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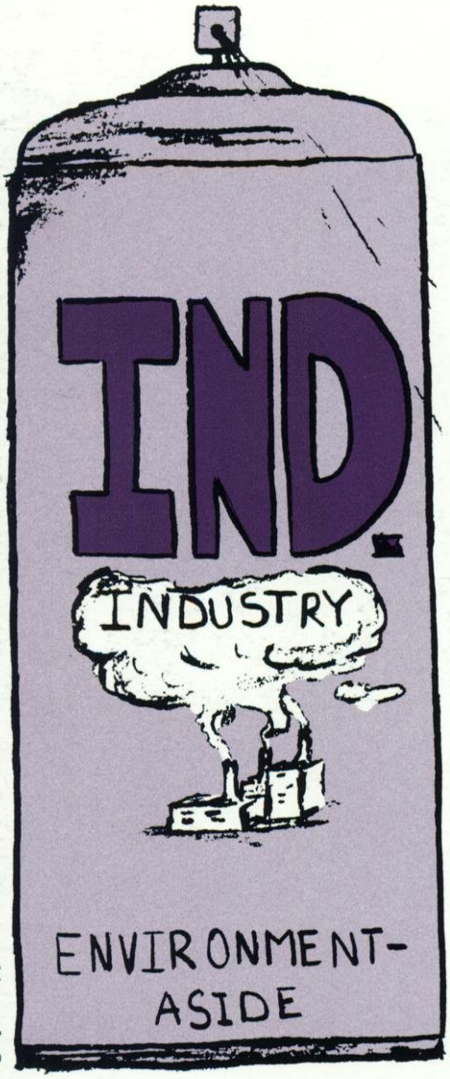
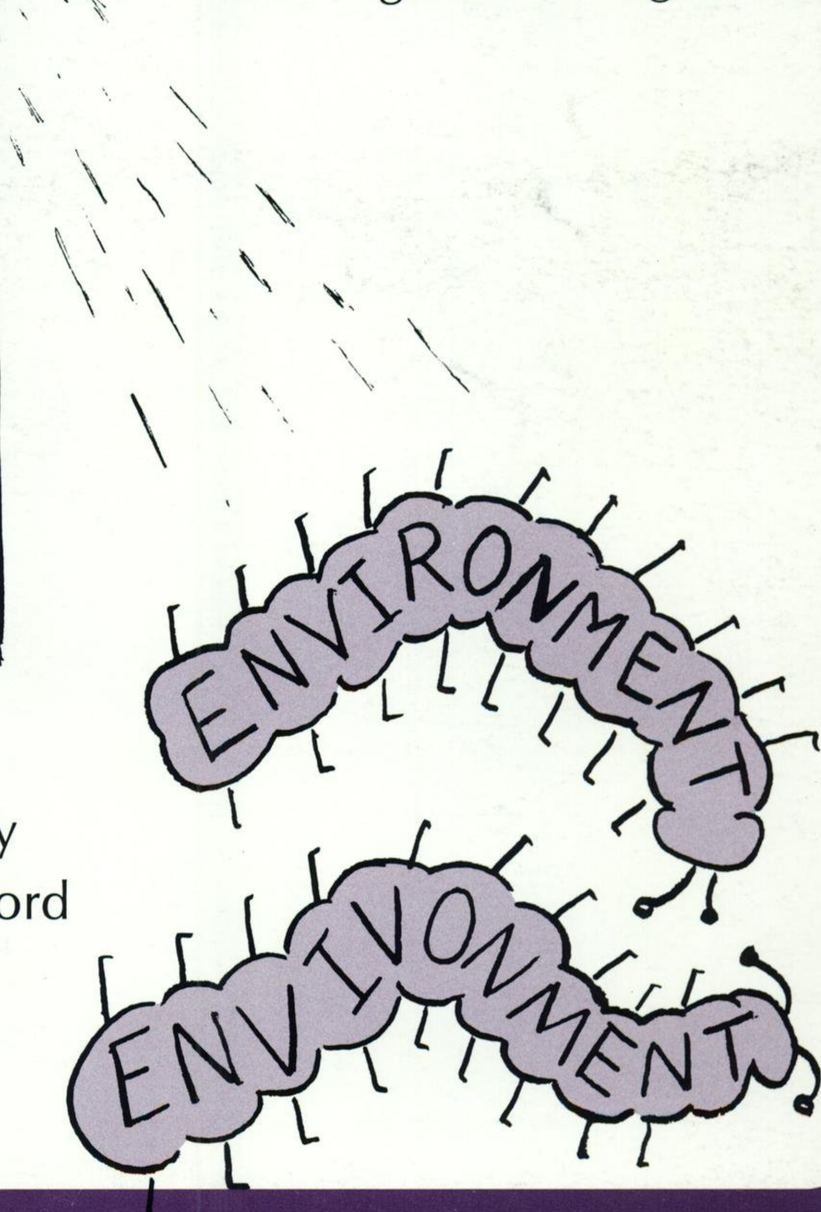


graphic by John Tucker

The Fight Continues

- Environmental Extinction?
- Garbage becoming Gold



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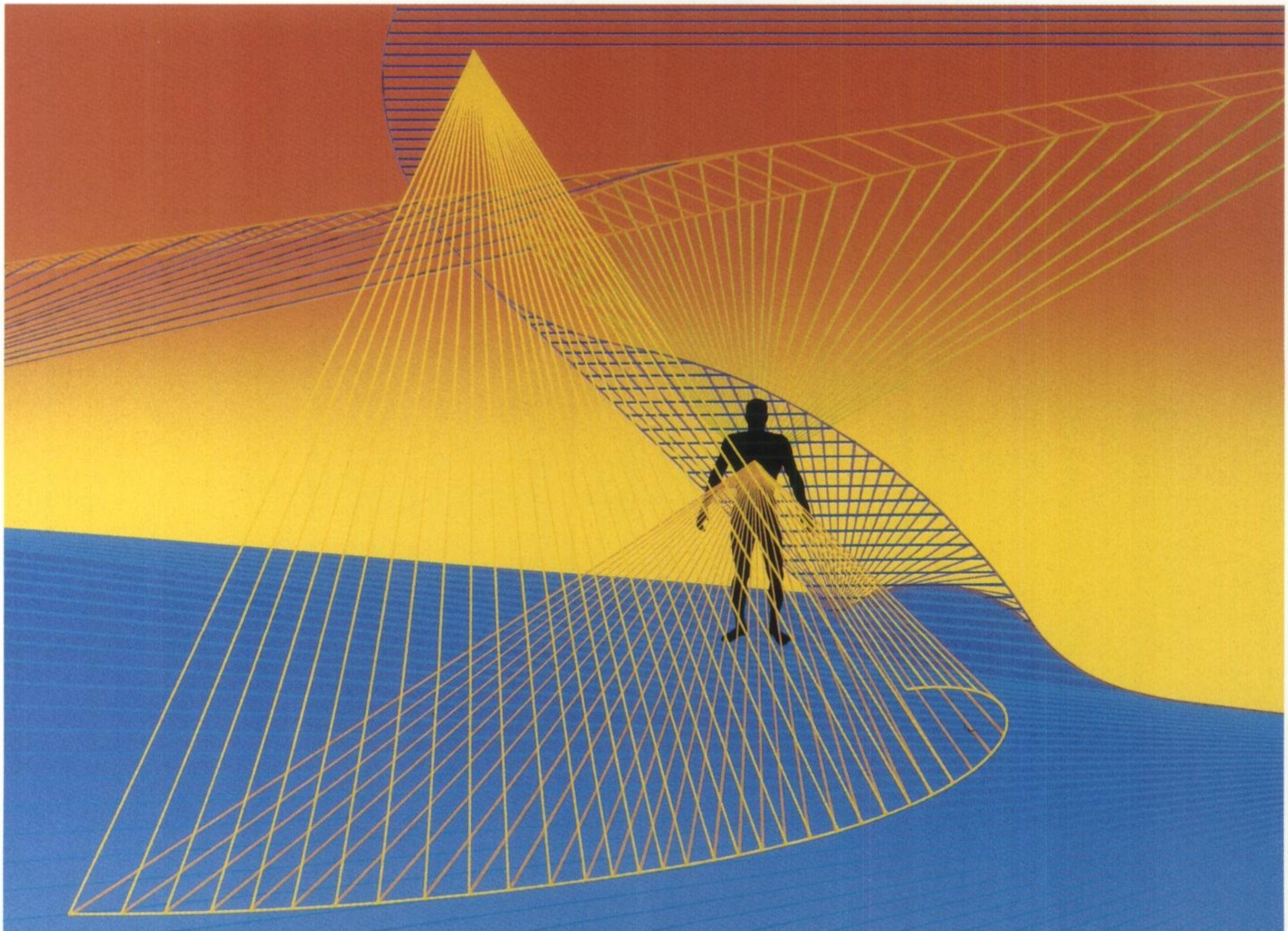
- Biotechnology
- Reagan's Record



