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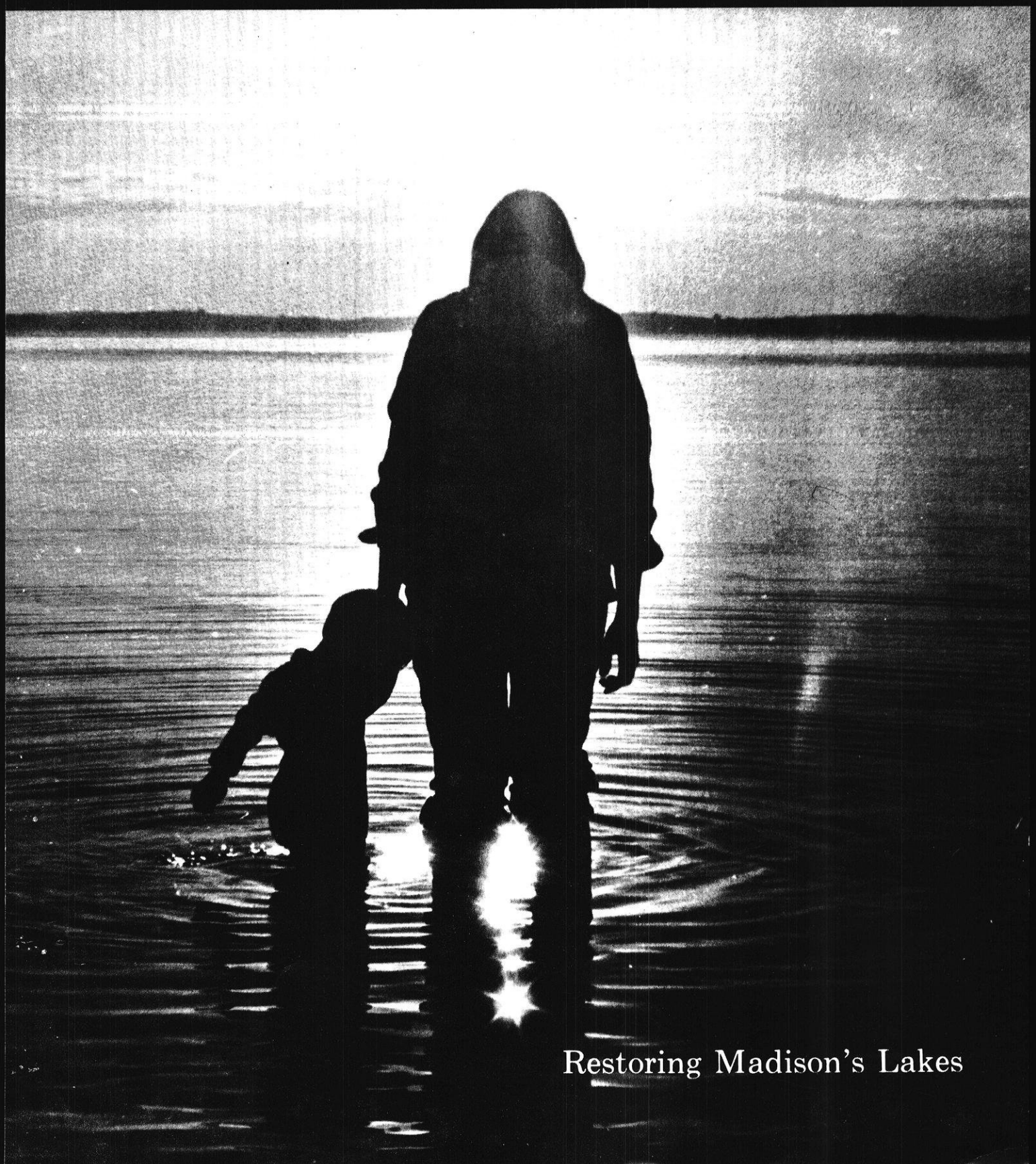
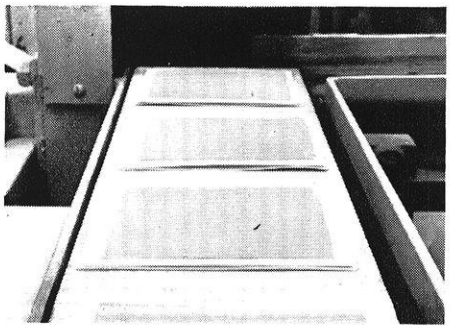
wisconsin engineer

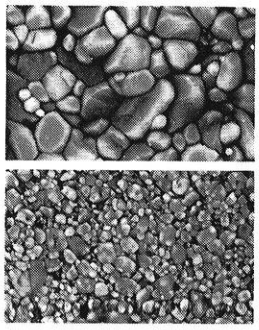


Restoring Madison's Lakes

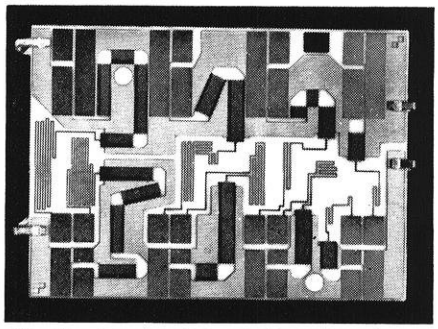
WESTERN ELECTRIC REPORTS



1500° C furnace was specially designed to fire these new substrates. The relatively low temperature results in smooth substrate surfaces for practically fault-free thin film bonding.



Electron micrographs show the great difference in grain size between new ceramic material (lower) and the previous material (upper).



Thin film integrated circuit shown here is part of a resistor network. It is one of many that benefit from the improved substrate. Metal leads on sides are bonded by thermocompression to tantalum nitride resistor film.

Smoothing the way for perfect thin film bonding.

Aluminum oxide, or alumina, is considered to have the best combination of properties for thin film circuit substrates. Until recently, however, the bonding of metal elements to gold-coated tantalum nitride resistor film on alumina was somewhat unpredictable.

Now, an advance at Western Electric has made it possible to get practically fault-free bonding of these materials.

This new perfection in bonding came through the development of finer grained alumina substrates.

The process has four basic steps: milling, casting, punching and firing.

During milling, alumina is combined with magnesium oxide, trichlorethylene, ethanol and a unique deflocculant. For 24 hours, this mixture is rotated in a ball mill. In a second 24-hour period, plasticizers and a binder are included.

The deflocculant plays a major role by dissipating the attraction forces that exist between the highly active alumina particles. This prevents thickening, which would ordinarily make an active alumina mixture unworkable.

The 48 hours of milling is followed by casting. When the material comes off the casting line, it is in the form of a flexible polymer/alumina tape, dry enough to be cut into easily handled sections.

After casting, a punch press cuts the material into the desired rectangles or other shapes. Holes can be punched at the same time.

Finally, because of the use of active alumina, the material is fired at an unusually low temperature which results in smooth substrate surfaces for reliable thin film bonding. The finished substrate is then ready for the various processes of thin film circuit production.

In developing this new process, engineers at Western Electric's Engineering Research Center worked together with engineers at the Allentown plant.

Conclusion: This new way to produce substrates is a truly significant contribution for thin film circuit production.

The ultimate gain from this smoother substrate is for communications itself. For through the achievement of nearly perfect bonding of metal leads to tantalum nitride, thin films can be produced with even greater reliability and economy.

Western Electric

We make things that bring people closer.

wisconsin engineer

Cover Photo
Courtesy of Pam Pinigis

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Editorial

Society Needs Educating

Engineers are being asked to solve uncomfortable living conditions within the context of continued abuses of the environment. Technology is asked by the public to provide additional coveniences; it is the Santa Claus that society writes to for gifts of easier living.

After some of the "toys" break, frequently from misuse, scientists are accused of a lack of social consciousness. As a result scientific professions are called upon to play a more active role in planning to assure that projects serve in the best interests of a community or nation. Answers to questions about technology's future must be answered; not only in terms of its impact on society, but how society actually uses it. Dean Marshall said in the Dean's Page this month that "Engineers of the next decades, students today, must be sophisticated in knowing their profession — not only from a technical basis, but also from the basis which requires their understanding of its impact on society's values." We would rather ask, how is society and its value system going to use engineering skills?

The local battle over whether another Holiday Inn should be built in Madison's Triangle urban renewal project is one example of the misuse of these skills. We question whether driving people out of their homes to eventually build a hotel can be considered urban and regional planning. Many civil and environmental engineers would not give credence to such use of the urban renewal concept.

The Alaskan Pipeline is another example where government may not have considered all the implications of a major project on society and the world in which we live.

Past errors in judgement have brought urban problems of transportation, air pollution, and congestion. Today's decision will affect us for many years to come. To blame technology for errors in decision making is like blaming the hand that does the work. Scientists and engineers are only small parts of the whole, whose values and accomplishments are reflections of the rest of society.

As Dean Marshall has said, there is much to do in the area of public understanding.

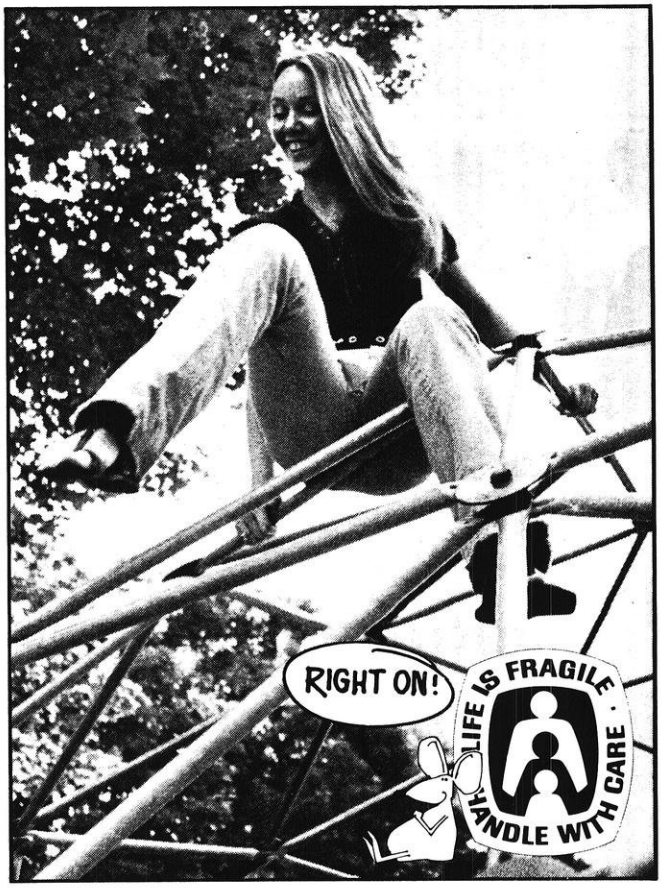
The gift nobody asked for

But being human, we cling to it For as long as we can

Life. In our zest for it, we sometimes grow careless. We forget that life is a fragile gift. One that needs constant loving care.

