned him a promotion to supervisor.

If you're interested in similar challenging employment opportunities at Bell Labs, write:

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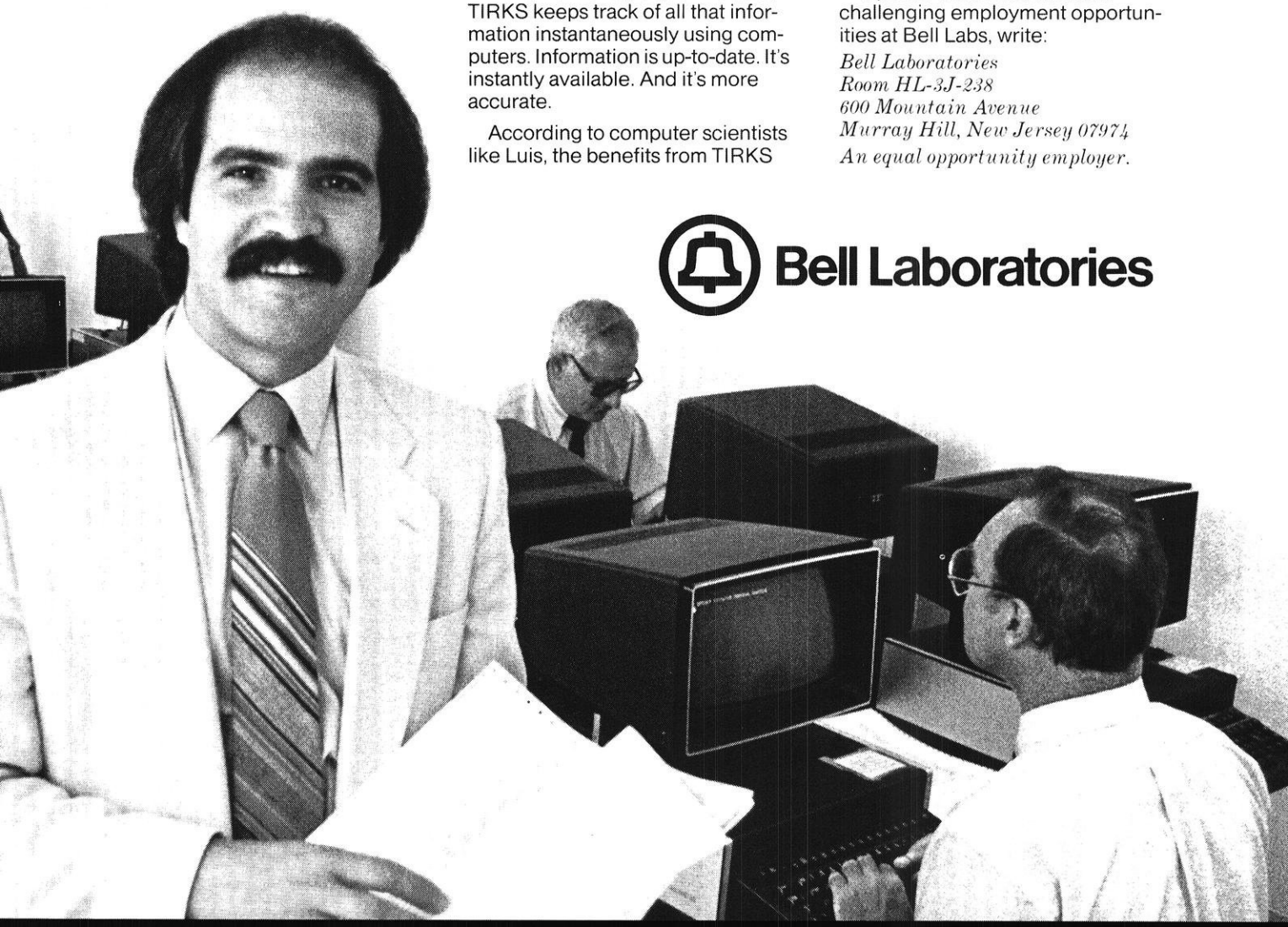

Bell Laboratories

Behind the Scenes of EXPO 83

by Tina Lee

Tina Lee is a senior in mechanical engineering from Bloomington, Minnesota. As a chairperson of the EXPO 83 Executive Committee, she is in charge of advance promotion and personnel.

For Mary Ciha, Industrial Exhibits Chairperson: We, the 1983 Engineering Exposition Executive Committee, dedicate this year's Expo to you.

Mary R. Ciha died August 13, 1982 in a tragic motorcycle accident in Texas. She would have received her Bachelor of Science degree in Industrial Engineering in May. During the summer Mary had been working on EXPO and as a summer professional employee at ALCOA in Rockdale, Texas. The Expo '83 Executive Committee not only lost its Industrial Exhibits Chairperson, but more importantly, we lost a special friend . . . .

It hasn't been easy, but Mary's memory has motivated us to make this Expo the best one ever. As a Committee chairperson, I'd like to tell the story behind Expo '83's Executive Committee, how they became involved and how they've worked to put together this year's Expo.

The Executive Committee is made of eight positions set up to organize and run Expo. Selection of the Committee took place during the spring of 1982. First the general co-chairpersons, Laurie Thering and "Whoopie" John Edlebeck were selected. Laurie and Whoopie applied for their positions and were chosen by Dean Ratner and Expo '81 general co-chairpersons, Jean Oliva and Joe Velk. Laurie and Whoopie then interviewed applicants for the six remaining chairperson positions. The rest of the Committee consisted of

Industrial Exhibits — Mary Ciha
Student Exhibits — Tony Lee
Building Organizations — John Bredesen
High School Relations — Tom Hurrish
Publicity — Brian Mast
Advance Promotion and Personnel — Tina Lee

This year's Executive Staff has incorporated the aid of an assistance committee. Each chairperson has worked with two or three people on various projects. As Whoopie John expressed, "This helps lessen each chairperson's load and give more people a chance to get involved with Expo." In addition to the assistance committee, we have two staff photographers.

All the committee chairpersons have stories about their Expo experience. Laurie Thering, graduating senior in MME and general co-chair, first got involved with Expo '79 on the mining and metallurgy project. Laurie and Mary were roommates and best friends; last spring Mary was the person who encouraged Laurie to apply for the general co-chairperson position. "I wanted this position, because it would give me a chance to organize all the pieces of the puzzle." Her hard work is closely matched by her love for popcorn and Tab.

Our other fearless leader, "Whoopie" John Edlebeck, graduating senior in CE, first got involved in Expo '79 also. He worked on ASCE's concrete canoe. Whoopie commented on this year's theme. "After thinking about it all summer, we went with 'Explore Engineering: the Bridge Between Technology and You,' because we wanted the general public to know that engineering relates to everyone." This is not the first time Laurie and John have consolidated their efforts. They've known each other since their sophomore year, but were unaware that they both had applied for the Expo positions. They got a big surprise when they learned that they both were chosen to head this year's Expo.

Heading up the student exhibits department is Tony Lee. Tony is a junior in ME from DeForest, whose introduction to Expo came in high school. "I came to Expo as a way to get out of school for the day." What he saw made a lasting impression. Since he wasn't involved in any student organizations, Tony felt that working on Expo was a good way to start. His biggest surprise has been that it takes a lot more work than he anticipated, but he's gotten to know many people in just a short time.