wisconsin engineer

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COLUMNS

ENVIRONMENTAL FEATURES

ADDITIONAL FEATURES

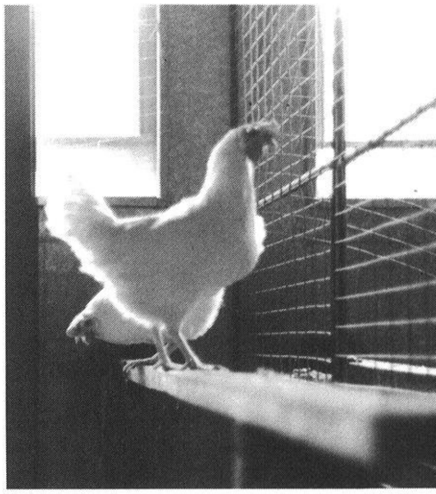

photo by Gary Webster

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The **Wisconsin Engineer Magazine** is published by and for engineering students at UW-Madison. Philosophies and opinions expressed in this magazine do not necessarily reflect those of the College of Engineering. All interested students have an equal opportunity to contribute to this publication. **Charter Member of the Engineeing College Magazines Associated. Chairperson:** John N. Clausen, Mechanical Engineering Building, University of Minnesota, Minneapolis, MN 55455. **Publisher's Representatives:** Littell-Murray-Barnhill, Inc., 1328 Broadway, New York, NY 10001 and 221 North LaSelle Street, Chicago, IL 60601.

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Lakewater
CIA on Campus

by Paul A. Stone

Wednesday, October 30, 1985: It was a rough day from the start. I was already fifteen minutes late to my 7:45 class, and being stopped by three policemen as I walked into the engineering building certainly didn't make things any better. I knew why they were there, however: the CIA was recruiting in the Engineering Placement Office. After convincing them that I was one of US (ie, an bonafide engineering student), they finally allowed me to go to class.

As the day fought off the morning, the situation grew more intense. Security increased, and tension was in the air. I returned to do some lab work after lunch and was again met by security guards. An antagonist from the demonstration was also at this entrance; he was lecturing the security guards on the CIA's involvement in Central America. It was undoubtedly an interesting discussion, but I had a lot of work to do on the other side of that "placement-office county line". Finally my adviser walked by and vouched for me. This place was beginning to feel like a prison!

As I worked on my lab, I heard the demonstrators outside becoming quite vocal: "CIA out of Nicaragua!"was chanted and exhibited on signs. About 1:30 an officer came by and informed us that a bomb threat had been made for 2:00. At this point, I considered my alternatives:

1) continue to work on my lab (which may be my last if I do);
2) go to the union and be sociable;
3) join in the demonstration.

I decided to compromise by going to talk to some of the demonstrators on my way to the union. After doing so, I came to some definite conclusions.

Although I respect the protests against the CIA's covert operations in Central America, the demonstrators are way off base on the recruiting issue. I am of this opinion for two reasons: First, intelligence is a necessary and important part of any sucessfully functioning government. As such, it must have educated, responsible people working for it. Secondly, a student should have the opportunity to discuss potential employment with any prospective employer. It should be the individual student's choice whether or not to interview with an employer.

A protest against the CIA's operations in Central America is fine; let's march to the Capitol. However, there is no basis for a protest at the Engineering Placement Office. Bomb threats are just plain stupid. The rally was not only disruptive to the CIA's recruiting efforts, but to those of other companies as well. All of the interviews scheduled for that afternoon were cancelled due to the protest. This denied some engineering students of the opportunity to interview with companies other than the CIA; in short, it may have cost them a job. In addition, the rally cost every company here a great deal of both time and money.

Let the CIA recruit on campus. They have a right to do so, and any student has a right to talk with them. Next year, I hope things are different.

Paul A. Stone, Editor

Written response is welcome.

Editor's Notes

Campus Media

The campus media's (ie, the Daily Cardinal's) coverage of the CIA rally was completely biased. They incorrectly emphasised the physical force used by police to keep the demonstrators in hand, and neglected the fact that the police were doing their job: maintaining order. The demonstrators were the antagonists; the police were not. Bomb threats and verbal abuse do not lend themselves to kind treatment in return. These points were not evident in articles in the daily newspaper on campus.

This Issue:

In the late 1880,s, England was poised on a precipice in time. Beginning at that time, radical social and economic changes were brought on through extensive modernization of production facilities: The Industrial Revolution was born.

Since then, the environment has been battered in the course of industrial and technological advancements. With increased and diversified industrial capacity, the problems of pollution and industrial waste became more and more intense. Today, we are faced with many serious environmental concerns: acid rain, spent nuclear fuel, chemical wastes, daily refuse, etc. ... .

Recently, we have begun to recognize that these problems do exist. Technology is finally becoming a force in correcting and eliminating them, rather than causing them.

In this issue, the WE looks at our environmental concerns and considers the efforts of technology in dealing with them.

Opportunity

While going through the tons of mail on my desk, I came across an outstanding opportunity to do something a bit out of the ordinary: Environmental conservation jobs are available for every season in 1986 through the Student Conservation Association, Inc. Volunteers are needed to serve for 12 weeks in professional resource management positions at over 75 national parks, national forests, and other conservation areas. Locations include, for example: Denali National Park in Alaska, Flathead National Forest in Montana, Bureau of Land Management near Moab, Utah, and Everglades National Park in Florida.

If you're interested, send a postcard requesting the "1986 PFRA Program List" and an application to the Student Conservation Association, PO Box 550C, Charlestown, NH 03603, or call for the same materials at (603) 826-5741.

Why not GO FOR IT ?!?

Dean's Corner

by John G. Bollinger
Dean, College of Engineering

Many students have asked about the standard of education in our College of Engineering compared to other institutions. My personal opinion is that the quality of the instructional program here at the University of Wisconsin - Madison ranks with the best engineering colleges in this country. I believe I can illustrate why I think this is the case by pointing out a number of qualitative and quantitative measures of the quality of education.

First and foremost in my mind is the quality of the faculty. In Engineering, it is important to have faculty who are good teachers, faculty who are active in their profession, and, in a research institution like ours, faculty who are actively engaged in indepth research programs in their fields of endeavor. I think most of you will agree that we do have some outstanding teachers on our faculty. I hear this from alumni as they reflect on their years of study here at Wisconsin, from the students who come to see me, from the faculty's participation in student activities, and from the awards that they are given by students, the College, the University, and professional organizations. Student evaluations of the teaching performance of our faculty are generally good, and when they are not, an effort is often made to correct the reasons why they are not.