So Dow people display the emblem you see here as a gentle reminder of life's frailty and the need to preserve and protect life in all its variety.

Life is Fragile began as a Dow safety awareness program, but it's much more than that now. It's become a way of life for us. A kind of code word by which we express our concern for all living things.



And we try to live by what the symbol says. At work. With our families. In our local communities.

Not because we're big on slogans, but because we don't want to lose the precious talent, enthusiasm and ideas of our people through carelessness or indifference.

So if you're one who loves life and wants to live it wisely, drop us a line. We'll be happy to send you your own Life is Fragile awareness kit.

And if you're in the job market, tell us about yourself. Could be we should get together. After all, good people are hard to come by these days. But that's not news now is it?

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Engineers Must Understand The Impact of Their Profession

One of the greatest challenges that the engineer faces today and will continue to face in the next decade is to provide answers to the public's many questions about technology's future impact on society. The engineering and scientific community already finds itself in many unusual and awkward situations caused by the "unanswerable questions" which society asks today, but which questions in earlier decades were largely ignored. As a result we observe the dilemma of engineers appearing to fumble the answers to the many questions and concerns of society — while, in fact, many of these questions are unanswerable to society's satisfaction. They are unanswerable because they deal so often with the impact of technology on the future — not on the present. How does one assure the public there will be **no** accidents, in any plant, car, etc.? As a result the lay public, the engineer, the scientist, and the politician find themselves in the dilemma of trying to make decisions more on the bases of speculation and opinion rather than on hard, proven facts.

In hindsight this situation could have been foreseen. In fact, warnings as far back as 15 years ago were expressed that we were not able then to predict the future consequences of our technological progress. Now we see many example of public concern and controversy over socio-technical issues, such as the ecological effects of power plants, the problems of automotive emissions reduction, the concern for noise abatement, the worries of product reliability and safety, etc.

All of these problems are legitimate and proper concerns of the public and egnineering. A fundamental problem, however, is that the public is not aware of the time required to obtain answers to many of the questions which are asked. This problem is generally referred to as the "problem of the public understanding of technology" and it is a problem which must concern both engineering education and engineering practice.

The College of Engineering is making some progress in this important educational area through the development of technology-oriented courses for non-engineering students and through a program of instruction for high school teachers to educate them in engineering concepts to be taught in a high school course called the Man-Made World. This course was developed by engineers. However, there remains much to do in the area of public understanding of technology and the engineering student of today should become vitally aware of his responsibility to educate the public about engineering, how it is practiced, and how man is governed by natural laws as well as man-made laws. The engineer faces an impossible task when he is asked to provide 100% safety, or zero risk, or 100% efficiency, or zero pollution. The public must understand the nature of the world he lives in and that 100% or 0% are goals which cannot be obtained in the world as we now know it.

Dean W. Robert Marshall

Thus, engineers of the next decades, students today must be sophisticated in knowing their Profession— not only from a technical basis, but also from the basis which requires their understanding of its impact on society's values. It is clearly predictable that some of the major socio-technical problems facing society can reach crisis proportions if a lack of public understanding results in a no-decision on a course of action— because a no-decision is a decison—a decison to do nothing. Engineering and technology must make every effort to help the public realize the impact of "no-decision" decisions.

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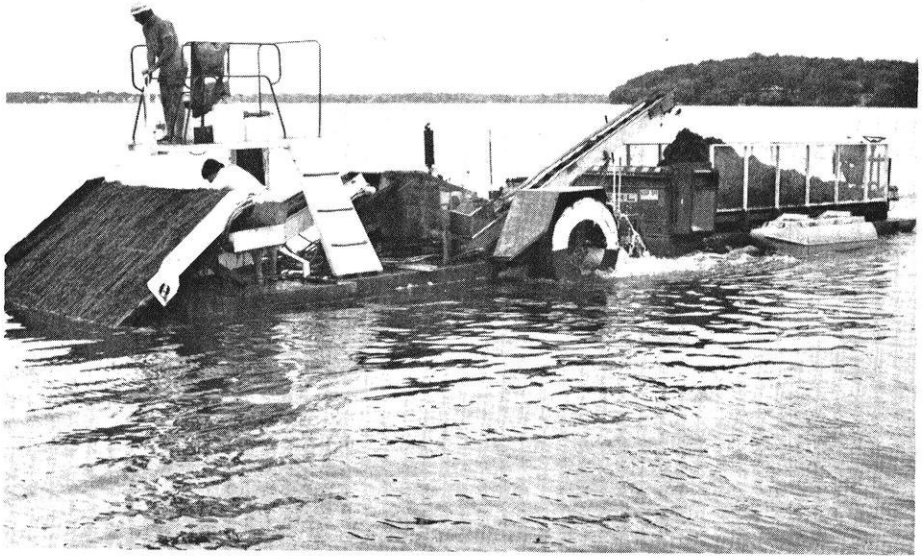


Weeding Out Pollution

by Se Hiong Sy and Harold Link

Excessive growth of aquatic plants in lakes and waterways reduces their beauty, utility, and recreational potential. This phenomenon, which is of increasingly widespread concern, is frequently attributed to man's activities that raise the nutrient level of the water.

These plants, however, also serve important positive ecological functions. These include addition of oxygen to the water during photosynthesis, provision of habitat for various aquatic life, stabilization of bottom muck, synthesis of food for aquatic animals from sunlight and minerals, and possible inhibition of free-floating algae. Eradication, even if feasible, would be a questionable goal.

Maintenance of nutrient levels below those which produce excessive plant growth would represent a basic solution. However, this does not seem attainable in the foreseeable future. Many aquatic ecologists feel that one of the better techniques for improving water conditions is the cutting and removal of problem vegetation. This method gives immediate relief from nuisance conditions and restores much of the original usefulness and beauty of the water resource without drastically upsetting the ecosystem. Mechanical management, moreover, adds no foreign substances to the water. It also gives the option of utilizing the harvested plant material for nutritional or other purposes.

Research by plant ecologists on small hand-harvested plots has shown that one or two cuttings per year, depending on the depth and water clarity, appear to be sufficient to eliminate most nuisance situations in lakes of the north central region of the nation.

The University's interest in mechanical management of aquatic plants dates back to the early 1950's when Prof. Don Livermore, present chairman of the Mechanical Engineering Department, designed a mechanical weed harvester as part of his M.S. thesis research. This machine proved to be the forerunner of a number of present day harvesters.

In 1968, Livermore and Prof.

Hjalmer Bruhn of the Agricultural Engineering Department, began a long term interdisciplinary study of mechanical control of aquatic plants, which was sponsored by the U.S. Department of the Interior. They were joined later by Dr. Dick Koegel of Mechanical Engineering and the Water Resources Center. Researchers from other departments, the City of Madison, Dane County, and several manufacturing concerns have shown their interest through counsel and through donated time and equipment. In addition to the authors, graduates and undergrades have worked on this project as research and project assistants, as student helpers, and in independent study projects. Continued funding through 1976 is assured by a recent grant from the National Science Foundation.

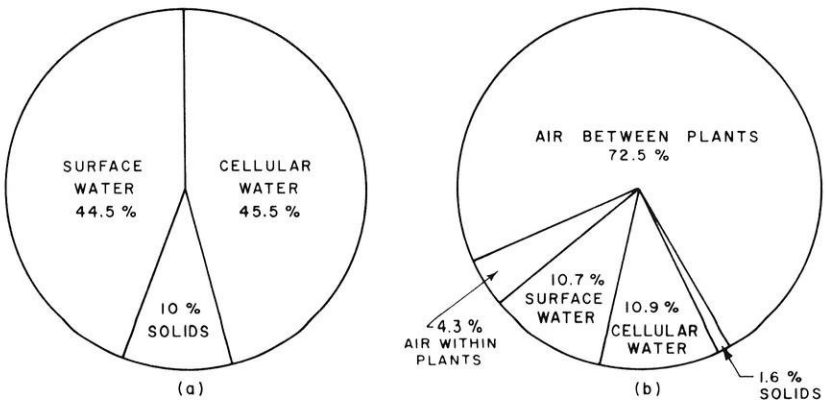
Evolution of Harvesting

Since it is desirable to harvest lakeweeds mechanically, what are the major difficulties involved? As far back as 1966, equipment has been successfully used to cut lake weeds. A simple reciprocating cutter can travel up to five m.p.h. and, with a six to 12 foot cutting swath, it can cut up to six acres an hour. At that rate, one cutter operating full time might be able to control problem weed areas on both Lake Mendota and Lake Monona. However, large masses of decomposing weeds washing up on the shores as a result would be a worse problem than the original weed beds. Pitchfork removal of floating cut plants at the shoreline is not feasible in most cases.

Presently the so-called single-staged harvester is in use. This harvester has a porous conveyor directly behind the cutting bar which lifts a high percentage of the cut material directly onto the deck. But the large four by eight foot frontal area of the conveyor presents a tremendous resistance to forward motion, especially when covered by a heavy mat of cut plants. This resistance limits harvesting speeds to approximately one m.p.h. or one acre per hour, and makes steering a desired course extremely difficult.

Research efforts are aimed at increasing harvesting rates to more than five acres per hour. Results from the last two years indicate that a two-stage operation, separating cutting and collecting, might be a significant improvement. Cut weeds generally float close to the surface of the water. A simple cutter is followed by a second boat which skims the cut weeds out of the water at a high rate of speed.

The present version of this collection unit has two horizontal, toothed arms in a "V" shape, with the open end forward, mounted ahead of a barge. The teeth extend downward into the water far enough to entrain the floating plant material. The teeth traverse the arms from front to back and thus gather floating plant material from the open end of the "V" to its vertex as the craft moves forward. The plant material concentrated at the vertex of the "V" is brought on board by a small, very porous conveyor that extends about ten inches into the water.



PERCENT CONSTITUENTS OF A TYPICAL MASS OF HARVESTED EURASIAN WATERMILFOIL. A. BY WEIGHT. B. BY VOLUME.

This "'skimmer," although in need of additional refinement, shows promise in eliminating one of the most difficult bottlenecks in the process of removing nuisance aquatic plants.

Another problem is that plant material removed from the lake generally contains more than 90 per cent moisture. For every pound of dry matter harvested, approximately nine pounds of water must also be handled. Methods which substantially reduce the moisture content of the plants during the initial stages of harvesting can greatly increase efficiency.