"We wanted the general public to know that engineering relates to everyone."

All the exhibits are housed in the engineering buildings. Organizing exhibit locations and exhibit routing is the job of graduating electrical engineering student John Bredesen. John has plenty of experience in organizing and time budgeting since he was a housefellow in Kronshage for two years and was vice-chairperson of IEEE. John's goals for this year's Expo are to make the exhibit route shorter and easier to follow with more rest areas.

Besides showing the general public about engineering, Expo tries to reach high school students to interest them in possible careers in engineering.

EXPO Executive Staff Members are, from left standing: Tom Hurrish, John Bredesen, Brian Mast, "Whoopie" John Edlebeck, and Tony Lee. Seated are: Laurie Thering and Tina Lee.

Tom Hurrish, another graduating senior in ME, takes care of high school relations. Tom hopes to double the high school attendance from '81 including schools from Wisconsin, Iowa, and Illinois. "Expo is a good way to introduce high school students to engineering. I wish that when I was in high school, I could have attended an Expo to learn about the different engineering fields." Tom also does a good job of promoting Expo; he wears his Expo t-shirts while running.

We are expecting 25,000 to attend this year's Expo, and it's Brian Mast's job to attract the big crowds through publicity. Brian is a senior in IE and will graduate in December '83. "My biggest challenge has been to hunt out all the sources to reach people. I want to promote Expo on campus and around the city as more of a fun family event." Brian first gained experience in advertising and publicity at his home, Manitowoc, with the Peter Quince Performing Company. Besides producing a musical and serving as president, Brian spent a summer in charge of publicity. "I'm anxiously awaiting the day when Expo is over and my life can return to normal."

As chairperson of advance promotion and personnel, Tina Lee has been responsible for the t-shirts, buttons, and all the students working at Expo. This year she gave people two choices of t-shirt designs. One has the Expo logo while the other has a more fun design-some say it reminds them of Pacman. Tina feels that the main disadvantage of her position has been having to store the boxes of extra t-shirts at her apartment; she's grateful that her roommates have tolerated the "modern art" forms (t-shirt boxes) in their living room. She's enjoyed her position, because it's given her the chance to work with local industries and students.

As mentioned before, Mary Ciha would have worked as industrial exhibits chairperson. In Expo '81, Mary worked on AIIE's winning student exhibit project, a scaled down version of a computer automated factory. Mary had a magnetic personality; she always was smiling and enthusiastic about everything she did. As Laurie says, "Mary had that special talent for living, learning and loving it." □

Tough Times Hit EXPO 83

by Cindy Christofferson

As if planning and implementing one of the largest and best known student run events in the midwest isn't enough, consider doing the job during an economic recession. That is what the EXPO '83 executive committee has had to do.

Co-chairmen Laurie Thering and John Edlebeck along with the rest of the committee have put in many long hours in order to make this year's Exposition a success. In the hopes of gaining wider support, the committee made a decision to present a more professional image of the event. Last September, they started to send over 700 personalized word-processed letters to companies nationwide. Included with the letter was explicit information explaining the Exposition and all the options for participation. It is the response to these letters that exemplifies the economy's effect on the entire business world.

The participation of business and industry is the main source of funding for EXPO. Companies that have some connection with engineering were offered a chance to exhibit and/or advertise in the Exposition Program Booklet. Other local businesses were asked for donations of food and other supplies and offered advertising space as well. Money donations were also suggested. Support in all these forms was down this year.

Most of the "Dear Laurie and John" letters had one thing in common: the phrase "limited budget." It seems that when budgets need cutting, advertising and public relations funds are the first to go. The only consolation in these rejection notices was the apparent interest in the event. Many companies wrote "Keep us in mind for next time."

The effect of the economy is most apparent when comparing the number of companies that exhibited at EXPO '81 with those of EXPO '83. In 1982, about 300 companies and agencies were contacted resulting in 33 industrial exhibits and 10 government exhibits. This year, of the 700 establishments contacted, only 23 of them committed themselves to an exhibit. Ten more businesses had expressed an interest but later pulled out du to the lack of funds.

"Many companies wrote 'keep us in mind for next time.'"

"Despite the tough times, we're not going to give up," said Laurie Thering in February. In addition to the letters sent in the fall, she and John contacted many of the companies personally to encourage their participation. They concentrated on local business and industry hoping that because the travel expenses wouldn't be high, they could afford to exhibit. One thing that the co-chairmen did not fall back on was the government institutions. In contrast to the policies used for EXPO 81, the military exhibitors were expected to pay the same fee as the other exhibitors which greatly reduced the number of such exhibits.

In attempt to compensate for the lack of industrial exhibits, the EXPO committee tried to think of some new attractions to fill the gap. One such idea was to invite university professors and advisors as well as business people to give short lectures on their involvement in engineering education and industry. The committee was also hoping to raffle off a ten-memory telephone, some solar calculators, and a home computer.

Although the engineering campus won't be quite so packed with industrial exhibits, this year's Engineering Exposition should be as worthwhile as ever thanks to the enthusiasm and hard work of its planning committee. □

Chemical Preservatives In Your Food And You

by Man Ken Cheung

A chemical preservative, as defined by the Food and Drug Administration, is "any chemical that, when added to food, tends to prevent or retard deterioration, but does not include common salt, sugars, vinegars, spices, or oils extracted from spices, substances added to food by direct exposure thereof to wood smoke, or chemicals applied for their respective insecticidal or herbicidal properties."[1] Nitrite (NO_2) is a chemical preservative that is added to cured meat products such as bacon, ham, salami, ans sausages. It is usually added as sodium and/or potassium nitrite. The National Academy of Science (NAS) has reported that nitrites can be converted to carcinogenic types of nitrosamines, and also high exposure to nitrates and nitrites may cause cancers of the stomach and esophagus.[2]

Nitrate (NO_3), unlike nitrite, is not a preservative, but when it is acted upon by microbes, it can be reduced to nitrite, and so it can be a continuing source of preserving nitrites during lengthy curing. Hence, the NAS recommends that nitrate not be used in the processing of poultry and meat products, except in the curing of meats such as dried beef, jerky, salami and pepperoni where lengthy curing processes are required.

"Other sources of preformed nitrosamines are drugs, cosmetics, agricultural chemicals, new car interiors, beer and Scotch whiskey."

Nitrite, on the other hand, can inhibit the growth of microbes that cause spoilage and botulism. Nitrite also retards the development of rancidity, enhances the flavor of certain meat products and reacts with myoglobin to maintain the bright red color of meats.

The NAS says that there are nearly 200 types of nitrosamines known to be carcinogenic in animals, and therefore suspect them as agents causing human cancer.[2] Carcinogenic nitrosamines are also mutagenic (causing genetic damage) and teratogenic (causing abnormal development of a fetus).[1]

Under an acidic environment, for example in meat, nitrites can react with secondary or tertiary amines, components of some proteins, spices and flavors, to form nitrosamines. First nitrites are decomposed to nitrous acid from which nitrous oxide is formed, and which can then react with amines to form nitrosamines (see Fig. 1). The nitrosation reaction can take place in the cooking of meats and also in their digestion.[3]

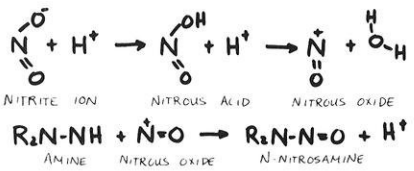

Figure 1. N-Nitrosamine formation.