"The quality of the instructional program at UW - Madison ranks with the best engineering colleges in this country." — Dean Bollinger

One way to assess the performance of an engineering college is to review the statistics published in *Engineering Education*, the journal of the American Society for Engineering Education. The March 1985 edition reflects some important facts. Among the Big Ten schools, the College of Engineering in Madison is fifth in size in terms of number of faculty and the number of undergraduate and graduate students enrolled. The report shows on the other hand that our school ranked second in the amount of outside research funds raised by the faculty in support of our research program. Madison ranked third in the number of Bachelor of Science degrees awarded per a faculty member per year. It ranked second in the number of MS degrees granted per faculty per year. It ranked second in the number of PhD degrees granted per faculty per year. This is amazing when one realizes that the Madison Campus faculty has been the lowest paid in the Big Ten group for sometime. We did lose a lot of faculty between 1980 and 1984. For those faculty who were lost to other institutions as chaired professors, department chairmen, and deans of other institutions, we can say we must have a good faculty if they are so attractive to other schools. While this is evidence of our excellence, it also threatens our existence as a quality institution. The salary catch-up which will begin in January of 1986 is going to help considerably to stave off the invasion of our campus by other institutions. Another defensive measure that we have taken is to search out young PhD graduates and attract them to our faculty by offering competitive salaries and attractive research opportunities in our many programs. We will continue to do this as long as we have the financial resources, and we have been most successful in attracting some outstanding new faculty to our campus.

Some students have asked me if the quality of our program would improve if our tuition were significantly higher. The answer of course is 'yes'. If we had a higher tuition, it would be possible to sustain a higher salary level, add new faculty to our ranks, and reduce the student/faculty ratio, which unfortunately is one of the highest in the country among our peer institutions. We could restore some of the personal project oriented instruction, which plays an important role in an engineer's education. This is one area where the lack of financial resources and the lack of space in which to conduct work have hurt our program. We have tried to substitute the historic personal attention that faculty gave students with new media for communicating ideas and problem solving. Computer aided instruction has played a major role in this effort. Our videotape material supporting our

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Dean Bollinger speaks out about engineering at UW - Madison

instructional program is a cornerstone of our trying to provide learning opportunities for students on a large scale with fewer people. We have not introduced these new technologies in teaching indiscriminately. We have made a special effort with each new media to evaluate its effectiveness and assure that we are moving forward instead of backward. As students, I hope you will agree that these efforts are positive contributions to your education.

A final measure that I would like to share with you is the feedback I get from the recruiters of the many companies who come to our campus and interview our students. This is one of the most positive indicators of the quality of our institution that I have found. You students have an excellent reputation among the recruiters. They are excited about almost every student they talk to, and nearly every recruiter makes some offers to our students for employment. For those of you who are graduating, I hope that you find my perception of the opportunities available to you to be true.

If you have some questions about the College of Engineering which you would like me to address in future issues of the *WISCONSIN ENGINEER*, please forward them to the editor.

Garbage: Trash or Treasure?

by Lisa Peschel

Here in America, we have a resource material of incredible potential and practically unlimited quantity. Literally thousands of millions of tons are produced in this country every day; there is no way we could use it up as fast as it is replaced. But this resource has gone largely unappreciated and unused. In fact, when people consider it at all, they usually consider it a nuisance. The city of Madison alone spends more than half a million dollars a year just to haul it away and bury it.

What is it? Garbage.

From coast to coast, in every area of our nation, wastes of all kinds are being produced in almost incomprehensible amounts. But our current methods of disposal are wasteful in themselves, for waste can be used to produce something that America badly needs: energy.

In America's egg producing farm industry approximately 280 million hens produce over 70 million pounds of manure each day.

Right here at the University of Wisconsin College of Engineering, researchers are exploring the possibilities of extracting energy from waste. Two very different types of waste are being studied, but both teams are trying to develop methods where the largest possible amount of energy can be produced at the lowest cost.

Energy Production Down on the Farm

A large portion of the total waste produced in our country consists of the organic waste that domestic animals give off. In America's egg-producing farm industry alone, there are approximately 280 million laying hens which, in addition to eggs, produce more than 70 million pounds of manure every day. Most of it is spread on the land surrounding the farms as fertilizer. However, poultry manure can be put to much more productive use. Since chickens are not ruminant (cud-chewing) animals, they do not extract as much energy from their food as do other domestic animals like sheep and cattle; thus, their manure contains much biodegradable organic matter. If this organic matter can be decomposed in an anaerobic (oxygen-free) environment, anaerobic bacteria involved in decomposition will produce methane gas. Methane, a major constituent in natural gas, is combustible and can be used as a source of heat and electricity. This can be very important to the modern poultry farmer, for today's poultry farms use large amounts of electricity. Power is needed for lighting, hydraulic feeding systems, and constant ventilation; in fact, electrical costs make up 2-5% of the farmer's total production costs. Many farms right here in Wisconsin could make use of a methane-producing system, for there are over 80 farms in our state with 3000 or more hens.

A few full-scale digesters are already in operation, but there is much room for improvement. With partial funding from the Wisconsin Division of State Energy, Professor William Boyle of the Civil Engineering Department, his graduate assistant Leonard Ripley, and Professor J. C. Converse of the Agricultural Engineering Department have been researching ways to improve the process. They have produced results that can be applied to full-scale digesters to make them more economical, more efficient, and easier to run.

There are several steps in the production of methane from chicken manure. After the manure is scraped or flushed from the barn, it must be diluted with water to allow it to flow into the digester. Ideally this is done in a mixing tank which will allow settling and removal of grit (small bits of oyster shells or crushed

photo by Gary Webster

These hens can be a dual source of income: from eggs and from manure.

limestone that are added to the birds' food to aid digestion). The slurry is then put into the digester, which can be a vertical or horizontal cylinder or simply a horizontal trench. The digester should also be heated: the methane-producing bacteria work best at about 95 degrees Fahrenheit.

Once the diluted manure is in the digester, there are three factors which determine how much methane can be produced: the feed concentration, the HRT, and the organic loading rate. The feed concentration is expressed as the weight percentage of volatile solids (the part of the manure that remains after drying at 103 degree Celsius) in the water-manure mixture. The HRT -- hydraulic retention time -- represents the average amount of time the slurry spends in the digester. The organic loading rate is the ratio of the other two variables: the weight of volatile solids per liter per day (g VS/L-day). An important part of the project was to determine the organic loading rate that would produce the highest volume of methane at the lowest possible digester volume.

When the volatile solids are dissolved in water, volatile acids are formed. These acids feed the anaerobic bacteria that produce the methane. It would seem that, the higher the concentration of acids in the digester slurry, the more methane would be produced. However, too high a concentration is harmful to the bacteria and will cause system failure. The question Professor Boyle and his associates had to answer was: "How much is too much?". Previous research and data from the few full-scale digesters operating in Wisconsin seemed to point to an organic loading rate of 1.6 to 2.0 grams of volatile solids per liter per day (g VS/L-day), which led to a methane yield of 210-300 milliliters per gram of solids added (mls/g VSa). But, using 3 custom-built five liter digesters, the experimenters were able to run a system on 3.0 to 4.5 grams VS/L-day while still getting around 230 mls/g VSa.

What does this mean to poultry farmers? It means a direct saving of money in the process. Since more manure solids can be added to each liter of water in the digester, digesters can be built with smaller volumes, perhaps one third to one half of previous volumes. This leads to savings in construction materials alone. The decrease in volume also means less energy is required to pump the slurry, and less energy is needed to heat the digester.

One of the most important discoveries the researchers made that helped them run the system at an increased organic loading rate was the quick and accurate test they developed to monitor the system and indicate impending system failure. When the system is being run at high loading rates, the concentration of acids is very close to the level that will cause system failure. Therefore, the operators must have a test they can use to warn them that the concentration is getting too high. Practical testing of the digestion system in a real-life farm operation must meet three requirements: it must be simple to perform, it must use relatively inexpensive equipment, and it must be able to indicate a system upset early enough that the operators can take action to prevent total system failure. The research team developed a system in

The 370 kW-hr per day electrical demand for the hen house would be worth $8100 per year.

which a sample of the digester fluid is titrated with acid, first to pH 5.75 then to pH 4.30. The volume of acid needed to go from 5.75 to 4.3 is then divided by the volume needed to reach 5.75. If this ratio is over .3, the digester is too acidic and steps should be taken to correct it. This test is quick and easy, and the equipment needed to perform it (a centrifuge and a pH meter) is simple and inexpensive.