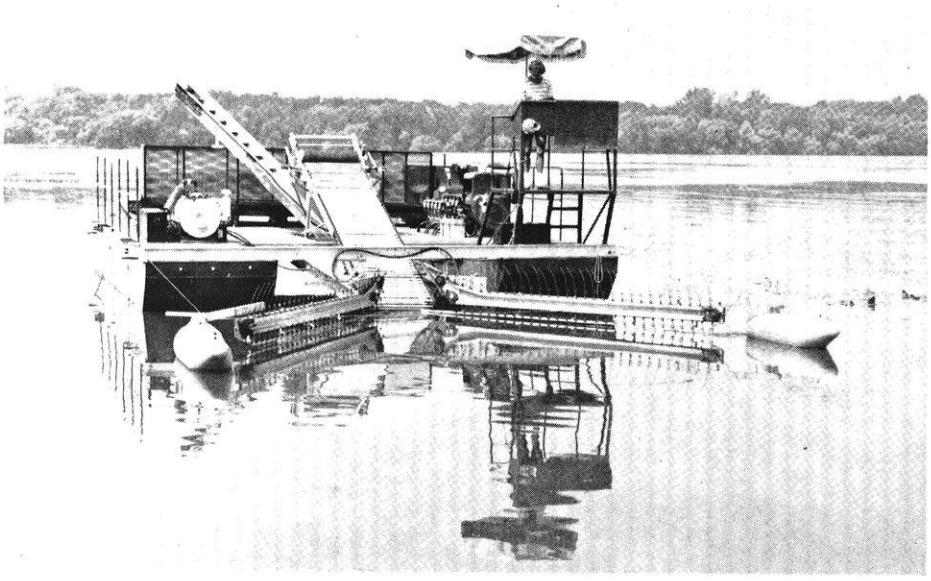
Processing Studies

Figure below shows the constituents, by weight and by volume of a mass of Eurasian watermilfoil as might be obtained by current harvesting operations. The low percentage of solids indicates a great potential for decreasing both the weight and volume of the mass by the expression of water and air.

Results on the use of a set of rubber covered rollers, similar to oversized wringer rollers, for the removal of entrained surface moisture shows that the rollers are capable of removing more than 50 per cent of the water in the harvested vegetation and 48 per cent of the initial weight of the plant material as received from the harvester. They also reduce the volume of the plants by 60 per cent.

Even with the surface moisture removal the final moisture content of the pressed residue is still quite high. Screw presses, which consist of a screw rotating inside of a closely fitted and perforated cyclindrical housing, have been widely used for expressing liquid from a variety of materials. Results indicate that a well designed screw press could reduce the moisture of the plant material to 60-65 per cent, and the weight and volume could be reduced to one-third and one-sixth of the original values while losing less than 20 per cent of the nutrients of the plant material. The resulting dewatered vegetation is suitable and convenient to use as a garden mulch, soil conditioner, or compost.

After harvesting, aquatic vegetation is a bulky, tangled mass which is difficult to unload, or to convey. Chopping eases handling, reduces volume, and allows more compact storage.



High Speed "skimmer"

Heat treatment, or blanching, of aquatic vegetation can also result in an 85 per cent increase of dewatering efficiency. If the treatment is not too severe, smaller amounts of solids will come out with the expressed liquid due to protein coagulation.

Dane County Operations

Dane County has one of the most extensive lake weed harvesting operations in the northern United States. In a cooperative program researchers at the University work together with Dane County personnel in an attempt to:

•Improve the efficiency and the success of county operations.

•Gather important information as to the practicality of equipment and processes.

•Investigate current harvesting methods to try to determine costs for each phase of harvesting operations.

One of the benefits of this cooperation was a demonstration last year at Tenney Park in Madison in which weeds were processed and made available to the public for use as a mulch or soil conditioner. Public response was very good. As a result the county no longer needs to haul all of the harvested weeds to landfill sites. Trucking costs had run approximately 40 per cent of the total harvesting budget besides helping to deplete remaining landfills.

The processing employed at Tenney Park was to chop the tangled mass of weeds into an easily handled form and then to run it through a screw-type press to reduce the weight to about one third original. A similar operation performed on the harvesting barge would drastically reduce the weight and volume of the weeds, allowing more extensive harvesting before unloading is necessary.

The University and the County worked together to modify one of the existing County harvesters for this purpose. An agricultural chopper was modified, equipped with a set of rubber rollers and installed upon the harvestor. Transport barges were equipped with modified agricultural self-unloading boxes and a coupling mechanism to secure them to the stern of the harvester. Thus the weeds are chopped to reduce their volume by better than one half and to make them easy to handle, and then loaded directly onto the transport barge which, when full, is immediately replaced by an empty barge.

The system was put into use in the summer of 1973 and proved to be very effective — increasing harvesting rates nearly 10 per cent over those achieved last year with the same machine.

Food Source

At present, a significant part of the cost of mechanical aquatic plant management is the disposal of the harvested plant material. Frequently this is trucked, unprocessed, to land fill sites a considerable distance from the harvesting site. If the harvested plant material could be profitably utilized, the economics of the whole process would be greatly improved.

The composition of watermilfoil has been fairly well documented. With a few exceptions, the composition of watermilfoil includes crude protein at 20-25 per cent, xanthophylls 650-1100 ppm, and crude fiber 10-12 per cent, all on the dry matter basis. These figures show watermilfoil as approximately equal to alfalfa in protein content.

A number of alternative procedures are receiving consideration for utilization or disposal of harvested aquatic vegetation.

Some minimal processing could make this vegetation acceptable as domestic animal food. In preliminary work it has been noted that a heat treatment seems to improve palatability, presumably by driving off some undersirable volatiles. Fermentation to a silage might serve the dual purpose of preserving the material while improving palatability.

Following initial dewatering and chopping, fractionation has been used to divide the plant material into a juice fraction and fibrous fraction. A protein and mineral concentrate may be made from the juice fraction and the fibrous fraction either disposed of or used as animal feed. The protein concentrates may have potential for use in human nutrition as well as for animal nutrition.

It has been demonstrated that large quantities of the chopped, partially dewatered plant material may be disposed of by spreading on lawns or agricultural land using conventional agricultural spreaders, with no negative effects.

Interest displayed by the public in the chopped, partially dewatered vegetation as a soil conditioner supports the belief that a large amount, if not all, of the vegetation could be disposed of by simply making it available to the public at dockside. The management of nuisance aquatic vegetation may tap a new resource.

Richard A. Moll

Professor, Metallurgical and Mineral Engineering

by Rick Giesler
Of the Engineer Staff

The Wisconsin Engineer is featuring a "professor of the month". This month's choice, Professor Richard A. Moll, received his B.S. degree in Metallurgical Engineering from the Illinois Insitute of Technology and his M.S. and Ph.D. in Metallurgy and Materials Science from Lehigh University. At Wisconsin, he previously held joint appointments in the Mechanical and Metallurgical Engineering Departments. Since 1972, Professor Moll has been with the University of Wisconsin-Extension and Metallurgical and Mineral Engineering Department (M and ME).

With material failure being one of Professor Moll's special field of interests, he plans to appear on a daily program produced here in Madison by Peter Fenney, dealing with unsafe products. The show will be a consumer alert of unsafe or faulty products. Professor Moll will discuss these products and their exact flaws to help the consumer in his purchases. The half-hour program will be shown on Channel 21 beginning in October.

Currently, Professor Moll is teaching M and ME 350, a material science course, and a course called Products Liability, one of "the most important courses any engineer can take" according to Professor Moll. Products Liability is a course that deals with problems of today in the real world. Besides these courses, Prof Moll's teaching assignments have included courses in metallurgy, design, and welding metallurgy manufacturing processes.

As a result of his increased activities with the University of Wisconsin Extension, Professor Moll is participating in and initiating continuing education program for engineers in industry in such areas as welding metallurgy, welding processes, products liability prevention, failure analysis, and practical applied metallurgy and design subjects.

Besides classroom teaching, Profession Moll is involved in the production of video-cassette tapes used in the teaching of materials courses. One such series of tapes is on the "elements of Materials Science", consisting of sixteen different tapes on su ch topics as "Internal Structure," "Structure Sensitive Properties", and "Atomic Bonding". These tapes will be made available to students concerned with these areas of study. These tapes will also be circulated throughout the United States, being shown to Engineers as a refresher course or to illustrate new advancements in materials technology.

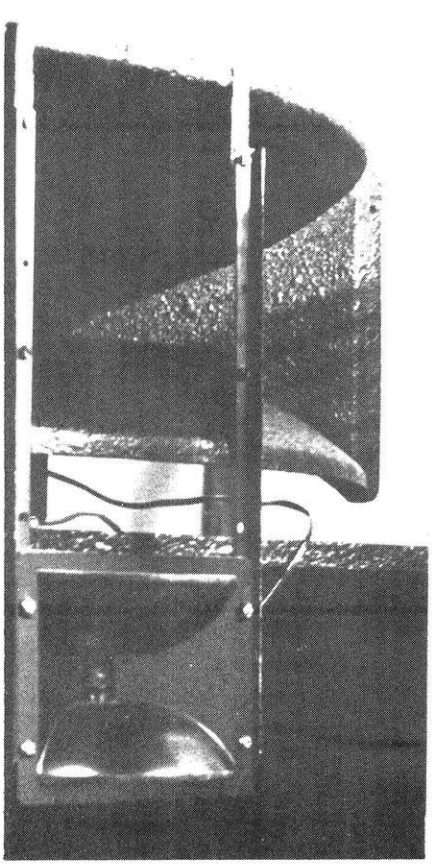
Professor Moll has also been doing research in welding metallurgy. The research project, sponsored by the Caterpillar Tractor Company, consists of developing a very high strength weld level using cheap materials. Most of the research is centered around the chemical effects of Boron on welded materials. The project has lead to an application for a patent on the data obtained.