Nitrates, on the other hand, do not directly form nitrosamines, but after passing through the stomach they can reach the saliva where about five percent of the total amount ingested is converted to nitrosamines.

Workers in rocket fuel, leather tanning, and ruber manufacturing industries are exposed to an average of 250 micrograms of preformed nitrosamines per day, many times greater than the amount (0.17 micrograms) consumed per day from bacon and other cured meats. Outside of the occupational exposures, cigarette smoke is the main source of nitrosamines (see Fig. 2). Other sources of preformed nitrosamines are drugs, cosmetics, agricutural chemicals, new car interiors, beer and Scotch whiskey.[2]

"The most promising way to reduce the health risk of nitrite is to add vitamin C and vitamin E."

Nitrates and nitrites do occur naturally in several fruits and vegetables, including beets, spinach, celery, lettuce and turnip greens. Sometimes these foods contain larger amounts of nitrate than those permitted for nitrate additives. Levels of nitrate in some plants may reach a point at which the plants are actually fatal to young children. Fortunately, at these high levels the plants usually do not appear edible. Under an acidic environment such as in a young child's stomach, nitrite reacts with blood to give rise to methemoglobinia.[1] Such a case has

been reported in children who had eaten spinach puree that contained 218 mg of nitrite per 100 g wet weight, and only a trace of nitrate. This finding is consistent with the knowledge that nitrate-nitrite reduction can occur in stored vegetables.[3] The level of nitrates in food plants depends on the type of soil in which the plants are grown, the harvesting and storage conditions, and the amount of fertilizer used.[2]

Although vegetables contain large amounts of nitrates and nitrites, they are also rich in Vitamins C and E, which inhibit the conversion of nitrites to nitrosamines and so the amount of nitrosamines formed in the body of a vegetarian may be significantly reduced.[2]

The most promising way to reduce the health risk of nitrite is to add ascorbate (vitamin C) and alpha-tocopherol (vitamin E), which inhibit the conversion of nitrite to nitrosamine, to bacon. Some vitamin C is currently used in bacon, but it does not dissolve well in the fat. Vitamin E, however, is very fat soluble and could enhance the effects of ascorbate in inhibiting the conversion.

Other alternatives to nitrite which have been suggested by the NAS are: (i) treating meat with ionizing radiation, which kills bacteria, (ii) adding non-toxic chemical compounds like potassium sorbate and sodium hypophosphite, and (iii) adding bacteria that lower the pH to inhibit botulism bacteria growth.

So far, the search for nitrite substitutes has had only partial success. More research is required to find a substitute which is not only effective against botulism, but is also non-carcinogenic. In the meantime, nitrite preservative is still the most effective way to prevent the growth of clostridium botulinum in our favorite cured meat products. □

Sources of Nitrosamines

Exposure to nitrosamines in micrograms per person per day.

	CREATED IN BODY*	SOAPS COSMETICS	CAR INTERIORS	BACON	TOBACCO SMOKE	WORK**
Smokers (average American diet)	1.1	0.41	0.20	0.17	17.0	0
Non-smokers (average American diet)	1.1	0.41	0.20	0.17	0	0
High cured meat diet (non-smokers)	2.0	0.41	0.20	0.68	0	0
Vegetarians (non-smokers)	12.0	0.41	0.20	0	0	0
People who drink water rich in nitrates	14.0	0.41	0.20	0.17	0	0

*When nitrates and nitrites are ingested in a wide variety of foods, chemical reactions in the body can create nitrosamines.

**Exposure to nitrosamines in some occupations (rubber industry, leather tanners, rocket fuel products) raises possible exposure to 250 micrograms per person per day.

Source: National Academy of Sciences.

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3. Rodricks, J. V. and Pohland, A. E. "Food Hazards of Natural Origin." *Food Safety Education.* John Wiley & Sons, 1981.
4. "Nitrite Substitues: Partial Success." *Science News,* 121 (May 8, 1982), 310.

Examining the Aura

A Look at the Kirlian Phenomenon

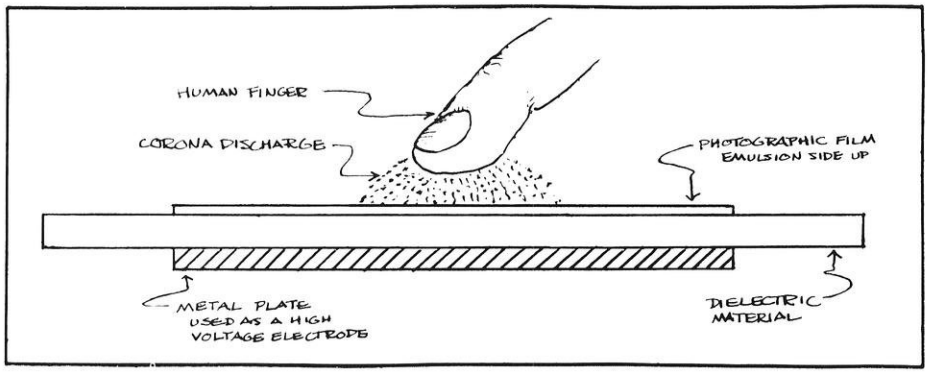
by Russ Wasserman

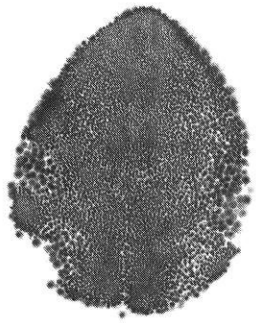
Russ Wasserman's interest in Kirlian photography stems from high school when he built a simple for the 1980 Marquette Science Fair. Now, as an engineer, Russ has teamed with Ed Jassin, also a junior in electrical engineering, to examine the Kirlian phenomenon in more depth.

There are many phenomena surrounding Kirlian photography that researchers are trying to explain. A simple example is the phantom leaf effect, in which the Kirlian photograph of a leaf with a small portion removed reproduces the corona intact.

In the human aura, Kirlian photography is claimed to record "Life Energy," a theoretical manifestation of the life force. According to Dr. Thelma Moss at UCLA's Neuropsychiatric Institute, patients experiencing altered states of consciousness or emotional changes display markedly different color and flare patterns in their auras. Kirlian photography has also been applied in the study of acupuncture to record the obvious emanation changes that occur after acupuncture treatment.

Various avenues of parapsychology speculate on why these strange patterns occur and what factors influence them. Professionals in many disciplines, such as biology, medicine, psychology, parapsychology, physics and engineering have formed the International Kirlian Research Association, in order to share new discoveries and establish standards in the field. □





At left is a diagram of the method Russ and Ed used to produce their Kirlian photographs. The specimen on the right is an aura from a small leaf.

Investigating Kirlian Photography is a research project built for EXPO 83 by Russell Wasserman and Ed Jassin. Their project produces a high voltage, high frequency signal that, when discharged through a dielectric to an object, produces Kirlian photographs. Under the supervision of Prof. Scherz of the Mechanical Engineering Department, Russ and Ed are studying how surface conditions such as temperature, pressure, humidity and dielectric factors affect the photograph. By varying the voltage, envelope frequency, resonant frequency and electrode configurations, they were able to find some interesting results that you'll be able to see at the EXPO.