Now that a good methane-producing system has been developed, how can it save money for poultry farmers? If the methane yield from the digester is 230 mls/g VSa, the gross energy yield for a farm with 65,000 birds will be 6920 kilowatt hours per day (kW-hr/day). A maximum of 20% of the energy supplied to a methane-burning engine/generator can be converted to electricity. Hence, the gross electrical generation would come to about 1380 kW-hr/day. After subtracting about 350 kW-hr/day to mix and pump the digester slurry, the net electrical production equals 1030 kW-hr/day. (The waste heat from the generator would be sufficient to heat the digester in the summer; in the winter, some of the 1030 remaining kW-hr would have to be used to supplement the waste heat.) The typical demand for electricity for a 65,000 bird house is about 370 kW-hr/day, so the farm is left with 660 kW-hr of excess electricity every day. What does this mean in dollars and cents terms? The electricity generated from the methane can be used to replace electricity bought from a utility (at 6 cents per kW-hr), or it can be sold back to the utility (at 3 cents per kW-hr). The 370 kW-hr per day electrical demand for the hen house would be worth $8100/yr. The remaining 660 kW-hr generated would be worth $14,460 if used to avoid electricity purchase or $7,230 if sold to a utility.

As you can see from these figures, methane production from the anaerobic digestion of poultry manure can save poultry farmers a significant amount of money. But what about the land that formerly received the manure as fertilizer? This value is not lost either. The fluid that is discharged after digestion is still valuable as fertilizer and can be disposed of simply by spreading it on the farmer's fields.

Landfill Gas

Professor Robert K. Ham is also working on a project that involves production of methane gas, but from a totally different source: municipal landfills. Household garbage, like animal waste, is produced at a phenomenal rate; according to World Wastes magazine, in 1984, Americans threw away an estimated 170 million tons of trash. Most of this material

Household garbage, like animal waste, is produced at a phenomenal rate.

is hauled away to landfills where it is left to decompose. But by simply burying this garbage and forgetting about it, we are neglecting what could become an important energy-producing fuel: landfill gas.

When garbage is buried in a landfill, it is sealed in at the end of each day with a layer of clean earth. This creates an oxygen-free environment where anaerobic bacteria thrive. They break down the garbage, and one of the products of this anaerobic decomposition is landfill gas, which consists of approximately equal proportions of methane and carbon dioxide and traces of foul-smelling gases like hydrogen sulfide. Sometimes this landfill gas escapes above ground and the foul smell becomes a nuisance. Sometimes it can become more than a nuisance; if enough gas collects in any one place, a spark or a carelessly thrown match could cause a serious explosion.

But this potential hazard can be turned into a great asset: landfill gas can be burned to produce energy. Professor Ham estimates that 40 or 50 plants have

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already been built and are producing gas and energy or are in the final stages of construction. Since 1976, Professor Ham has been working with the Getty Synthetic Fuels company, which was formed to extract and utilize gas from landfills. The company currently has 11 plants in operation. He is trying to find ways to answer questions which are very important to the builders of a landfill gas plant: how much gas is the landfill generating? How much decomposition has already occurred, and how much potential for methane production still exists? These facts are extremely important. Before investing a huge amount of money in a plant, the builders must know whether it will produce enough to be worth the investment.

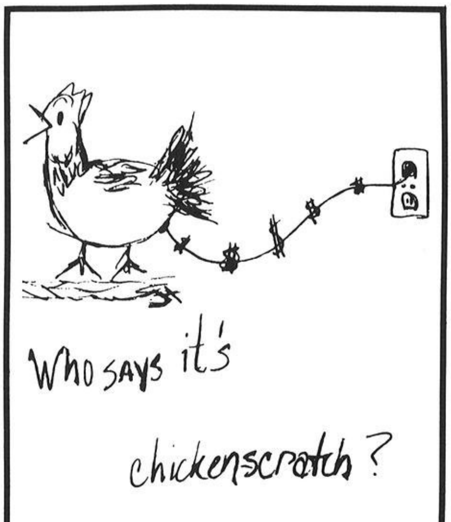
There are three possible methods of use for the landfill gas, but all use basically the same method for extracting the gas. The gas is withdrawn from the landfill by the use of vertical wells and horizontal trenches dug through the material of the landfill itself. Usually a blower in the plant is used to create a partial vacuum in these pipelines and bring the gas to the surface. Once there, it can be sent through normal pipelines and can be put to several different uses.

The gas can be pumped directly to a nearby industry and used as a supplementary fuel in the industry's boilers. Such use requires that the industry provide a 365-day-a-year market; gas production is very consistent and must be burned every day unless storage tanks are to be built also. The user should also have a back-up energy system to use during times of heavy need. There is no way to speed up production of methane for use during peak periods. One good candidate for this kind of methane use is the hotel industry. Hotels are usually open 365 days a year and have a high need for electricity and heat. Currently, a hotel and convention center in Los Angeles is supplementing purchased natural gas with landfill gas. Other good candidates are oil companies. They can use methane-produced energy in their extraction and refining processes.

A second possible method for use of the extracted landfill gas involves piping the gas to a gas processing plant. There it will be purified and compressed; after that it can be sold directly to a utility, which will pay the same price for it as it will for natural gas. A processing plant such as this costs about $20 million to build, but with a good methane source it is entirely capable of paying for itself.

A third possibility is that an electrical generating plant can be built right at the landfill site and the gas can be used right there to run a turbine to drive electrical generators. This method is already being used at several plants. The Puente Hills landfill near Los Angeles is a good example. It produces more than enough energy to sustain itself, then sells the excess to a California utility for about $3,000 a day. It is currently generating enough power to serve the electrical needs of approximately 5,600 homes. Even this large plant is barely scratching the surface of its potential. It is presently using only 20% of the gas captured at the site, but plans are underway to prepare the plant to use 100% of the gas.

As we continue to run out of cheap sources of energy, production methods such as these will become more appealing and more economically feasible. Besides saving money, we will also be getting more use out of our resources. As Ariel Parkinson, who served for five years as a member of the California Waste Management Board, said, "In place of the one-way pattern of materials flow -- extract, exploit and dump -- we must substitute their recovery, reprocessing and reuse in a closed system." The research of people like the experimenters here at the University is helping us travel in that direction. Lowly garbage and waste may become a valuable resource for our future.



graphic by Jeaneen Haley

Oil Shale: America's Ace in the Hole

by Matt Piette

Ours is a society based on oil. From the gasoline which runs our cars to the fibers in our clothes, we are all dependent on oil. The OPEC oil embargo of the early seventies showed us just how dependent we are. The majority of the oil reserves in the world, however, are not locked deep under the Middle Eastern deserts, but in our own Rocky Mountains in the form of oil shale.

The total reserve of oil locked in shale in the U.S. is 28,000 billion barrels. It is contained in rock which has 10 or more gallons of oil per ton of rock. The majority of this rock is located in two main deposits: the Green River Formation in the West and the Devonian shales in the East.

The hydrocarbons are removed as vapor while the spent shale and ceramic balls are removed from the bottom of the drum and separated.

In the middle of the Eocene epoch, about 60 million years ago, the Green River Formation was deposited by two great lakes, each covering approximately 20 thousand square miles. These lakes were formed by the Uinta Mountains which ran parallel to the western third of the southern boundary of Wyoming. These were originally fresh water lakes but later turned saline. In fact, large deposits of halite, the mineral form of sodium chloride, are found in these areas. These lakes were perfect for blue-green algae and other aquatic life which eventually formed the oil shale deposits.