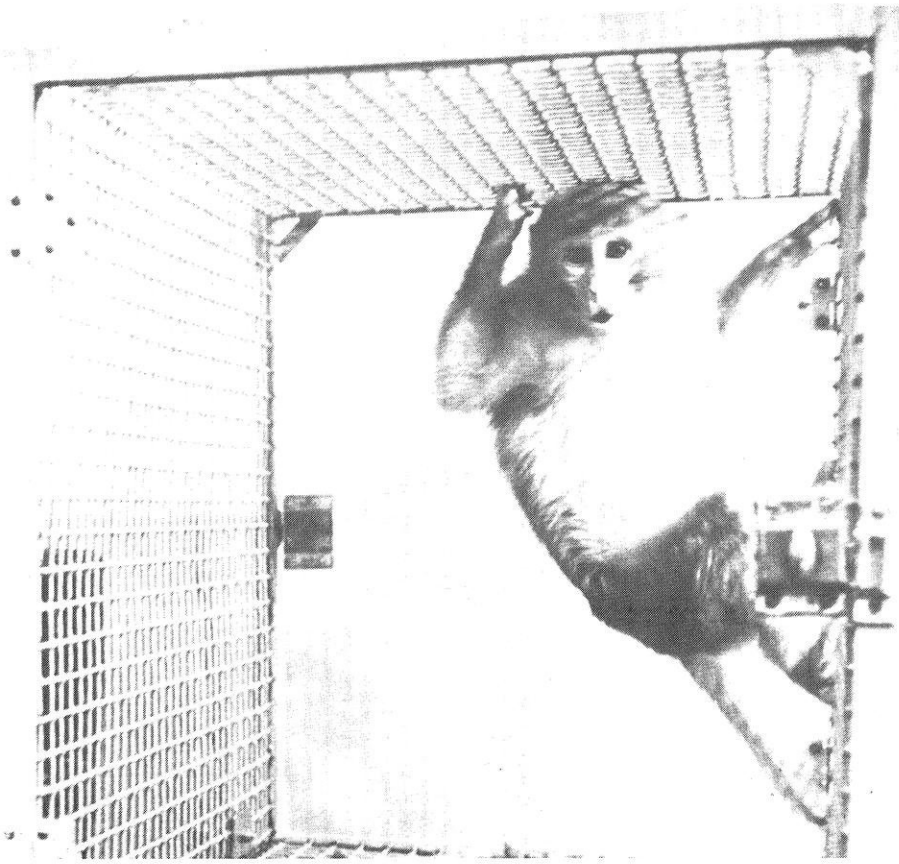
In 1972, he received the Pi Tau Sigma Distinguished Teaching Award, the Adams Memorial award, and the 7th District Meritorious Award from the American Welding Society. Professor Moll is a registered Professional Engineer in Wisconsin and holds membership in Sigma XI, Pi Tau Sigma, and Triangle Fraternity.

- NOISE -

A Drive from Bananas to Deaf

by Don Johnson





Noise poises a probable health hazard to 40 million Americans. According to a report by the federal Environmental Protection Agency (EPA), at least 80 million people, or 40 per cent of the population, are affected by noise.

"Roughly one-half of the total impact of noise represents a potential health hazard (in terms of hearing impairment alone)," the report noted, "and the remaining half represents an infringement on the ability to converse in the home." The agency also said that harmful noise levels, previously confined to factories and work situations, "are today being recorded on city streets and, in some cases, in and around the home."

Despite efforts by several municipalities, including Madison, to curb excessive noise, city dwellers find themselves living in a seemingly boundless sea of din.

"Of greater importance is the fact that the nervous system automatically reacts to noises of even moderate intensities," remarked Dr. Jack Westman, psychiatry professor at the University of Wisconsin-Madison. "The emotional tone of the body is clearly affected by sound."

Westman explains that a function of the central nervous system is the "protective arousal of the body for fighting or flight" in response to loud noises. Sound levels produced by dishwashers, garbage disposers, and other appliances are sufficient to cause physiological responses. The increase in mechanized household aides over the last decade has given the kitchen the acoustical qualities of a boiler room at times," he said.

Westman referred to "an acoustical generation gap between high noise production of children and the low noise tolerance of adults . . . It is likely that human and machine-generated noise plays a significant role in robbing family living of pleasure and that the most neglected aspect of architectural planning in homes is sound control," he said.

Rural areas are not unaffected. EPA researchers found that farm children, subjected to the clamor of farm machinery, suffer from impaired hearing. Even the refuge of peaceful forests can become unbearable when a swarm of snowmobiles roar through the trees.

A recent study of noise effects on Wisconsin wildlife, the first such study in the world, indicates that animals are affected and increase their physical activity when snowmobiles operate in or near their normal home area. Sponsored by the International Snowmobile Industry Association, the study is an apparent response to public criticism of noise emitted by snowmobiles. According to Mechanical Engineering Prof. John Bollinger, one of the directors of the project, "Both rabbit and deer activity did increase. (But) just noise alone did not seem to bother them."

The study cautioned, however, "(It) could not be determined whether it was the noise of the machine or its physical presence that disturbed the animals. Answers to these questions are needed before conclusions can be drawn regarding the placement of (snowmobile) trails in the vicinity (of animals). The hypothesis tested in these studies has only been examined for short term effects," the report continued. "It is not possible to predict how the animals would behave after more frequent or lengthier exposures."

Don Beghin of the Department of Natural Resources outlined state regulations on snowmobile noise emissions. In 1971 state law set an 82 decibel noise limit on noise emissions for snowmobiles manufactured after July 1, 1972. State regulation also prevents purchasers from altering the muffler system on the vehicle. By July 1, 1975 snowmobile noise emissions cannot exceed 78 decibels.

"(Although) manufacturers claim that they cannot get it down that low, there is one (snowmobile) on the market that is down to 71," Beghin commented. An automobile traveling 60 miles per hour produces 60 decibels.

He also said that most of the recently enacted noise control laws are the first on the books. "Anything so far would be only preliminary."

Every level of government, though, has begun efforts to combat the encroachment of noise. Adopted by Congress October 18, the Noise Cmntrol Act of 1972 authorizes the following:

- •The EPA was given broad authority to establish noise levels for new motors and engines, and for transportation, construction, and electrical equipment.
- •The EPA will be required to conduct an extensive study of noise standards for aircraft and sumbit proposals.
- •Federal rules and regulations will override state and municipal laws. But power to regulate particular products will remain in local hands.

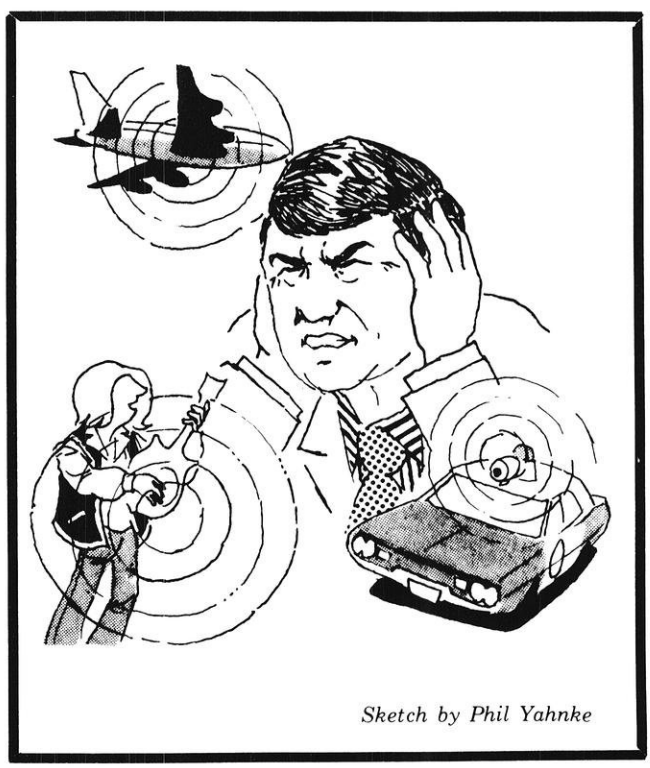
A Madison ordinance, sponsored by 10th Dist. Ald. Alicia Ashman and former 21st Dist. Ald. William Dries, sets forth detailed limitations on sound emissions. Passed in August 1971, the ordinance requires all equipment and vehicles sold after January 1, 1972 to comply with specified decibel levels, depending on time of day and zoning area of the city. Fines for non-compliance range from $10 to $500.

Ald. Ashman commented that administrative details are being worked on. Rather than make Madison retailers test noise producing products, she suggests that manufacturers list the decibel level on their products. Under the ordinance, efforts will be made to replace city-owned machinery with quieter machines as they wear out. She foresees stricter controls in the future.

Deputy City Attorney Larry O'Brian explained that enforcement of the ordinance has been on a very informal basis. The police department has relied on a complaint basis of enforcement. "They don't send patrols out looking for violations of the noise control ordinance," he said.

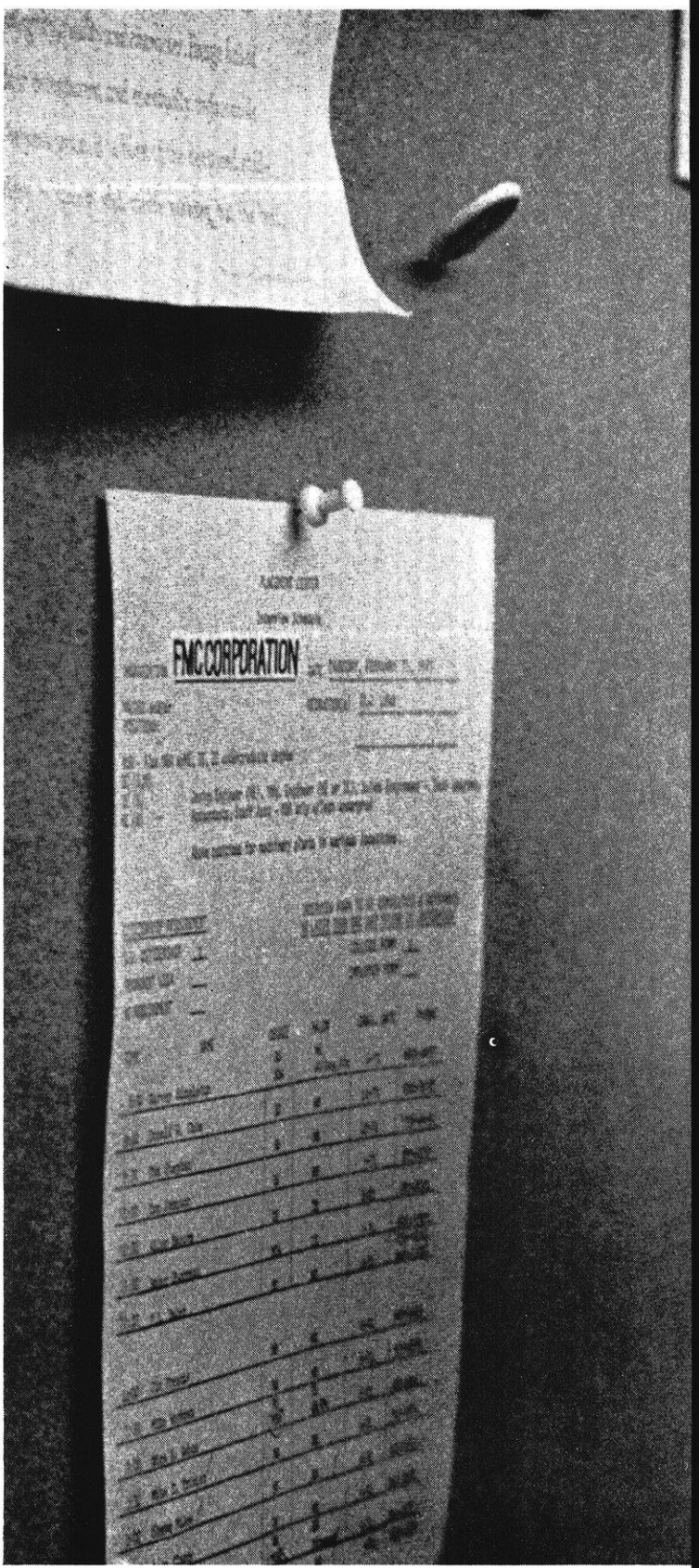
O'Brian indicated that shortcomings in the ordinance dampen its effectiveness in noise abatement. Decibel reading limits are based on municipal regulations from Chicago, New York, and Los Angeles. "The complaints received have been only on the levels that far exceed comfort," he said. "It may mean that the limits are too high."