Kirlian photography, or high voltage corona discharge photography, was developed by Semyon and Valentin Kirlian in 1939. Basically, the process records on photographic film the effect of an electromagnetic field on an object, anything from a leaf to a human hand. Under this field, a luminous corona discharge creates intricate patterns in a wide range of intensity and color.

The 21st Century Express

by Darci Buelow

Visitors to the 1983 Engineering EXPO may find themselves overwhelmed with scientific jargon and concepts. The theories behind the projects may seem so complicated, it could be impossible to see applicable ways to use the information from the displays. Fortunately this is not always the case. One display will definitely bring out the child in the participants and show practical uses for the project.

Kappa Eta Kappa, the University of Wisconsin - Madison Electrical and Computer Engineering Fraternity, has designed a project which uses a model railroad system to assimilate real-life mass transit problems.

The purpose of the project is to demonstrate some of the capabilities of the TI 990/12 computer system by having it direct traffic on a model railroad system.

The railroad track has been laid out to contain three railroad terminals. There are a total of three trains. The route of the railroad track has been designed so that the trains have to travel over common track to reach each of the terminals. This route is designed to be a microcosm of real-life traffic problems.

One train has been designated a "Commuter Express". It is on a constant schedule between terminals, stops for a predetermined amount of time at each and then travels to the next terminal on its route. This train is given highest priority so that it remains on its schedule. The other two trains are controlled by the user. The route is communicated to the computer and relayed to the trains.

The problems which the TI 990/12 computer must solve is to decide what route each train must follow and the timing of that route so that the trains do not collide. To accomplish this, an Infra-Red Position Detection System is placed on the track. It finds where the trains are and relays this information back to the host trains, continually giving the "Commuter Express" highest priority.

The EXPO visitor can take an active part in the project by communicating to the computer what route is desired for the remaining two trains. A Graphics Display System will ask the visitor for specific instructions and will feed this into the TI 990/12 for operation.

In addition, the Infra-Red Position Detection System will feed the Graphics Display system with the progress of the trains. The Graphics Display System will then map out the route on the Color Monitor.

The practical applications for the TI 990/12 and Infra-Red Detection System are obvious. If it can be adapted to a city mass transit system, it would speed up and make the transit system more efficient while minimizing the chance of collisions. □

Engineering Registration: Joining the Ranks of the Pros

by Bonnie Buhrow

During their senior year, engineering undergraduates are bombarded by **more** sets of initials in addition to the now familiar M.E., I.E., E.E., etc. What do these new letters - F.E., P.E. - stand for, and why do they keep popping up? These initials are worth investigating because they concern engineering registration - a possibly crucial factor in a successful engineering career.

A person can become a registered Professional Engineer in either of two ways. An engineer who is over 35 years old and has at least 12 years of experience can become registered without examination. However, if that seems too long to wait, registration can be accomplished by taking and passing yet another test.

"The P.E. tests the candidate's knowledge of his engineering specialty, and more strongly emphasizes practical problems and judgement."

The examination for engineering registration consists of two parts: the Fundamentals of Engineering Examination (F.E.) and the Principles and Practice of Engineering Examination (P.E.). Formerly, the Fundamentals exam was usually taken during a student's senior year; the Principles and Practice exam could not be taken until four years later, after an engineer had gained on-the-job "qualifying experience". However, the four years experience requirement was recently dropped and now both parts can be taken while a student is still in school.

The Fundamentals of Engineering Exam is an eight hour exam which tests the applicant's knowledge of a variety of basic engineering subjects. It is usually offered twice a year, in the spring and fall. The test is open-book - the examinee can use textbooks, **bound** notebooks and reference materials, a calculator and/or a sliderule. Writing tablets or unbound notes are not permitted.

The four hour morning session of the F.E. consists of about 140 multiple choice questions. Wrong answers are not penalized, so guessing is a good strategy if the applicant is stumped. The National Council of Engineering Examiners (NCEE) lists the following major subject areas to be covered in this session, and the approximate percentage of questions from those areas:

Subject	Percentage
Chemistry	7%
Computer Programming	6%
Dynamics	9%
Engineering Economics	4%
Electrical Circuits	13%
Fluid Mechanics	10%
Materials Science	4%
Mathematics	9%
Mathematical Modeling of Engineering Systems	6%
Mechanics of Materials	9%
Statics	9%
Structure of Matter	4%
Thermodynamics	10%

In the afternoon section - also four hours long - 50 questions covering four required subjects - Engineering Mechanics, Mathematics, Electrical Circuits, and Engineering Economics - must be answered. The examinee also has to choose two of five additional subjects - Computer Programming, Electronics & Electrical Machinery, Fluid Mechanics, Mechanics of Materials, and Thermodynamics/Heat Transfer - and responds to ten questions in each category.

The format of the Principles and Practice of Engineering exam is similar to that of the Fundamentals test; it is eight hours long (four in the morning, four in the afternoon), and is also open-book. The P.E., however, tests the candidate's knowledge of his/her engineering specialty, and more strongly emphasizes practical problems and judgement. Because the P.E. examines depth rather than breath of engineering background, fewer questions must be answered - usually only four per session are required.

The various engineering disciplines have been divided by the NCEE into

two groups for the purpose of Principles testing. The P.E. exam for Group I - Chemical, Civil, Electrical, and Mechanical engineering - is administered twice yearly, in the spring and fall. Disciplines placed in Group II include Agricultural, Industrial, Mining, Nuclear, and Petroleum engineering; Principles exams for this group are offered in the fall only.

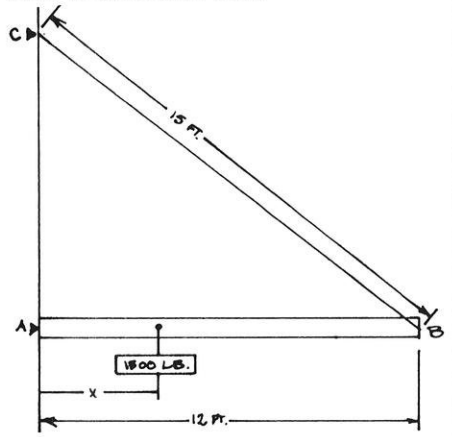
"If an engineer is planning on setting up his own practice rather than working for a large firm, registration is almost a necessity."

Unlike doctors and lawyers, who must pass board examinations before they can practice their profession, all engineers are not required by law to take registration exams. According to Donald Gritzmacher, Associate Professor of Engineering, UW-Extension, registration is not mandatory for several reasons. A corporation itself may be registered, thereby taking responsibility for the safety of a bridge, or a product design. And employees of, for example, public utilities, are covered by other legislation. But although registration isn't always a legal requirement, for some engineers it is a very good idea.

Registration is probably most important for students majoring in civil, structural, or mechanical engineering; this can be deduced from the high percentage of questions on the Fundamentals exam dealing with subjects like statics, dynamics, and fluid mechanics. Most engineers in responsible positions in state and city governments need to be registered. And if an engineer is planning on setting up his/her own practice rather than working for a large firm, registration is almost a necessity. For some career paths, academia in particular, registration is not as essential. According to Dr. Gritzmacher, there is "very little pressure of any kind" on UW-Madison faculty members to become Professional Engineers.