The Green River Formation covers 16,000 square miles and contains roughly 4,000 billion barrels of oil in shale. This shale contains 10 or more gallons of oil per ton of rock. Approximately 1,200 billion barrels are contained in certain zones which contain 20 or more gallons per ton. Abut 600 billion barrels of oil are recoverable by current technology.(1)

Shale deposits in the East are much older than their counterparts in the West. In the late Devonian and early Mississippian periods, 330 to 360 million years ago, a large portion of the eastern United States was under the inland Chattanooga Sea. This stagnant body of water was fed by several major rivers which flowed into it from the east. The black shales found in these areas were deposited by the kelps and algae which flourished under these conditions.

The United States Geological Survey estimates the known resources of the Devonian deposit at 400 billion barrels with an estimated 2600 billion additional barrels thought to exist.(2) The recoverable oil in this shale is approximately 1000 billion barrels, enough to fulfill the requirements for the United States for 100 years at the current consumption level.

Oil is recovered from the shale through a retorting process. This can be done either on the surface or in situ.

In an in situ process, holes are drilled into the shale zone and are loaded with explosives and fired. The zone is fragmented, leaving the broken shale with high permeability. The void space required is created by either an uplift of the overburden or the removal of 35-40% of the rock prior to detonation.

This zone constitutes an in situ retort. Air holes are drilled at one edge of the retort and gas-out holes are drilled at the other. A fire is started at the leading edge of the shale and proceeds horizontally to the other. The combustion gasses pro-

330 to 360 million years ago, a large portion of the eastern United States was under the inland Chattanooga Sea.

duced from the fire drive out the oil, which then drains through the rock, flows along the bottom and is pumped out of the retorter.

Several different methods of surface retorting exist. One such process developed by Tosco, called the Tosco II process, retorts the shale through direct contact of the rock with ceramic balls.

The shale is first crushed to less than ½ inch particles. These are then preheated and added to a rotating pyrolysis drum along with the hot ceramic balls. The drum is operated at 900 degrees Fahrenheit. The hydrocarbons are removed as vapor while the spent shale and ceramic balls are removed from the bottom of the drum and separated.

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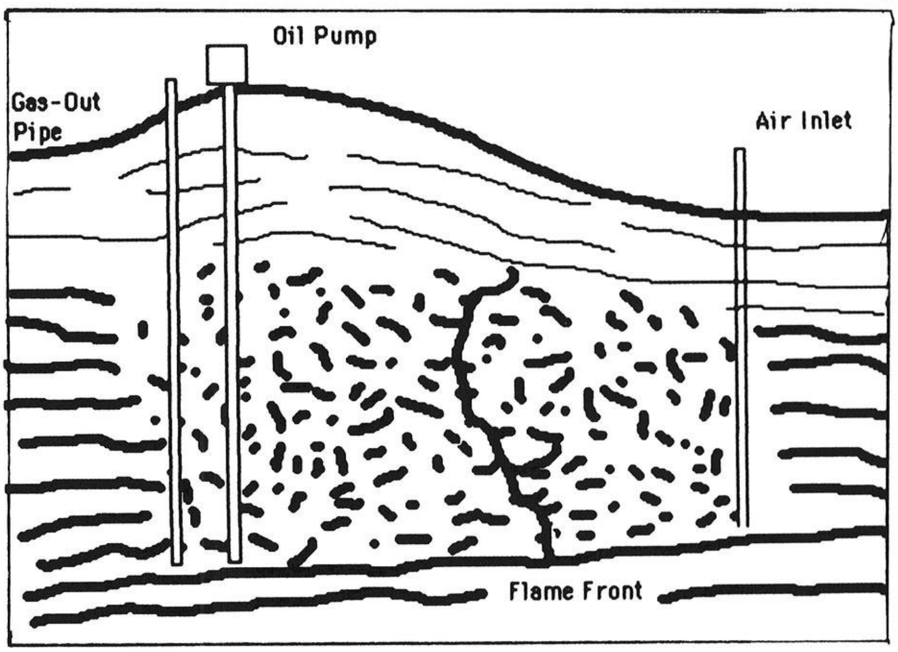

The Clean Air Act: Industry's Housekeeper or Hangman?

by Jerome Holbus

Over the past fifteen years or so, the balance of power between a healthy environment and a working industry has changed significantly. In the early 1960's, American industry boomed, economic growth peaked, and pollution, well, it became an issue.

But today, pollution is much less a problem then it was 20 years ago. This literal clearing of the air has resulted from the implementation of the Clean Air Act in 1963 and its admendments that followed.

Still, all the dirt in our nation's air has not left without some remaining residue. The Clean Air Act (CAA) has undergone many complaints from industry as being a road block on the highway of industrial progress.

These complaints from industry and business are, as proven by the detrimental economic outcomes of the CAA, completely valid and worthy of consideration and respect. Industry's role in society deserved much more consideration than it was given when the CAA was implemented in the 1960's and later revised in the 1970's. Because of this lack of consideration, American industry suffered .

The balance of power between a healthy environment and a working industry has changed significantly.

But before any bad-mouthing of the CAA is inflicted, some very positive outcomes of the Act should be mentioned.

When passed into law, the CAA made the Federal Government the primary researcher on the nature of air quality. Its goals, according to the February 1985 issue of*Congressional Digest*, were to enhance the quality of air, promote public welfare, and improve the productive capacity of the country. These goals are carried out through stringent controls of health based air on quality standards imposed by the Environmental Protection Agency (EPA).

In the twenty-two years under the agency's control, the Clean Air Act has been heralded as a great success.

From 1970-1982, the amount of Sulfur Dioxide and Carbon Monoxide in the atmosphere has been reduced by 44% and 30%, respectively. In addition, soot and ash from factories decreased by 16%.

In December 1980, the Council on Environmental Quality commented "The nation's air quality is continuing to improve." Many facts support this quote, including the following:

Combined data from 23 major urban areas show that the number so-called

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In the Retort B process, retorting is accomplished through direct heating of the raw shale. The crushed rock is preheated and added to the bottom of the retorter. The solid is pumped upward through an expanding conical shell and is heated along the way by recycled gasses which are fed to the top of the retorter. The kerogen in the shale is decomposed and liberated as oil and flows downward through the vessel. This cools the oil, effectively quenching any polimerization reactions which make the liquid difficult to refine. The operating temperature of the Retort B process is between 950 and 1000 degrees Fahrenheit.

Any of these retort methods produce large amounts of water which must be disposed of. This water comes from three primary sources: water of reaction, water of hydration, and feed shale moisture.

Water of reaction comes from the combustion of hydrogen and other fuels within the retort. In in situ processes, it is undesirable to burn these fuels since this will reduce the value of the recovered products. The production of water is therefore an indication of inefficient retorting. Still, this is unavoidable and the oil produced often contains as much as 50% water by volume. Water of hydration is the water which is chemically bonded to the shale and is released at the retorting temperatures. Feed shale moisture is water that is contained unbonded within the shale and is released at its boiling point.

The water produced is high in many impurities including organics, solids, ammonia, hydrogen sulfide, and heavy metals. Extreme care must be taken in order to prevent the discharge of this water into the environment. The most common method of disposal is through evaporation ponds. Although this is an effective method to protect the environment, it would not be adequate if a full-scale oil project was put into operation.

Another environmental concern is the large quantity of spent shale which would be produced. This waste material is void of many nutrients, especially nitrogen, which are essential for plant growth. It is also saline, has a high pH, and contains several toxic elements including nickel, selenium, beryllium, and chlorine. While some of these elements are essential to plant development in small quantities, large concentrations are deadly to many species of vegetation.

Despite this, advances have been made in reclaiming this spent shale. Nutrients can be supplied and leaching is effective in removing salts and altering the pH. Woody plants such as skunkweed and juniper are effective in re-vegetating the shale.