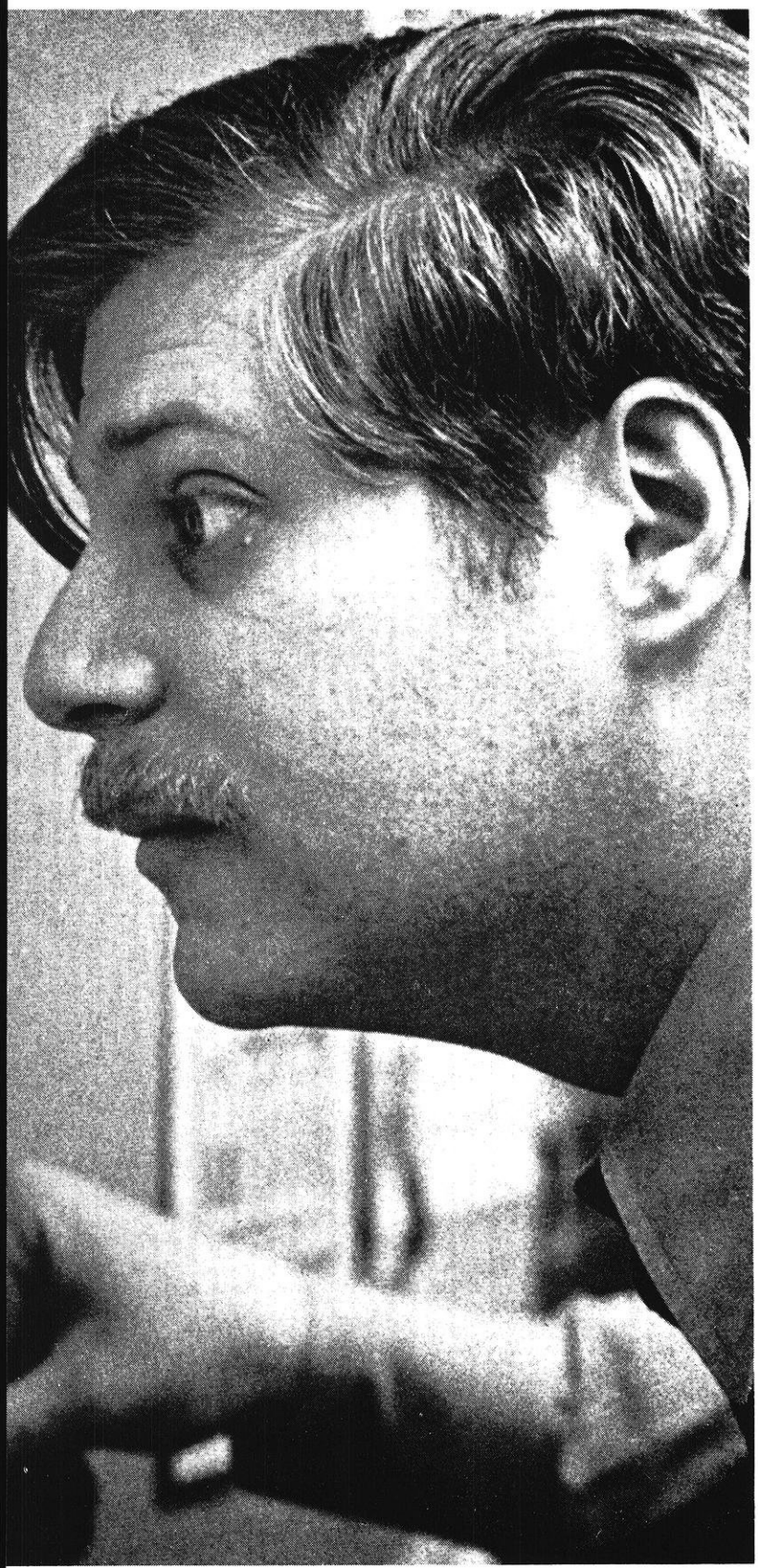
"Considering the cost of the (decibel) meters and their availability it is difficult to get engines tested." Madison has two meters. "I can't say the noise ordinance is doing a bang-up job. I'm not sure if it is," he added. "But the Madison council wanted a start. At least we got a foothold . . . no, I'll say a toe-nail-hold on the situation."



Sketch by Phil Yahnke

Don't let our name confuse you.





On some campus in the U.S. this year a well-intentioned interviewee is going to confuse us with the Foremost Machine Company or some other FMC.

We'll understand.

Having only letters for a name might be sophisticated in some circles.

But sometimes it's just plain hard to remember.

Perhaps we should explain how it came about.

FMC doesn't mean Ford or Foremost or anything else but FMC. Way back long ago it used to mean Food Machinery Company. And later on, it stood for Food Machinery and Chemicals.

But ten years ago, because of the variety of products we were making, we shortened our name to just our initials.

Today, we're doing a myriad of things in the broad areas of machinery and chemicals. FMC cranes and excavators are helping rebuild cities. And our sewage processing plants are keeping city pollution problems down. To help meet the energy crisis, our petroleum equipment is a vital factor in locating and transporting oil. And our food machinery and agricultural chemicals make major contributions to world food production.

Most of what we produce is not sold directly to the public, so our name is seldom visible. Worse, it sometimes gets confused.

So remember: FMC means FMC. If that still doesn't do it for you, write us at One Illinois Center, 111 East Wacker Drive, Chicago, 60601 for a copy of our annual report that tells all about us. Or see your placement director for an interview. We're an equal opportunity employer.

FMC

FOREIGN SCHOOLS ATTRACT STUDENTS

by Prof. Merton Barry

You don't have to join the Navy to see the world. The College of Engineering has several programs that provide opportunities to travel, study and work abroad. The oldest and best known, now in its 13th year, is the junior year exchange with Monterrey Tec in Mexico. A contingent of three Wisconsin students are now studying engineering subjects at Monterrey - one of the best engineering schools in Spanish-speaking America — developing language competence and learning what life is like in a different culture. During vacation periods, Tim Graves, David Iverson and Doug Matzke will have opportunities to travel elsewhere in Mexico in addition to picking up such extracurricular skills as guitar playing and bullfighting.

Europe also beckons, with opportunities available in France and Germany. Three students spent their junior year in Germany in 1972-)73, Walter Djordjevic at Munich and Jay Hecker and Reggie Duerst at Karlsruhe. Their local advisors at those schools were teachers who had previously been visiting professors on the Madison campus. This year Kurt Papke is pioneering a new exchange with the Ecole Centrale des Artes et Manufactures near Paris, studying electrical engineering.

Six students returned to the Madison campus this semester from summer jobs in Holland, and Finland which were arranged through the International Association for the Exchange of Students for Technical Experience (IAESTE). The work assignments under this program have varied from jobs with construction companies, as in the case of Jay Hecker, to government research institutes, as in the case of Tom Mathison, from on-line computer control research at the Technion in Israel (Tom Kern) to working with a weather satellite launch team for the European Space Research organization (George Bussey and Terry Hastreiter).

Professor Merton Barry
Director of Foreign
Programs in Engineering

For those interested in the other side of the world, a College of Engineering committee is now engaged in working out the details of a Master's level study program in Japan. Profs. R. B. Bird (Chem. Engr.) and Ed Daub (General Engr.) have authored a text in Technical Japanese to help students prepare for their year in Japan.

Most of the above programs, with the exception of some IAESTE ones, require competence in the local language of the country involved. Consequently the engineering student who wants to go off to see the world while pursuing his studies must make plans early in his college career to prepare himself. Many students can build on German, French, or Spanish they have studied in high school. However, there are other ways to increase language competence. Kurt Papke spent the summer in intensive study in Paris prior to enrolling at the Ecole Centrale for his engineering courses this fall. The Monterrey exchange students also spend a summer in Spanish language and culture courses in Mexico before their fall classes begin.

Engineering Foreign Programs also helps students from outside the U.S. with study arrangements. It currently has a Vietnamese student spending his fall semester in Paris, and an Iranian student has just completed a summer of liberal arts studies in Italy.

Students who have been on these foreign programs generally find their employment opportunities enhanced. Some of the jobs former participants have acquired as a result of their foreign experience include Head of the Department of Industrial Chemistry at the University of El Salvador, teaching in Bolivia, working with Mexican branch of Ford Motor Company and representing an international corporation in Central America and the Caribbean countries.

The gateway to these opportunities is at 439 Engineering Research Building, the Engineering Foreign Programs office, operated by Prof. Merton Barry. He reminds interested students that applications for the IAESTE programs must be made during the fall semester (by December 15) previous to the summer they hope to study abroad. Students with an academic average of B or better, who plan to participate in the French or German programs, should begin to make arrangements a full year in advance.

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Industrial Engineering Experiments With Senior I

by Jim Widmaier

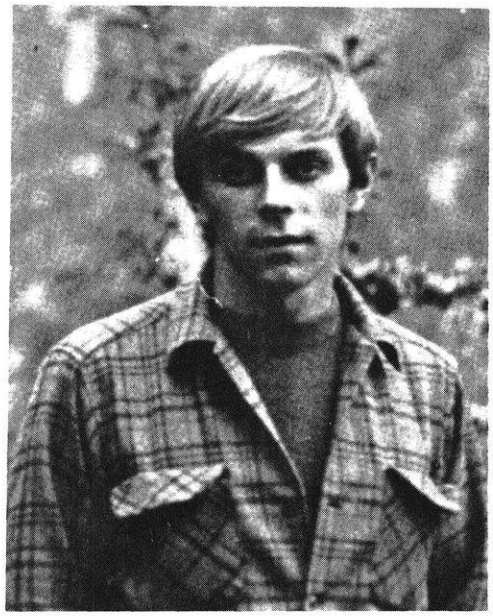
An experiment is being undertaken by the Industrial Engineering department at the University of Wisconsin to integrate three courses into one-12 credit package called "Senior I". The effects of this new learning organization will be compared with the standard isolated course situation presently utilized by most schools.