Further information about the registration exams can be obtained by writing the National Council of Engineering Examiners, P.O. Box 1686, Clemson, South Carolina. Application forms for exams are available from the Examining Board of Architects, Professional Engineers, Designers and Land Surveyors, 1400 East Washington Avenue, Room 178, Madison, WI 53702, phone (608) 266-1397. □

Question 71. Assume that the beam is supported at B by a rod BC as shown, and that the supports at A and C and the joint at B permit unrestricted rotation. What is the maximum vertical component of deflection at B?



Modulus of elasticity E = 30,000,000 pounds per inch^2
Moment of inertia I = 20 inch^4
Cross-sectional area A = 3.375 inch^2

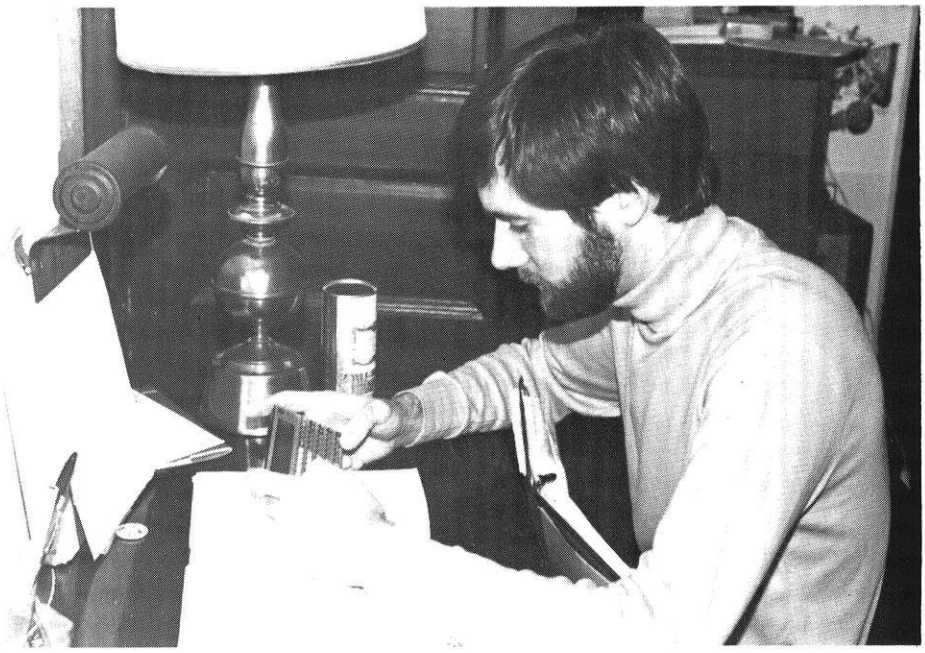
Professional engineering exams cover material on a wide variety of topics related to engineering. The sample question above is typical of what may be found in the Materials Science section.

Adjusting to a New U

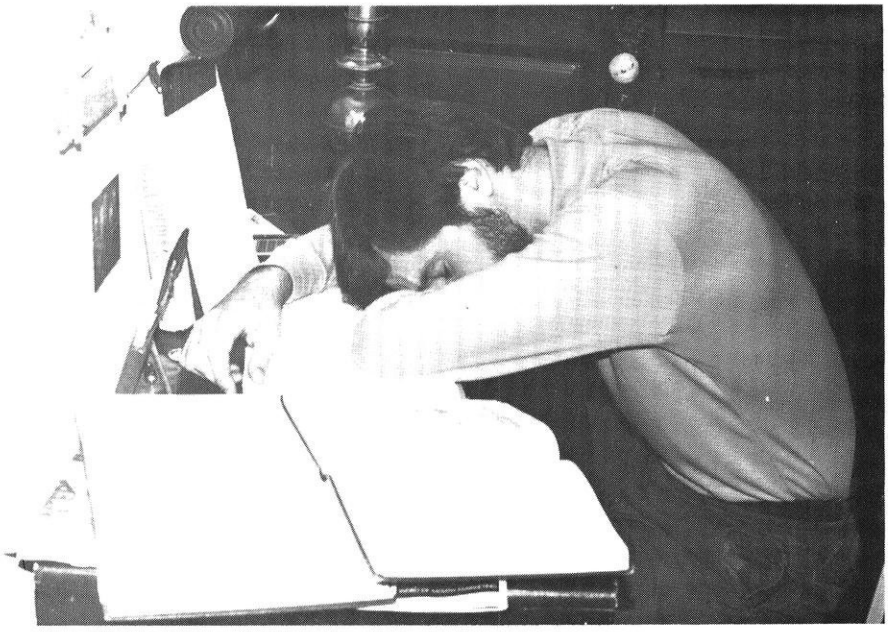
by Dave Yngsdal

Everyone knows that by the time you're a junior you have this thing called "school" pretty well figured out. You know you're in the right major, have probably experienced dorm life, know the campus layout and, after getting through calculus, feel you can handle whatever they throw at you. Right? . . . Well, that's not always true. Especially for transfer students. Many transfer students have spent their freshman and sophomore years on other U.W. campuses that don't offer majors in engineering and they probably still have some doubts about whether they can handle the demanding curriculum of an engineering school.

Transfer students find many changes in their academic life when they come to Madison. They generally find the course work to be more difficult and/or time consuming than they have had previously and their first semester G.P.A. often reflects this fact. Another common change is in the amount of personal student-teacher interaction that they receive. Having no doubt come from smaller campuses, many students have previously had the luxury of a personal relationship with one or more of their professors. But now, with some professors lecturing to over 100 students in a class, if a professor knows you at all it's often only by your test scores in his grade book. One change that is particularly hard for any transfer student to make is to transfer while in the middle of the physics, calculus or chemistry series. This means getting used to a new textbook, a huge lecture hall instead of a regular classroom, and sometimes even a different approach to the material.



Students like Steve Rueth often have to adjust to a heavier work load when they transfer to Madison.



Transfer student's new burdens can sometimes seem a bit . . . tiresome.

Certainly not all of the changes a transfer student must make are directly related to the classroom. Frequently some of their most difficult changes come in their social life. The average transfer student doesn't usually come with a whole caravan of friends when transferring to Madison, so meeting people and making new friends is quite often a high priority. This problem is diminished considerably if the student chooses to live in a dorm for at least his first year here. The dorm provides the student with a way of meeting new people and also makes certain that not all of his friends will be engineering majors. For some transfer students this may even be the first time in their college life that they have lived in a dorm. Everyone's first experience of dorm life is always one to remember, but if this occurs when you are 20 or 21, it can be even more memorable. At times it can be very easy for an upperclassman to feel out of place in this primarily freshman and sophomore domain.

Since over 1/3 of all engineering students at Madison are transfers it's clear that they are certainly not in the minority. Actually the past few years have shown a noticeable increase in transfer students into the College of Engineering. Tight money, higher tuition and a scarcity of jobs are some of the reasons why more students are choosing to spend their first year or two of college at a U.W. System school in or near their hometown. This way they can save money by living at home and many times they can even keep their high school job through their first couple of years of college. Then when they transfer to Madison they have completed the basic science and math courses common to all branches of engineering and are ready to take the engineering courses of their particular major.

"Many students have previously had the luxury of a personal relationship with one or more of their professors."