Still, the complete environmental effects of a large-scale oil shale operation are unknown. Although the benefits of the vast quantities of locked-in shale are tempting, until more is known regarding the disposal of the water and spent shale produced, the development of the oil shale industry in the United States must proceed with caution.

The aggregate number of "very unhealthful" and "hazardous" days in these same areas declined from 537 to 358 during these years--a 35% reduction.

The total number of "hazardous" days dropped from 33 to 15--a 55% decrease.

But along with the positive outcomes of improved air quality, the quickly expanding American industry of the 1960's was forced to reduce its pace. The high environmental standards included in amendments to the CAA have proved too costly for U.S. industry to handle.

Seven years ago, the Council on Environmental Quality predicted that expenditures for meeting the nations's clean air goals between 1978 and 1987 will total $278,900,000,000. It is also estimated that industry will spend $400,000,000,000 between 1970 and 1987 on air pollution reduction. This huge expense will undoubtedly hit the consumers in the forms of costs and services. Moreover, a Business Roundtable report concluded that heavy industries, such as auto and steel manufacturers, have to wait three or more years and spend up to $300,000 in order to obtain permits necessary for the construction of a single new plant.

Small businesses find themselves in a similiar bind since they are required to meet the same standards and fill out the same forms as larger companies.

The end result is companies have found it difficult to come up with the financial resources to keep their plants running competively. John E. Schork, Chairman of the Board and Chief Executive officer at Research-Cottrell Inc., says industries can not operate competitively (with the environmental restrictions imposed on them) because they can not finance "....the long term capital with which to modernize, expand, and pursue technological innovation--all essential to reindustrialization."

This lack of reindustrialization in the U.S. over the past several years has resulted in increased competition in world trade. Since the 1970's, the American industry has been hit hard by foreign competition in the auto, steel, and other machine tool markets.

Small businesses find themselves in a similiar bind since they are required to meet the same standards and fill out the same forms as larger companies.

In addition, these strict air quality controls have been restraining industry from expansion. Restricted by costs of these controls, most expanding industries are choosing between three discouraging options. Companies are either purchasing outmoded existing plants, building outside the U.S., or scrapping the idea of expansion altogether. None of these options forcast a bright future for American industry or American industrial workers.

But thanks to the latest revisions in the CAA, economic and employment growth have improved. Still, one must wonder if these short-sighted problems in the CAA were rectified too late. Is it possible that the economic recession of the early 1980's could have been less severe if earlier revisions in the CAA were made? Arguements such as these, by proponents of industry, stand strong against the CAA.

Still, there is no doubt that the Clean Air Act fullfilled its goals in a time when the pollution problem was a high priority concern. But more careful consideration should have went in to the planning of the act--consideration that may have prevented such a severe industrial recession of the early 1980's.

Hopefully, emerging issues such as Acid Rain, fossil fuel mining, and foreign fuel purchasing, will be given more intense forethought before any set plan is implemented. Hopefully, these issues will be analyzied with their respective pros and cons given equal weight.

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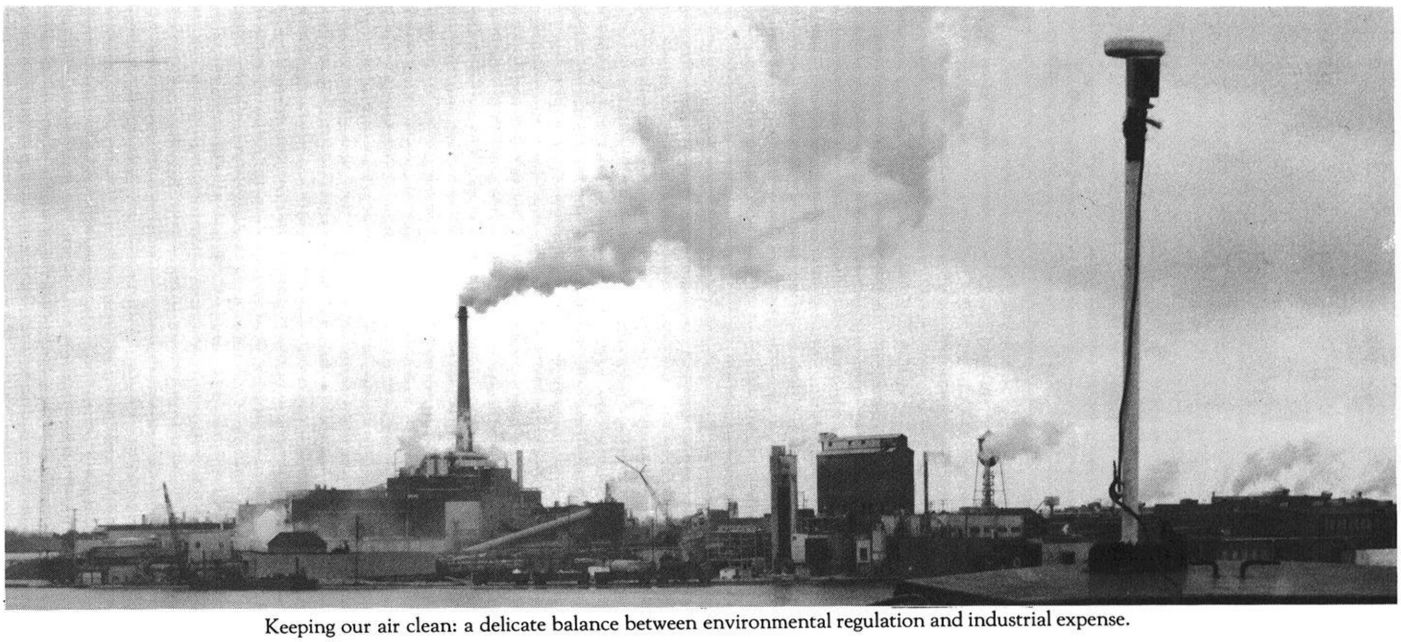

Keeping our air clean: a delicate balance between environmental regulation and industrial expense.

New Life for Old Tires

by Ann Conklin

Throw away a pop can these days and you can be almost sure that somebody will find it, flatten it, and turn it, along with hundreds of other cans, into a few bucks. Pick out a greeting card and chances are that it will say "100% recycled paper" on the back. Since the early 1970's, people have become increasingly aware of the environment and of the need to conserve the world's natural resources. Materials such as paper and aluminum are relatively easy and economical to recycle and, consequently, play a visible role in the conservation movement. Other materials, however, are much more difficult to reuse, and people find letting such waste collect in garbage dumps more profitable than funding research to develop recycling technologies.

However, due to the work of researchers at the University of Wisconsin - Madison, one such technology, cryogenics, has made feasible the recycling of many solid wastes that were previously too difficult or too expensive to reprocess.

Of all the cryogenically recyclable products, however, none lends itself so well to the process as the automobile tire.

Cryogenics is the study of low temperatures and their effects on materials. Given the winters in Wisconsin, it isn't surprising that such research would take place here. The temperatures associated with cryogenics are approximately -60 degrees Fahrenheit and colder, and are typically produced by cryogens such as liquid nitrogen or carbon dioxide. Applications of cryogenics cover a wide spectrum, from quick-freezing fast foods to embrittling old paint so it can be easily removed during the Statue of Liberty restoration. The embrittling properties of cryogens are what make cryogenics useful in recycling. In order to be a good candidate for cryogenic recycling, a product should consist of a combination of materials, some of which shatter when cooled by a cryogen, and others that do not. Plastic-coated copper cable, for example, is reprocessed using cryogenics. When frozen, the plastic insulation becomes brittle and is easily broken away, leaving the polymers in the plastic and the copper wire intact and completely reusable. The copper and steel in automobile generators, alternators, and starter motors can be separated in a similar manner. In this case, the steel shatters and is magnetically lifted away from the copper. Of all the cryogenically recyclable products, however, none lends itself so well to the process as the automobile tire.