Senior I was initiated because of an increasing interest in problem or issue centered study, as opposed to the subject or technique centered study in common use, wherein four to six, unrelated courses are taken simultaneously. This system was originally devised to allow the student maximum choice and freedom. However, educational effectiveness is open to question.

Questions have been raised on the possible educational disadvantages of students taking 40 or more individual, unrelated courses. The lack of coherent threads tying the courses together and the competitive pressures of four or five courses each vying for the student's daily time and energy are both severe constraints on the productivity of the learning environment. Joseph Tussman in **Experiment at Berkeley** (1969) argues that these issues are the major impediment to learning in humanities during the first two years. His Experimental Program was one of the most extensive attempts to cope with these problems, although others had made earlier efforts. Tussman himself credits Alexander Meiklejohn's Experimental College at the University of Wisconsin in the 1920's for much of his inspiration.

Tussman offered an integrated set of studies, occupying ten credits of the student's time each semester, for the first two college years. This program was run for four years and appears to have been largely successful. Although few objective measures were made, Professor Tussman's experience, coupled with his astute analyses of faculty, student, and curricular problems, provided a strong argument for further experimental efforts on possible methods for the integration of course material.

In 1969, the University of Wisconsin's Department of Industrial Engineering set up a



About the Author

Jim Widamier is a senior in Industrial Engineering. Jim is a past National Vice-Chief of the Order of the Arrow of Boy Scouts of American, has co-oped at Johnson's Wax in Racine for the past two years, and is currently Regent of Theta Tau Professional Engineering Fraternity.

Curriculum Task Force to design, *de novo*, an industrial engineering curriculum. Tussman's ideas and their possible implementation were discussed at length. The final decision was to experiment with integration by taking three Industrial Engineering courses, taught in the Junior and Senior years and put them together into one, 12 credit course to be offered in the first semester of the student's senior year (Senior I). The first offering of this integrated course was in the fall of 1972.

In addition to the three courses integrated into one 12 credit package, the student was allowed the option of taking one or two other courses, approved by the Department.

The material presented in the 12-credit package was arranged by the participating faculty. The concern of the faculty was to present the material in a manner that showed the interrelationship of the subjects to be studied. Basically, each subject area is studied in a concetrated period of time with no interruptions or competition from other courses. After a given subject area is covered, the students are evaluated and a new topic is then presented. Knowledge gained from prior subjects is retained and can be effectively integrated into the study of a new subject area.

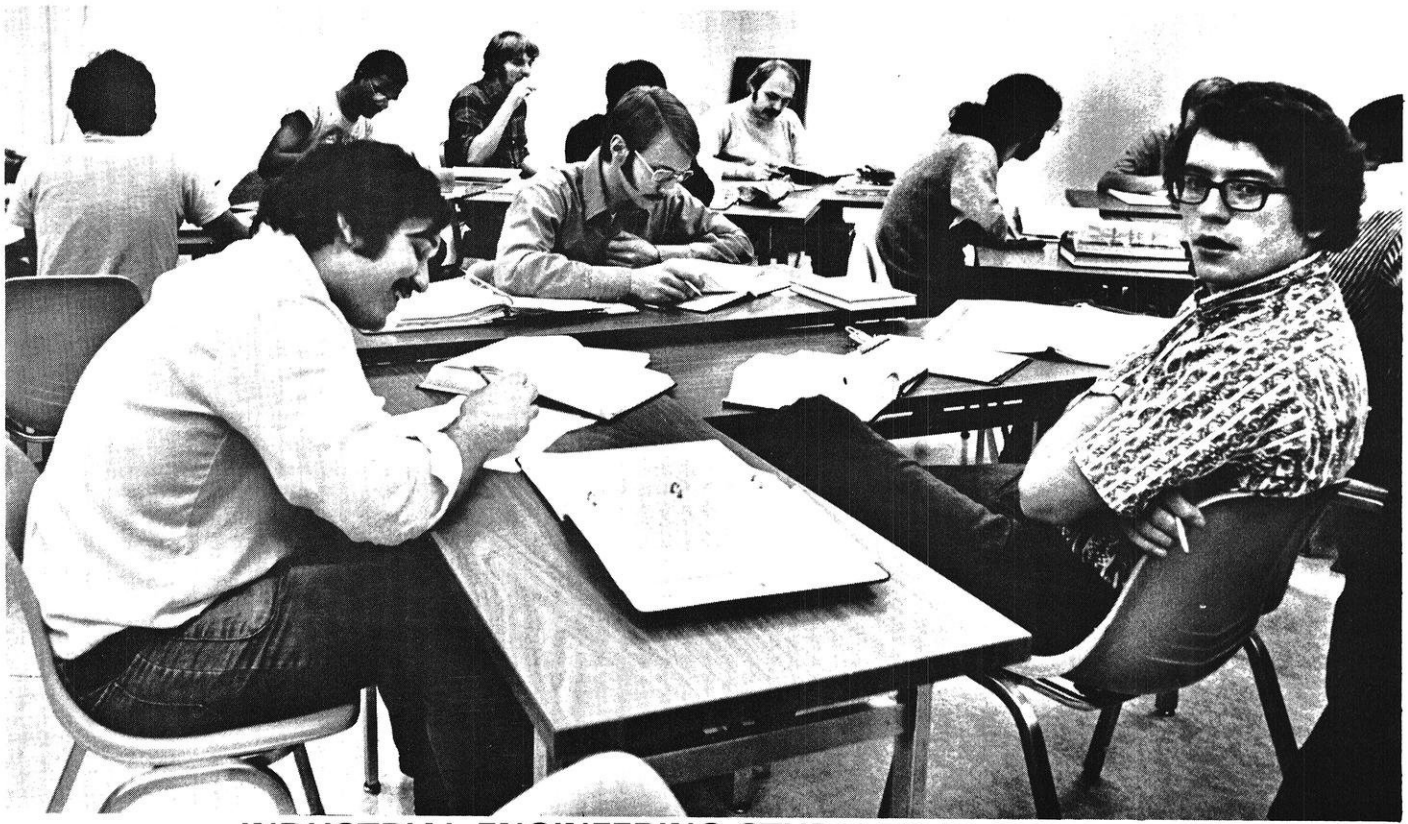
Only one classroom is used. To eliminate the stigmas of a single classroom environment, the students are able to design the interior of the room to meet their own needs. This cooperative effort is also evident in problem solving and general discussion of subject matters. Since each student has a common interest, there is no hesitation to share ideas and problems. There is also an informal student-professor relationship which gives the student the confidence to readily ask questions during and after a classroom day.

Since most of a student's week is devoted to the study of a single subject, from a single professor, there are few conflicts with specially scheduled field trips or speakers. Students in Senior I also are not faced with the mid-semester exam and final exam schedules that plague most students.

Frequent criticisms of B.S. engineering graduates center on their lack of abilities to integrate and apply the material "learned" and to communicate their results effectively. They have typically had little exposure to the selection of an attack on a problem as opposed to the process of the attack, once selected. One approach is a return to more "real world" design efforts. Many programs now include senior design courses and design at even earlier stages. Another approach is that outlined here; the integration of material from different "courses" while they are being taught. It may be true that Tussman's suggestions on the severe constraint caused by completing, unrelated courses is as true at the specializaiton level as in introductory material-possibly for different reasons.

Senior I, now in its second semester, has undergone an extensive evaluation to determine its effectiveness. Feedback from students of the Fall 1972 program, interviewed before and after their exposure to the program, was favorable.

If this project continues to indicate success in its new organization, it will be extended to other subject areas. The results of these efforts will be shared with other departments and schools as the successes and failures become more recognizable.



INDUSTRIAL ENGINEERING STUDENTS IN SENIOR 1

Special Report

Education

Social Studies Sponsored In Engineering

by Mary Stein

of the Engineer Staff

Engineering educators, aware of society's high level of consciousness of technological boondoggles, have been forced to "sell" their product to more students.

The Alfred Sloan Foundation, New York, has helped the University of Wisconsin-College of Engineering to the tune of $312,000. The money, in the form of a two-year grant, is funding research and course development between engineering, social science and humanities.

Professors in the three areas spent the summer in research and have come up with several new courses to embellish second semester's timetable, offered to junior, senior, and graduate students in engineering and corresponding social science and humanities majors.

"Because these seminar-type classes have a limit of 20, interviews will be given to determine a student's qualifications for the courses," said Prof. Ed Daub, one of the administrators of the grant.

Howard Harrison, Mining and Metallurgy professor, and another coordinator of the grant, said that developing the social conscience of the engineer was nothing new "This increasing emphasis on the professional responsibilities of knowing the law and other areas besides engineering, has been shown, for example, in the mood of Congress," Harrison said.

The trend is subtle however, in teaching the engineer that we don't have to use all available technology, but chose the best amongst it to benefit society," Harrison added.

New courses include:

- Technology and Law, taught by Prof. Wayne Milestone, Mechanical Engineering, and John Kidwell, Law School: examing products liability, effective ways to legislate, etc.
- Energy and Society, taught by Profs. Wesley Fell, Nuclear Engineering, and Charles Chicetti, Economics; exploring energy resources and needs in the United States.
- Institutional Alternatives to Handling Public Goods, taught by Charles Faulkner, Nuclear Engineering, and Martin David, Economics: studying problems of solid waste disposal and whether public or private utilities are best for a community.
- Socio-Economic Problems in Bio-Medical Engineering, taught by Profs. Ted Berstein, Electrical Engineering, and Ken MacNeil, Sociology; examing the development of machines and standards of operation and the impact on health.
- Case study: Effects of Air and Freight Transport on Communities, taught by Profs, Harrison, and Ken MacNeil.
- Technology and Philosophy, taught by Profs. Daub, and Gary Young, Philosophy; exp;oring philosophy; exploring philosophical problems raised by technology, the difference between science and technology; and asking whether there is a technological world view?
- History of Technology.
- Technology and Arts.
- Technology and Literature in the 19th and 20th Century.

A new course, offered this fall called Man, Science, and Society, only drew 11 students, which disappointed Daub. But he said that the introductory overview course will be offered again this spring.

Whether or not the program will continue, will be seen when the Sloan funding ends. Daub said some professors in the engineering college were skeptical about the program but others had generously volunteered to work on the project.

Professors in the social sciences are compensated for half of their salaries for time spent away from research in their own departments. Engineering faculty are compensated one-fourth their salaries from the grant, and the departments donate the other one-quarter. In addition, each course will have a project assistant from both disciplines.