Obviously for a transfer student to make a smooth adjustment to Madison they must perform well in the classroom. And many times the student's living conditions and ability to make new friends will heavily affect how easy this adjustment is. But whether a transfer's first year is filled with problems or is trouble free, it always goes quickly and before they know it they feel right at home on the U.W.-Madison campus. □

Engineer's Library

The Dragons of Eden

A book by Carl Sagan

When I picked up Carl Sagan's best-seller *The Dragons of Eden*, I did so primarily on what I had heard of his reputation as an innovative scientist and a writer of superb quality. Not disappointed, I found myself launched on a fascinating adventure through billions of years of time and evolution -- I was following the saga of the human brain. Sagan presents a well ordered explanation of how the brain and nervous system work; debates on the nature of intelligence itself; and outlines the steps by which the human brain evolved to what it is today.

One subject covered in depth was the concept of the triune brain. The brain can be looked at as three separate systems, each of which evolved at a different time.

Sagan points out that it is logical for brain development to occur in successive stages in such a fashion that each new stage is added to the whole without changing the structure or function of the previous stages. He argues that evolution proceeds by selective mutation -- and that organisms would probably not survive if changes were made in the basic structure of their nervous systems. So any change in the nervous system of an organism would be in the form of additional structures that would further help it to survive, yet not affect previously evolved systems of proven survival value. He then gives much evidence to show that our behavior and mental processes may still be greatly influenced by these earlier brain structures which remain essentially intact in modern man.

The oldest of these systems is the reptillian complex which developed some hundreds of millions of years ago. As well as supplying a basic neural framework, the R-complex also plays an important role in governing aggression, social hierarchies, and ritual behavior.

The limbic system, about 150 million years old, is primarily concerned with generating strong and vivid emotions.

The neocortex is concerned with higher mental functions such as memory and reasoning. It began to evolve tens of millions of years ago, but its development has greatly accellerated over the last few million years to the point where it now accounts for 85 percent of the brain's mass.

One insight that I found particularly interesting had to do with the pain of childbirth. It seems that childbirth is painless for every species other than Homosapiens. He points out that this must be a consequence of recent and continuing increase in the size of the human brain and skull.

I also enjoyed the section where he disputes the often repeated fallacy that people use less than half of their brain. He asks, "Why would it have evolved if it had no function?" He follows this by showing evidence that memories are often stored in more than one locaton in the brain.

Other topics that Sagan addresses include these very interesting questions. What is the evolutionary basis for sleep and other related behaviors? How does the intelligence of higher order mammals compare with that of man? What is the significance of the two separate brain hemispheres? And in what direction is the future evolution of the brain likely to take? It is fascinating material and it is presented clearly, and in a very readable style. It is an elegant piece of work -- and a book that I would recommend to anyone who is interested in getting a firmer understanding of the working of the mind.

-- Reviewed by Scott Paul. □

Energy Problems and Solutions for a Technical Society

by Terry Mackey

Terry Mackey is a senior in metallurgical engineering and will be graduating in May, 1983. He was inspired to write this article because of his interest in energy issues and national energy policy. He hopes to pursue this subject further in an article in the July issue.

The very foundations of our society are rooted in energy. Modern industrial society depends upon an ever increasing supply of cheap energy to fuel rising production levels which in turn satisfy the needs of a growing world. Yet our ability to meet this increasing energy demand may soon constrain future economic growth. The failure of our governmental, industrial, and educational sectors to realize this, therefore, has serious consequences for our nation.

Americans have become accustomed to an energy supply that is both inexpensive and plentiful. As shown in figure 1, energy prices actually declined from 1950 until 1973, when world oil prices quadrupled. The real price of energy decreased about 28% during this period.

"We cannot rely upon technological breakthroughs, new discoveries, and efficiency gains to supply the growing level of demand for inexpensive energy."

This phenomena has lead to a 3.5% average annual increase in U.S. energy consumption for this period, with energy consumption doubling every 20 years. While admittedly this tremendous growth pattern has slowed somewhat during the past several years, our ability to continue to increase the supply of cheap energy at such a rate is seriously in doubt.

Of course, we can curtail our increasing demand for energy through conservation, recycling and improved efficiencies. In the absence of a concerted national effort in these areas, however, we must depend upon an increasing supply of energy to fuel our future. Yet we cannot rely upon technological breakthroughs, new discoveries (of nonrenewable resources), and efficiency gains to supply the growing level of demand for inexpensive energy.

Economists, pointing to decades of exponential technological growth, seem optimistic about the ability of technology to continue this trend. Many scientists, on the other hand, are not so optimistic. They realize that exponential growth of any kind cannot continue indefinitely. While engineering breakthroughs can deliver a short-term 'fix' for our energy dilemma, we cannot afford to depend on this unreliable solution. In the long run it could lead to stagnation of our economy if energy supplies are unable to keep up with industrial growth.

Annual Rates for Change of Energy Prices, 1950-1973.

Period	Yearly Change (percent)
1950-55	-0.62
1955-60	-0.75
1960-65	-1.31
1965-70	-1.73
1970-73	-1.87

Source: Edward J. Mitchell, **U.S. Energy Policy: A Primer.** Washington, D.C., American Enterprise Institute for Public Policy Research (1974), p. 82.

The above statistics show that energy prices have actually declined in the past three decades.

New discoveries of nonrenewable energy sources, whether they might be oil fields or uranium deposits, are unlikely to provide us with the plentiful, inexpensive energy we crave. With much of the planet well-mapped geologically, most future discoveries are likely to be small and located deeper in the Earth's crust (resulting in increased recovery costs and decreased recovery rates).

Efficiency gains serve to increase supply as well as decrease the demand for energy. The increased efficiencies to be realized through enhanced recovery techniques and generation/transmission improvements, however, are unlikely to supply the tremendously increased amount of energy needed to fuel our factories and homes in the distant future.

"Most future discoveries are likely to be small and located deeper in the Earth's crust."

Important strides can be realized in the near future through cogeneration techniques and energy storage. Cogeneration involves, for example, the production of both electricity and processed steam from a high-pressure boiler (a savings of 15% over the energy required to generate them separately). In this way, the starting fuel is used more efficiently and thermal and air pollution are reduced. Energy storage systems enable us to store off-peak power for use during times of increased demand (such as during an extended cold spell). Pump storage, compressed gases, storage batteries, and magnetic field storage thereby allow us to demand for, limited periods more energy than we can instantaneously supply.

It is important to realize when talking about efficiency that this topic is one of much confusion. Consider that electricity is often stated as being the most efficient form of energy -- the highest grade of energy. But conversion losses as it is generated from burning coal (coal is our main electric power supply) and again as the electricity is transmitted makes the overall efficiency not as great as some would have you believe. This confusion makes comparisons among alternative forms of energy misleading at any times. Yet awareness of this problem is necessary to intelligently select between the various energy forms which will fuel our nation in the future.

By and large, an engineering education fails to create an awareness of the importance of energy as a determinant in process selection. While emphasizing the performance/property difference to be obtained among the various alternative methods, the energy requirements of these methods has been downplayed or totally ignored. The engineer does not get a firm grasp of the total picture.

"Such an outward movement of our industrial sector would result in a decline in our self-sufficiency."

Doubtless, energy requirements are taken into consideration when determining the overall profitability of an operation. Some would also argue that economics isn't a basic element in an engineering education. Yet an appreciation for the interaction between engineering and energy will definately benefit our nation as we try to tackle the tough decisions sure to face us in the future.