Automobile and truck tires, which are being discarded at a rate of well over 200 million per year in the United States, cannot be buried, burned, or biologically decomposed. Consequently, in the past fewer than ten percent of used tires were recycled. Now, however, rather than collecting in junkyards worn-out tires are being incorporated into many new and innovative products. Fifteen plants around the world economically separate used tires into three basic materials: metal, nylon rayon, and, of course, rubber. Because tire manufacturers are concerned about the quality and composition of the rubber they buy, only about seven percent of this extracted rubber is used to make new tires.

More commonly, recycled rubber is used in our roads and airport runways. Rubber mixed with asphalt can increase the life of a road up to ten times. Studies at the University of Toronto indicate that the rubber adds about one percent to the initial materials cost of a road. This addi-

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Cryogenics is turning old, useless tires into a valuable material resource.

tional cost is quickly repaid in improved durability and lower maintenance costs. Unfortunately, cities often overlook the long-term benefits of rubber reinforced roads in favor of less expensive, short-term solutions. Reprocessed rubber is also placed in roads near railroad tracks. The thick rubber sheets still allow the tracks to be used, but they make driving over the tracks a more comfortable experience. Other applications for the recycled rubber are abundant. Most sports fields made today are fabricated from rubber that may once have been the tires on someone's car or truck. Locally, a company in Baraboo, Wisconsin uses recycled tires to make large rubber mats for cattle farms. The 72" × 30" mats help prevent arthritis and other illnesses by giving cattle a warmer and more comfortable place to sleep. Also benefitting farmers are the strong, long-lasting irrigation hoses made from (you guessed it), old tires. Another company in Dallas-Fort Worth, Texas uses the recycled rubber to make flower pots. The demand for these weather resistant, nearly unbreakable flower pots keeps the production line moving at a rate of 70,000 per day, seven days a week. A firm in Minneapolis makes rubber seals for ore mills from old tires, while another in Colorado uses the rubber to make flexible lawnmower blades that cut like the metal ones, but won't dent or bend when something other than grass gets in their way. The list goes on and on, and researchers are still working on more ways to conserve resources through cryogenics.

Professor Norman Braton, the man responsible for many of the advances in cryogenic recycling, is now retired, but he is continuing his research to improve the recycling process. Professor Braton states that each tire contains about twelve pounds of nylon rayon fibers. Working in conjunction with the chemical engineering department, he hopes to perfect a method to unlink the polymers in the fibers so that they may be injection molded into new products.

Not only has Professor Braton's research helped to alleviate the problem of what to do with worn tires, but he has also aided in the development of new products to improve our daily lives. Cryogenic recycling has come a long way. However, according to Professor Braton, the technology is still in its infancy, and we have many advancements to look forward to as it grows toward its full potential.

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About WE

The *WISCONSIN ENGINEER* is produced five times yearly by students of the University of Wisconsin - Madison College of Engineering. 3000 copies of each issue are printed and distributed to Wisconsin high schools, paid subscribers, and other universities across the country. In addition, issues are distributed free of charge around the College of Engineering and the campus in general. The *WISCONSIN ENGINEER* is a self sufficient, non-profit organization funded through the sales of local and national advertisements.

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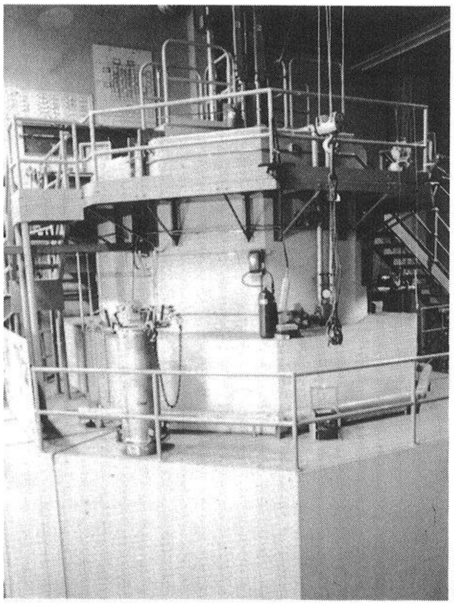
Nuclear Electricity: Today and Tomorrow

by Paula Grgurich

Take hold of the nerve of creation, nuclear energy, and translate it into electricity. We hoped that would become the gift of the atom -- an eternal, inexpensive power source to revitalize the world. That was the dream. The reality (some years later) has turned out to be different. In the United States, as well as many other countries, nuclear energy is already supplying a significant share of the electricity consumed. In l984, nuclear plants produced approximately 14 percent of our electricity. More kilowatt-hours was produced with nuclear generation than with oil. International confidence is perhaps even stronger than here in the US. Over 60 percent of France's electricity is nuclear-generated. Bulgaria, Finland, Sweden, Switzerland, and Belgium already generate more than a fourth of their electricity from nuclear power plants. Japan is moving forward from an especially ambitious nuclear program -- with 25 reactors already operating, they plan to double their nuclear capacity by l990. An interesting note is that in many cases the nuclear plants in other countries are being built by U.S. firms using American technology. Based on this backround information, one can see that nuclear energy has a solid history that demonstrates the technology is manageable. So "where's the beef?"

Japan is moving forward with an especially ambitious nuclear program -- with 25 reactors already operating, they plan to double their nuclear capacity by l990.

The nuclear industry in the U.S. is going through a troubled time. The industry is confronted with the high cost of building new plants, spent fuel problems, regulatory uncertainty, a well organized and loud opposition and an anxious public -- all of which add to nuclear energy's problems. Three mile Island is perhaps a good case in point in discussing the challenges American elecri- city industry leaders are to face. This incident -- grossly overstated by the media, politicians and nuclear opponents -- had a profoundly negative impact on the public perception of nuclear energy. Convinced that the future of nuclear power depended on a joint industry effort to achieve a high standard of excellence in construction and operation of nuclear plants, they came up with a powerful concept uncommon to the American economic system. INPO(Institute of Nuclear Power Regulators) was formed. Based in Atlanta, INPO is made up of 300 engineers, scientists, and specialists. Their jobs



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This small scale nuclear reactor, located in the Mechanical Engineering Building, is used for research and teaching.

include analyzing safety procedures and insuring that the operators of nuclear plants have the best possible training and supervision. Through its communication network, INPO also enables nuclear utilities to benefit from each other's experience. Its muscle comes from the fact that each member is committed to voluntarily open its operation to careful scrutiny by INPO's experts. In addition to INPO, the industry has also organized The Nuclear Safety Analysis Center, an industry think tank devoted to research. It is located in Palo Alto, California. One major issue that requires the time and attention of the U.S. nuclear industry is spent fuel and nuclear waste disposal. Nuclear power plants are now storing on-site the radioactive fuel that will eventually be removed for chemical recycling or permanent disposal. The industry has worked hard for the passage of the Nuclear Waste Policy Act of l982 which established Federal responsibilty for storage of high-level waste in deep geographical formations that have been stable for millions of years. The disposal is being financed by fees collected from the utilities.

Another issue is to maintain an excellent safety record to help convince a doubting, concerned public to accept the fact that the industry is able to operate nuclear plants safely. In this regard, the

There is no turning back on this vital component of the U.S. energy economy.

industry has a good record. No employee or member of the public has ever been seriously injured by a nuclear accident at a commercial plant. American plants are regulated by the Nuclear Regulatory Commision (NRC) whose strict safety standards make nuclear energy probably the most carefully scrutinized industry in the world. But with INPO, the industry has gone far beyond meeting NRC standards.

While nuclear power is under intensive scrutiny there is simply no turning back on this vital component of the U.S. energy economy. We need a balanced fuel mix which includes nuclear. The performance of plants is both good and improving. Convincing the public of this fact will restore much of the enthusiasm our nation once had for the "Atoms of Peace"concept under the Eisenhower administration.