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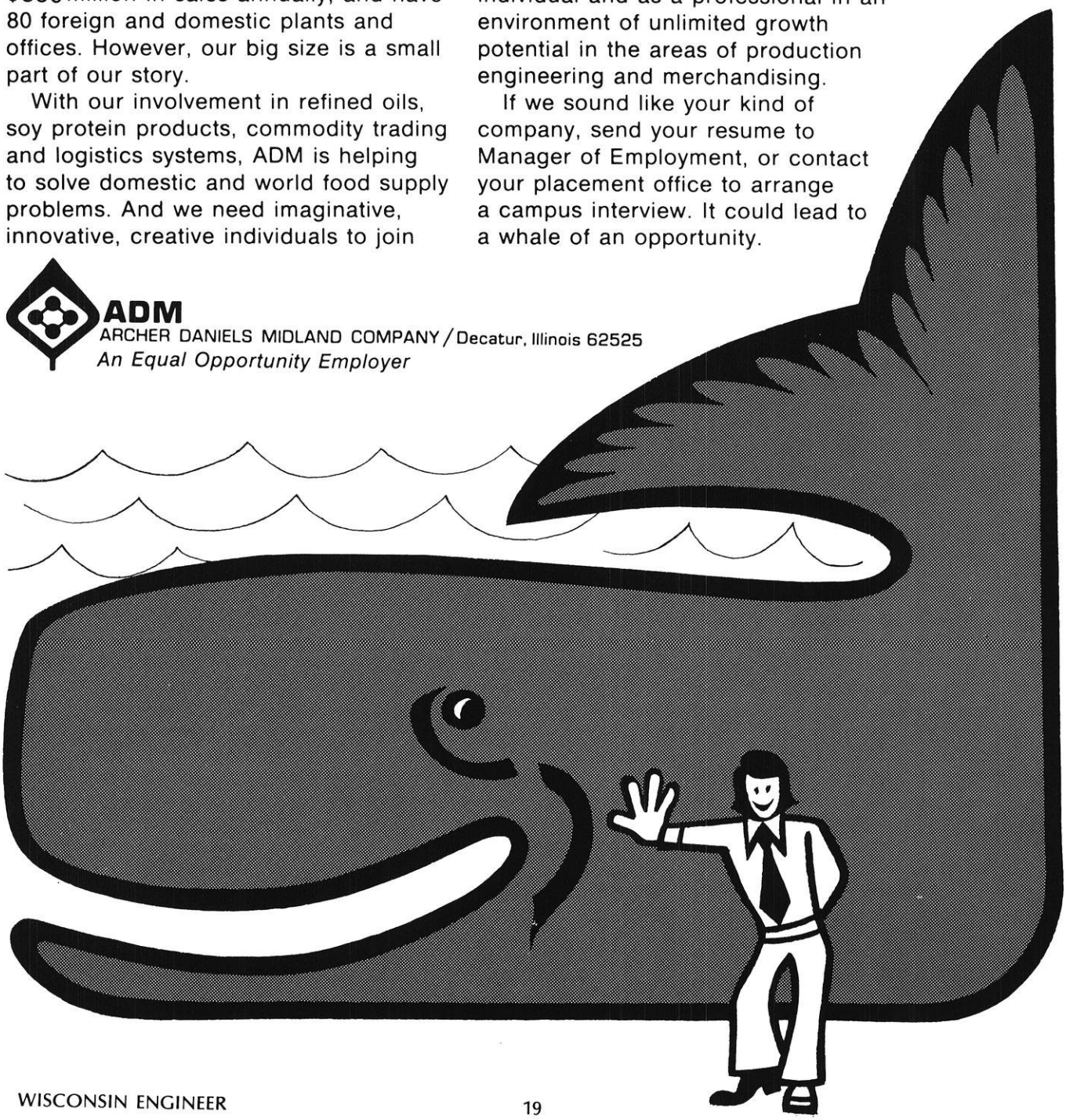

Engineers Adopt Nurses in Co-ed Dorm

by Jeanne Fisher

Here is our heroine racing from the scene of the crime. It all started when the cry of "Come on girls, let's start our own panty raid!", echoed from the halls of Cole where the women were ready to retaliate.

Women's Lib was off and running as about five females descended on Jones House, a men's residence. It didn't take long before the guys wanted to get into the act, and before you could say "jock strap" a rowdy crew had assembled in the courtyard. Brimming water buckets were appearing from everywhere and anyone within range was getting soaked.

Our heroine was an innocent bystander from another dorm who only wanted to investigate the commotion. But her admirable motives were misconstrued and soon the thundering herd was after her also. With the water bucket brigade at her heels, our heroine headed for the protection of the men she lives with in Gilman House.

But before you find out what happened to our heroine, you're probably dying to know what makes Gilman House so special. Starting this fall, Gilman became the only co-ed dorm at Lakeshore and the first to house engineers and nurses under the same roof.

The rationale, explained College of Engineering Associate Dean Fred Leidel, was that both nurses and engineers have to take math and chemistry and they could help each other with their homework. So far the arrangement seems to be working out very well. There are 28 women living on the third floor and 50 men on the first and second floors combined. This arrangement serves as a natural security measure.

In fact, the only unwanted guest who has made it to the girls' floor was a wily raccoon. His hideout in a wastebasket was discovered at 3 o'clock one morning by a resident who evidently was not a raccoon fan. Her screams prompted Patrick Madden, House Fellow and self-appointed big game hunter, to remove the little critter from the premises.

Even on a normal day, Gilman House is certainy not dull. Myths about engineers and nurses are quickly debunked when you walk in the front door. Live music travels up the stairs from the basement where a band is practicing. Doors are wide open and students are socializing in the boldly designed blue, orange and white hallways. There are no stereotypes, just friendly people. John Frost, president of the house, says that there's a family feeling here. A nurse comments that living in Gilman is like having a lot of brothers.

Gilman has a unique form of self government. Hall Advisor Dave Mills explained that three committees run the show: the Social and Academic Committees have obvious functions, and the Welfare Committee covers maintenance. It's handy to have your own live-in engineers when something needs fixing.

There is a lot of group participation in Gilman whether it's setting up a party, expanding the downstairs library, participating in intramural sports, or planning to build a sauna. House Fellow Pat is very pleased with the co-ed situation. "The girls add a human side to the house", he said. "It's almost more of a club than just a place to live."

By the way, our heroine made it home alright. The bucket brigade was unable to get past the strong defensive line of the Gilman House males who guarded the doorway. Women's Lib or not, it's nice to have a man around the house.

Engineering Organizations Plan Semester Activities

ASMI

The purpose of the ASME Student Section is to promote the profession of Mechanical Engineering on the student level. Monthly student meetings are held during the noon hour with lunch provided for members. A short business meeting is followed by a presentation. Past presentations have been in the areas of ecology and animal life, highway safety and computer analysis of machine elements.

To familiarize the students with engineering in the industry, plant trips are arranged. For this year, some of the industries under consideration are; Allis-Chalmers in Milwaukee, Madison Gas and Electric and Oscar Mayer in Madison.

Student membership costs $5.00 per year. This includes a subscription to Mechanical Engineering magazine and other benefits. Membership packets can be obtained from the ASME office or from Professor Feiereisen, faculty advisor.

SAE

The Society of Automotive Engineers, seeks to proide a link between the engineering student and the industry. Business meetings are held monthly after which a program, usually of a professional nature, is presented. At their first meeting, SAE heard Kris Kubly talk of his racing experiences as part owner and builder of an A-Production Corvette which has competed in Trans-Am races.

A survey of the members at the first meeting revealed a strong interest in emmission control, Wankel and stratified charge engines, Sterling cycle engine, vehicle safety, and vehicle test procedures. Possibilities for plant trips to American Motors and the General Motors Assembly plants generated interest also. Other plans include the semi-annual SAE Gymkhana, held on Sept. 29, and the annual Student night trip to the Milwaukee section meeting Oct. 4.

Kappa Eta Kappa

Kappa Eta Kappa, which is celebrating its fiftieth anniversary this February, is a social-professional organization for electrical engineering students at the U.W.-Madison.

Our house is located at 114 N. Orchard St., one block from the engineering campus. Most of the members live in the house, but membership does not require it. All the members enjoy many benefits which the organization has to offer.

Basically, we strive for scholastic achievement. However, our activities include a variety of social events, work projects, engineering and community projects. Many of the E.C.E. faculty have accepted honorary membership in Kappa Eta Kappa. We have informal get-togethers and formal banquets. This is one way for members to become better acquainted with the professors.

In addition to these activities, we find time to devote to other areas. For example, we operate an amateur radio station located at the house. The station is at the disposal of any member who obtains an F.C.C. license.

We enjoy our college days here at Kappa Eta Kappa and believe that this organization can truly enhance the educational and social life of the electrical engineering student. After all, we've had 50 years of practice.

ASCE

The purpose of the American Society of Civil Engineers is to help the student prepare himself for entry into the profession. Programs are presented bi-monthly featuring professionals in various branches of Civil Engineering. On Sept. 19, Prof. Johnson gave a descriptive talk on plastic structures, and on October 10, Mr. John Rinne, National President of ASCE gave an interesting talk entitled "Opportunities Unlimited".

The Madison student chapter has plans for future meetings on October 24 November 14. Mr. John Rogers from Gates and

Rogers Construction Company will speak on Civil Engineering in Construction. The November meeting will be an informational meeting about graduate studies in Civil Engineering.

AIChE

The University of Wisconsin Student Chapter of the American Institute of Chemical Engineers is the fourth oldest student chapter in the United States. It was established in June, 1925 with the object of "...fostering of the interests of students in Chemical Engineering and the promotion of their welfare as prospective members of the profession."

The AIChE holds monthly meetings at the Union South. A short business meeting is followed by a speaker who will make a presentation on a topic of current interest. Free refreshments are served at the end of the meeting. Other activities such as field trips and orders of Perry's *Chemical Engineers' Handbook* at reduced prices are sponsored.

Membership in the AIChE is a good way to meet other students and faculty members. If you are interested in becoming a member or would like to be notified about our next meeting call Ron Holten at 255-2023.

Theta Tau

Now in its 51st year as a campus organization, Theta Tau National Engineering Fraternity is serving as a valuable alternative for the social and professional development of its members. In addition to their educational concerns, each member recognizes the importance of a professional organization and they have been able to integrate its program into their active schedules.

Each semester, a new membership program is initiated and all interested engineering students are invited to visit the chapter house and learn about Theta Tau. Membership is open to students in all engineering fields.

A brief orientation program must be completed before full membership is attained. During this period a prospective member is acquainted with the social and professional activities which include: beer suppers, parties, plant trips, guests speakers and participation in various intramural sports.

The chapter house is located at 1633 Monroe St., just four blocks from the engineering campus. Theta Tau invites all engineers to visit the chapter house and to participate in its professional development program.

INTERVIEWING OPPORTUNITIES

MONDAY, OCT. 15
American Oil — Amoco R&D
Amoco — RT&E
Armco Steel
Battelle Columbus (1 of 2)
Bechtel (2 of 2)
Borg Warner-Roy C. Ingersoll Res. Cntr.