All this paints a rather bleak picture of energy and our future growth and well-being. Aside from possible technological advances and efficiency improvements (which are only short-term solutions), it seems uncertain that we will be able to expand our energy capacity to fill the needs of our growing country. Yet our inability to do so could drive our manufacturing industries out to other countries that possess abundant supplies of inexpensive energy.

Such as outward movement of our industrial sector would result in a decline in our self-sufficiency. Indeed, this trend has been growing in magnitude over the past several years as shown by increased imports of finished goods and refined raw materials from abroad.

Self-sufficiency, however, is an important aspect of our national security. As energy is increasingly used as a political bargaining chip in the international scene, this issue is likely to grow in importance.

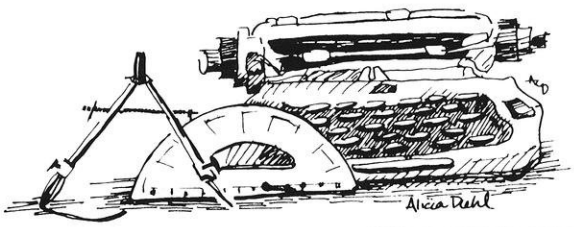
Thus our country finds itself in need of a comprehensive, coherent, national energy policy. The national energy policy would be instrumental in developing our energy industry so that future economic growth is not constrained. Such development could also be tied in with political, economic, and social goals.

A main feature of the national energy policy would be to encourage conservation by offering tax credits or low-interest loans. Conservation is important so that we can limit the growth in demand to more accurately match the level at which we can increase the supply of energy. Conservation also stretches out the supply of depletable energy resources.

The national energy policy should stress the importance of alternative energy systems such as solar, geothermal and wind. In addition, load management and energy storage techniques must be considered. Progress in these areas would help increase our energy supply and limit the demand.

Because of the long lead times involved in energy development, this topic urgently needs to be discussed so we may more effectively prepare for the future. In addition, government financing, research by both the industrial and educational sectors, and public education are necessary to ensure the success of the national energy policy. □

Bits & Threads



State of the Unions

Member groups of the Council of Engineering and Scientists Organizations have voted on a referendum concerning joining a national union. The Seattle Professional Engineering Employees Assoc. voted 75% in favor. The Westinghouse Engineering Assoc. voted 76% in favor, but the Engineers and Scientists Guild at Lockheed Corp. voted 54% against. The Southern California Professional Engineering Assoc. at McDonnell Douglas voted 58% against.

WE Goes for the Gold

The Wisconsin Engineer staff will attend a national convention of college magazines this month. The annual convention offers workshops in writing, layout and business strategies. It will be held on the Chicago Circle campus of the University of Illinois, April 7-9.

The climax of the convention is the awards banquet at which prizes are given to the nation's best college engineering magazines. Awards recognize the best all-around magazine, technical article, layout and other qualities.

The Wisconsin Engineer came up with three first place awards at last year's convention and hopes to fare as well this year. Our chief rival is the Illinois Technograph, which took the title for best all around magazine last year. The WE staff has confidence in its entries and hopes to steal the championship title from the Technograph.

Public Questions Test Ethics

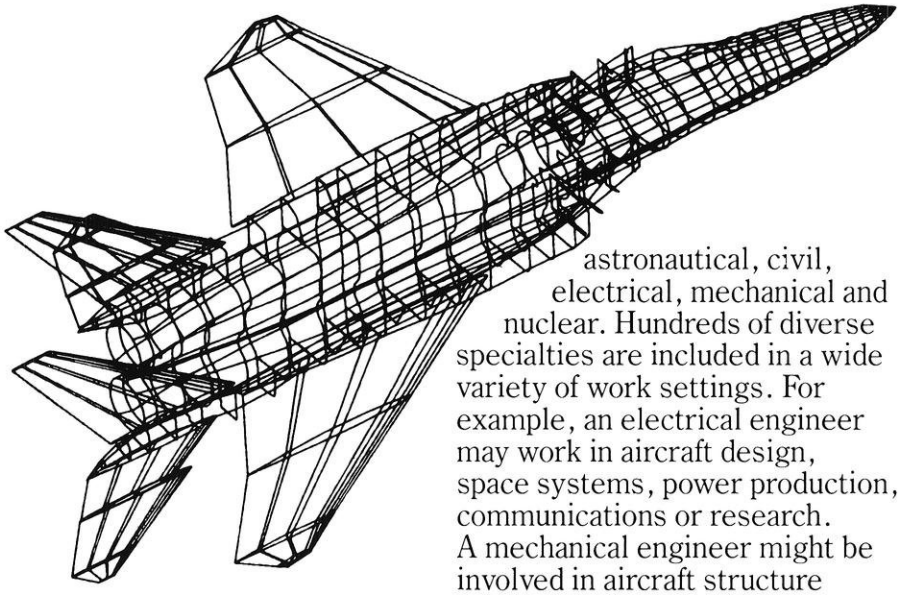
Last fall, public high schools in New England gave their seniors a vocational aptitude test. Results of the test are supposed to help kids decide whether they are best suited to become lawyers, artists or engineers. It was a routine test, like most standardized tests, except for an odd flavor to the first twelve questions. They contained thinly veiled propaganda for military service.

Question #1 read: "Do you want your test scores sent to the Dept. of Defense so they can contact you directly about ... opportunities and benefits?" Other questions determine whether kid's parents or guidance counselors have discouraged them from joining the military. "Are you aware that individuals can take courses while in the military and have 75% of their tuition paid?"

It turns out the Defense Dept. provides funding for administering the test and processing its results. High schools get free vocational aptitude scores, and the D.O.D. gets a prescreening of draft registrants. It sounds illegal and it just might be. Concerned parents have started asking questions, and the test may violate the Family Privacy Act. In Cambridge, Massachusetts where the test had been given, one School Committee ended up deciding not to send in the results. School systems in Vermont, Connecticut, and New York are also deliberating on what to do with the tests.

If the legal problems continue, it may be the end for these tests. But if not, tell every kid you know. The New England program was designed as a pilot. Next year the tests are slated to go out nationwide.

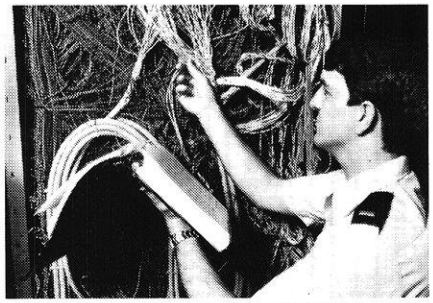
ENGINEERING TAKES ON EXCITING NEW DIMENSIONS IN THE AIR FORCE.



Computer-generated design for investigating structural strengths and weaknesses.

Developing and managing Air Force engineering projects could be the most important, exciting challenge of your life. The projects extend to virtually every engineering frontier.

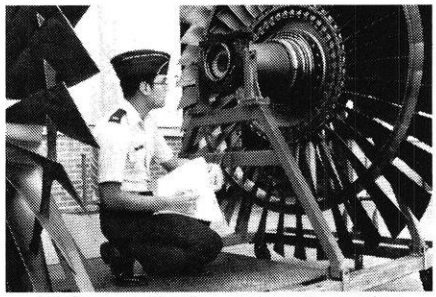
8 CAREER FIELDS FOR ENGINEERS



Air Force electrical engineer studying aircraft electrical power supply system.