Celanese (1 of 3)
Clark Dietz & Associates
Cummins Engine
Nekoosa Edwards
Ohio Dept. of Transportation
St. Regis Paper
Std. Oil of Indiana (1 of 2)
TUESDAY, OCT. 16
American Can (1 of 2)
Babcock & Wilcox
Bell Telephone (1 of 3)
Chicago Bridge & Iron
Dow Chemical (1 of 2)
Exxon Corp. (1 of 3)
Leeds & Northrup
WEDNESDAY, OCT. 17
Arthur Anderson
Bell Telephone (2 of 3)
Dow Chemical (2 of 2)
Engelhard Minerals & Chemicals
Exxon Corp. (2 of 3)
Gates Rubber (1 of 2)
Indiana Dept. of Nat. Resources
Material Service
Shure Bros.
Wisconsin Electric Power (2 of 2)
THURSDAY, OCT. 18
American Electric Power
Cleveland Cliffs Iron Co.
Exxon Corp. (3 of 3)
Falk Corp.
Globe Union Inc.
B. F. Goodrich
Honeywell Inc. (1 of 2)
National Steel Corp.
Northern States Power
FRIDAY, OCT. 19
American Hospital
Beloit Corp.
Commonwealth Edison
Honeywell (2 of 2)
I.B.M.
Illinois Div. Water Resources
Illinois Tool Works (2 of 2)
Marathon Electric
Penn Controls
Wisconsin State Government
U.S. Federal Highway
MONDAY, OCT. 22
Atlantic Richfield (1 of 2)
DuPont (1 of 5)
Eastman Kodak — PhD —(1 of 3)
Johnson Service
Raytheon Co. (1 of 2)
Republic Steel (1 of 2)
Square D Co. (1 of 2)
Texas Instruments (1 of 2)
West Bend Co.
TUESDAY, OCT. 23
Allen Bradley
Atlantic Richfield (2 of 2)
Deere & co. (2 of 2)
DuPont (2 of 5)
FMC — Northern Ordnance
Raytheon (2 of 2)
Swift & Co. — Globe Engr. Div.
Texas Instruments (2 of 2)
UCC — PhD's
U. S. Patent Office (1 of 2)
N.S.A. (1 of 2)
WEDNESDAY, OCT. 24
American Appraisal (1 of 2)
CTE Automatic Electric
Deere & Co. (2 of 2)
DuPont (3 of 5)
Eastman Kodak (1 of 2)
Goodyear Tire (1 of 2)
Mobil Oil Corp. (1 of 2)
PPG Industries (1 of 2)
Union Oil of California
U. S. Patent Office (2 of 2)
THURSDAY, OCT. 25
Boeing Co. (1 of 2)
DuPont (4 of 5)
Eastman (2 of 2)
Ford Motor Co. (1 of 2)
Goodyear (2 of 2)
N. L. Industries
Pioneer Services & Engr.
Texaco Inc. (1 of 2)
FRIDAY, OCT. 26
The Ansul Co. (2 of 2)
Boeing Co. (2 of 2)
Cargill
DuPont (5 of 5)
Eaton
Ford Motor (2 of 2)
Outboard Marine
Texaco (2 of 2)
Underwriters Labs
Action/Peace Corps/Vista (5 of 5)
MONDAY, OCT. 29
Ethyl Corp. (1 of 2)
General Telephone
Hanilton Standard
Hughes Aircraft
3M Co. (1 of 5)
Newport News Shipbuilding
Northwestern U. School of Law
Shell Companies (1 of 3)
Shell Development (PhD) Texas
Std. Oil of California (1 of 5)
U.S. Steel Corp.
TUESDAY, OCT. 30
Allis Chalmers Corp. (1 of 2)
Burroughs Corp.
Charmin Paper Co. (1 of 2)
Ethyl (2 of 2)
Ladish Co.
Milwaukee Road
3M Company (2 of 5)
Shell Companies (2 of 3)
Std. Oil of California (2 of 5)
Warner & Swasey Co.
U. S. Medical
WEDNESDAY, OC. 31
Allis Chalmers Corp. (2 of 2)
Archer Daniels Midland (1 of 2)
Charmin Paper Co. (2 of 2)
Dow Corning Corp. (2 of 3)
General Foods (1 of 2)
Lawrence Livermore
3M Co. (3 of 5)
Shell Companies (3 of 3)
Std. Oil of California (3 of 5)
THURSDAY, NOV. 1
Archer Daniels Midland (2 of 2)
Dow Corning Corp. (3 of 3)
General Electric (1 of 2)
General Foods (2 of 2)
Hercules Incorp.
Std. Oil of California (4 of 5)
FRIDAY, NOV. 2
Air Products & Chemicals
Combustion Engineering
General Electric (2 of 2)
Heil Co. (2 of 2)
Rockwell International
Std. Oil of California (5 of 5)
Wisconsin Power & Light Co. (2 of 2)
Youngstown Sheet & Tube
MONDAY, NOV. 5
U. S. Navy (1 of 3)
TUESDAY, NOV. 6
U. S. Navy (2 of 3)
WEDNESDAY, NOV. 7
U. S. Navy (3 of 3)
FRIDAY, NOV. 9
Northwestern U — Grad School of Mgmt.
MONDAY, NOV. 12
NOAA — Env. Res. Labs
U. S. Marines (1 of 2)
THURSDAY, NOV. 15
Loyola University

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[1]All power measurements taken at 120 volts/60 cycles, 8 ohms, 20Hz-20kHz, all channels driven simultaneously.
[2]Manufacturer's suggested list price which may be higher in some areas.

If you're in the market for four channel, you already know you've got to spend a good bit of cash for a receiver. So it'd be a good idea to spend a good bit of time checking specs on everything available just to make sure you get the most for your money.

To make your search a little easier, we've prepared the blank comparison chart above with spaces for some of the best-known brands and most important specs. Just take it with you to the store, fill it in, and you'll be able to tell at a glance what you get for what you pay.

We took the liberty of filling in the Sylvania column with specs for our RQ3748 four channel receiver. We did it because we know we're not the best-known name in four channel, and we didn't want you to overlook us for that reason.

Because we think the RQ3748's specs are really worth remembering.

50 watts of RMS power per channel at 8 ohms, 20-20kHz, with all four channels driven. 125 watts per channel in stereo bridge mode. A THD and IM of less than 0.5% at rated output. An FM sensitivity of 1.9 microvolts. A discrete four channel receiver with matrix capabilities so you can use either type of quadraphonic material. And much, much more.[3]

We can offer so much because we have so much experience. We were one of the first in the audio field. And now we're applying all our knowledge, all our engineering skill to four channel.

Once you've proven to yourself which receiver has the best specs, move on down to that last line in the chart and compare Sylvania's price with all the others. Find out which one gives the most for your money.

We feel pretty confident you'll discover that the best-known names aren't necessarily your best buy.

[3]So much more that it won't all fit here. So send us a stamped, self-addressed envelope and we'll send you a four-page brochure on our four channel receivers.

GTE SYLVANIA

Sylvania Entertainment Products Group, Batavia, N.Y.

Now that you've decided to be an engineer, how do you decide what kind?

Trying to figure out the exact kind of engineering work you should go into can be pretty tough.

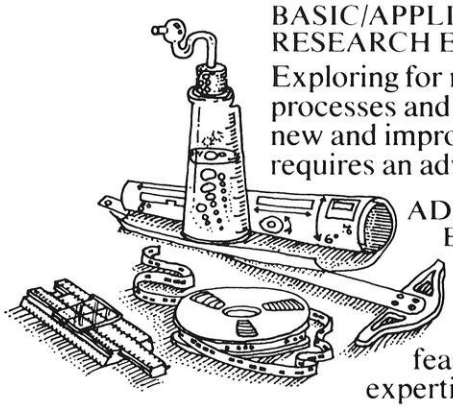
One minute you're studying a general area like mechanical or electrical engineering. The next you're faced with a maze of job functions you don't fully understand. And that often are called different names by different companies.

General Electric hires quite a few engineers each year. So we thought a series of ads explaining work they do might come in handy. After all, it's better to understand your options before a job interview than waste your interview time trying to learn about them.

Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

This ad is a brief outline of the most common engineering functions at GE. In future ads we'll cover individual functions in more detail.

Development and Design



BASIC/APPLIED RESEARCH ENGINEERING
Exploring for new materials, processes and systems for making new and improved products. Usually requires an advanced degree.

ADVANCE PRODUCT ENGINEERING
Thinking up ideas for new or improved products, then proving their technical feasibility. High technical expertise required.

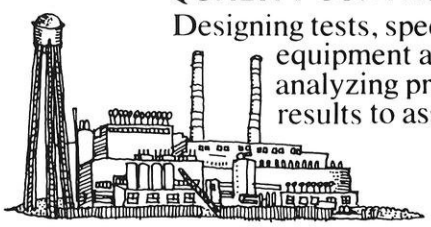
PRODUCT DESIGN ENGINEERING
Transforming the product idea into a design that meets given specs and can be manufactured. Following through to production.

ENGINEERING MANAGEMENT
Planning, organizing and supervising engineering work in a product business or project operation.

Manufacturing

MANUFACTURING ENGINEERING
Planning exactly how a product will be manufactured. From consulting with designers to creating tools and machinery to planning production flow.

QUALITY CONTROL ENGINEERING
Designing tests, specifying test equipment and procedures, analyzing production test results to assure product quality.



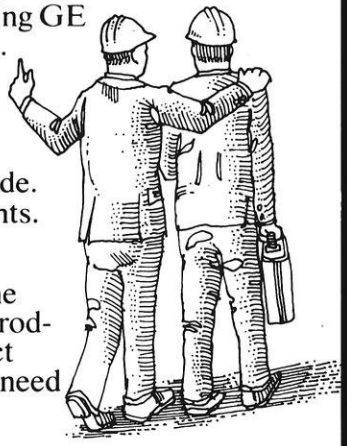
FACTORY MANAGEMENT
Supervising a factory's people and machines. Making sure all the many elements run smoothly.

MATERIALS MANAGEMENT
Designing materials flow systems to make sure vital parts and materials are at the right place, at the right cost, at the right time.

Sales and Service

SALES ENGINEERING
Identifying the needs of GE's utility, industrial and governmental customers and recommending the products and services to fill them.

APPLICATION ENGINEERING
Analyzing special equipment needs of customers, then specifying GE products and systems to fit.



FIELD ENGINEERING
Installing and servicing large machinery systems for GE customers worldwide. From motors to power plants.

PRODUCT PLANNING
Marketing. Determining the need for new or modified products. Making sure a product line offers what customers need at competitive prices.

GENERAL ELECTRIC

An Equal Opportunity Employer