Engineering opportunities in the Air Force include these eight career areas: aeronautical, aerospace, architectural, astronautical, civil, electrical, mechanical and nuclear. Hundreds of diverse specialties are included in a wide variety of work settings. For example, an electrical engineer may work in aircraft design, space systems, power production, communications or research. A mechanical engineer might be involved in aircraft structure design, space vehicle launch pad construction, or research.

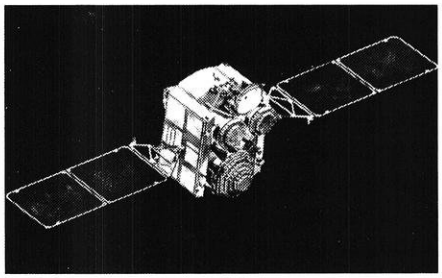
PROJECT RESPONSIBILITY COMES EARLY IN THE AIR FORCE



Air Force mechanical engineer inspecting aircraft jet engine turbine.

Most Air Force engineers have complete project responsibility early in their careers. For example, a first lieutenant directed work on a new airborne electronic system to pinpoint radiating targets. Another engineer tested the jet engines for advanced tanker and cargo aircraft.

OPPORTUNITIES IN THE NEW USAF SPACE COMMAND

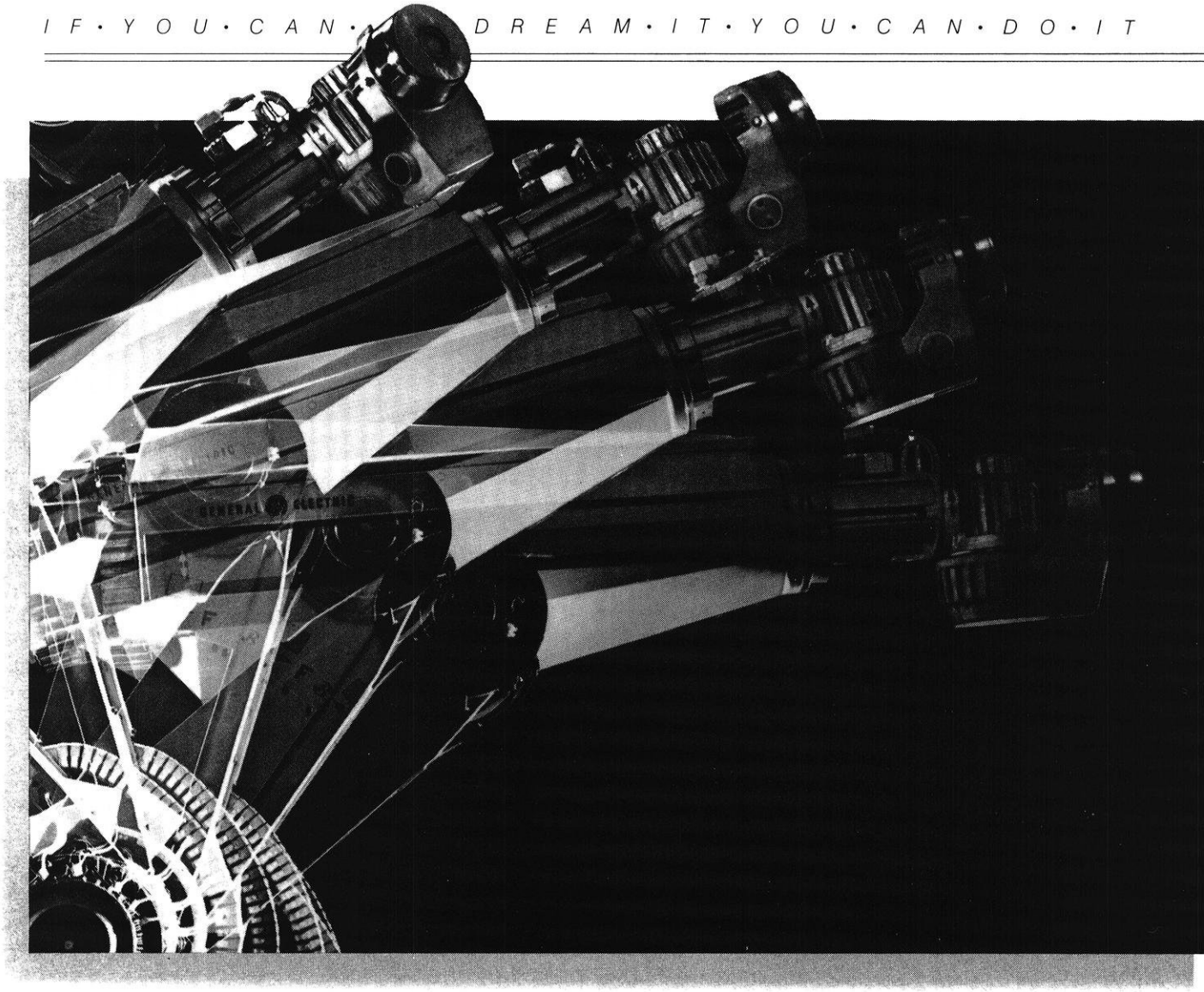


Artist's concept of the DSCS III Defense Satellite Communications System satellite. (USAF photo.)

Recently, the Air Force formed a new Space Command. Its role is to pull together space operations and research and development efforts, focusing on the unique technological needs of space systems. This can be your opportunity to join the team that develops superior space systems as the Air Force moves into the twenty-first century.

To learn more about how you can be part of the team, see your Air Force recruiter or call our Engineer Hotline toll free 1-800-531-5826 (in Texas call 1-800-292-5366). There's no obligation.

AIM HIGH
AIR FORCE



Teach a robot the facts of life.

There was a time when most robots earned their livelihoods in comic books and science fiction films.

Today, they're spraying, welding, painting, and processing parts at manufacturing plants around the world.

Necessity has caused this amazing leap from fantasy to factory.

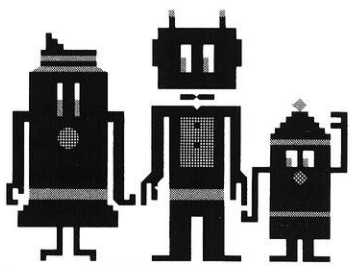
The world wants long-lasting, high quality products, now. And robots fit perfectly into this scheme of things: They can make those products – quickly, easily and accurately.

What kinds of robots? There is GE's Allegro,™ for one. It can position a part to within 1/1000th of an inch – or about ¼ the thickness of the paper this article is printed on. Or there's GP 132 (shown here). This loader, unloader, packer, stacker and welder – can lift and maneuver 132 pounds with no trouble at all.

So what's left for me to teach robots? You might ask. Consider this glimpse into the future by Dr. Roland W. Schmitt, head of GE corporate research and development:

"One of the big frontiers ahead of us is putting the robot's nervous system together with some senses – like vision, or touch, or the ability to sense heat or cold. That can give you an adaptive robot, one that can sense how well it's doing its job and make the adjustments needed to do that job better."

That's a tall order. And one we'll be expecting you to fill. With foresight, talent, imagination – all the things that robots have yet to learn.



WE BRING GOOD THINGS TO LIFE

An equal opportunity employer.