Biotechnology: Present Applications and Future Horizons

by Thomas Nikolai

The discipline of biology today is dramatically different from the science that existed only 10 years ago. With the advent of powerful new experimental techniques, an explosion of new information has become available which could open a host of new experimental possibilities. More importantly, many of these new techniques are being applied on a larger scale; these beginning applications have resulted in the upstart of a biotechnology industry. Biotechnology is simply applied biology: the use of existing biological principles to accomplish specific purposes or to produce specific products.

Biology had traditionally been a discriptive science; experimenters classified and grouped the varieties of living organisms by observation of their gross outward appearance or microscopic similarities. As higher-powered microscopic techniques were developed, the biologist was able to observe with increasing detail the intricate workings of cells and subcellular organelles. These visualization techniques culminated in the development of the electron microscope; almost every structure in a cell could be resolved with great precision. However, these observations raised many new questions while leaving fundamental ones still unanswered: What is the molecular basis for the enormous biological complexity and variety that exists in nature? How are such sustems controlled, and ultimately how does a parent organism pass this information and control to its progeny (offspring)?

The answer to these questions was of course provided in 1953 when James Watson and Fransis Crick perceived the double-helical structure of DNA (deoxyribonucleic acid). This two-stranded molecule was shown to have the capacity to carry enormous amounts of information in the form of "genes". A gene may be thought of as a specific location on a length of DNA, analogous to an address on a street. Each "address"contains a code that a cell can read and translate into a sequence for a specific protein. One length of DNA may contain hundreds or even thousands of genes, which corresponds to the same amount of individual proteins! For this reason DNA has been termed the "biological blueprint" of life.

The enormous advance of molecular biology since Watson and Crick's discovery has been aimed largely at understanding how DNA interacts with other components of the cell to express the wealth of information it encodes. The knowledge of how DNA can be manipulated and integrated into organisms provided the theoretical base on which the biotechnology industry stands. The following examples of current biotechnological fields all depend on these principles in one way or another.

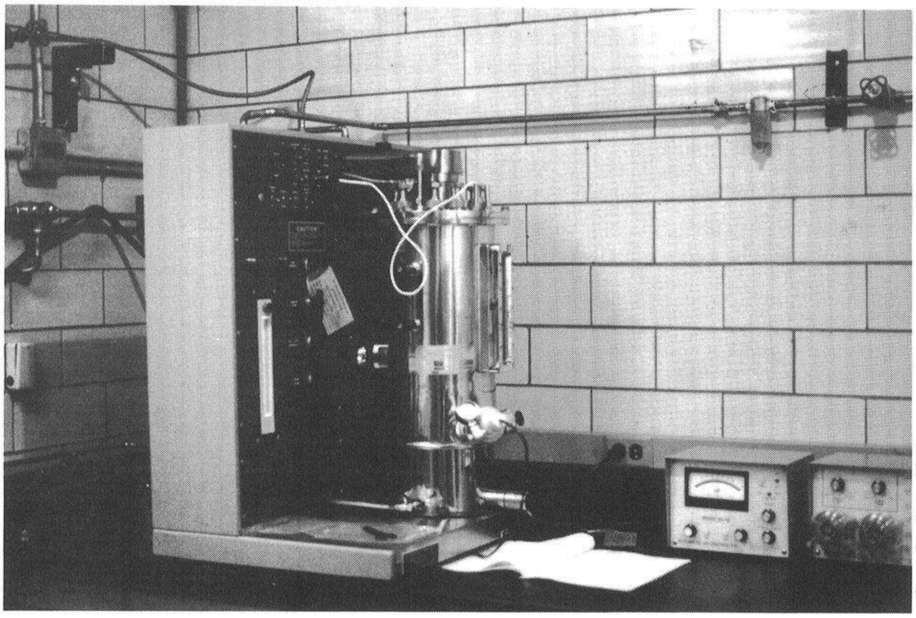
photo by Brian Lake

This fermenter is part of the biotechnology research at UW - Madison

Gene splicing:

The technique of recombining DNA (gene splicing) is by far the most well known topic in the biotechnology industry. Although the technique is simple in concept, it often presents quite complex problems in practice. The major objective of these techniques is to insert a foreign gene that codes for a desired product into another organism such that the foreign gene will be expressed at a much higher rate than any of the organisms native genes. The most widely used organism for such purposes is the bacteria *E. coli*. This is because there is an enormous body of information and know-how that has been accumulated for it, and it has been found to make almost any protein studied thus far. The biological products produced for commercial sale are usually proteins that previously could only be obtained in small amounts (which makes them very expensive).

One method of creating new plants is to bring together chromosomes from two different plant species.

An excellent example of the application of recombinant DNA techniques to synthesize a scarce, highly valuable protein is found in the commercial production of insulin. Insulin is a protein that the body requires to metabolize sugar in the bloodstream. Diabetics, whose bodies cannot synthesis insulin, require injections of insulin after meals; without it their blood sugar level goes up until they go into shock (prolonged periods without treatment can result in blindness or even death). The insulin required for treatment was originally obtained from the pancreatic tissue of pigs, which have insulin very similar to that of humans. Many kilograms of pancreas organs were needed to obtain a few milligrams of porcine insulin, and the purification of the protein from this tissue was very expensive. Also, since porcine insulin is similar but not identical to human insulin, some patients receiving this treatment suffer from immune system reaction to the foriegn protein, and must discontinue its use.

In September of 1982, human insulin was released for sale. This commercial production was made possible by using the recombinant DNA techniques described earlier. By inserting the gene for human insulin into *E. coli* and inducing the bacteria to overproduce the protein, it is now possible to purify kilogram amounts of insulin at a fraction of the previous cost. More importantly, the product is human insulin (not porcine or bovine) which eliminates patient immune reactions. Recombinant insulin can also be obtained with far less impurities present. Since 1983, other proteins have become available as a result of recombinant production: many types of interferons (being tested in cancer research), human growth hormone (used to partially or fully cure dwarfism), human albumin, and porcine and bovine growth hormones.

The knowledge of how DNA can be manipulated and integrated into organisms provided the theoretical base on which the biotechnology industry stands.

Protein engineering

Given a set of instructions furnished by a gene, organisms can synthesize proteins corresponding to this gene. The gene can be isolated from another life form, or it may be artifically synthesized. The technology is now emerging where a protein may be "engineered" to produce biologicals that are superior to natural ones, or to design enzymes for use as catalysts in the production of high-value specialty chemicals. Such enzymes may even find use in the large-scale production of more common industrial chemicals.

An enzyme is a protein that serves as a catalyst for a biological reaction; it can accelerate the rate of the reaction a thousandfold without actually being consumed itself. The number of good industrial catalysts is still quite small, and many that do exist have their problems. One of these problems is that they are not that specific; i.e. the rate of side reactions increases as well as the reaction of interest. Enzymes, in contrast, are generally very specific; they can promote virtually no side reactions. The implications of being able to construct an enzyme to assist an industrial reaction are thus enormous.

Agricultural research

For nearly four decades plant breeders have worked diligently to be able to obtain varieties in which such characteristics as yield, pest resistance, and nutritive qualities are greatly enhanced. Their kinds of techniques will continue to be important, but will be supplemented by new biotechnological ones now under development.

One method of creating new plants is to bring together chromosomes from two different plant species. This was first done in the 1960's with wheat and rye. The tolerance of such strains to poor soils and adverse weather conditions are superior to wheat. Experiments with crosses between other species will continue and may yield improved strains.

Although recombinant DNA techniques are routinely used to improve or modify the genomes of microorganisms, this is not the case with plants. The state of knowledge of plants lags behind that of animals and some microorganisms. Progress is being made in the these areas, however, and impressive objectives are being mentioned, such as improving a plant's nitrogen-fixing ability, photosynthesis ability, or resistance to pests and pathogens.

Reagan's Environmental Record

by Todd W. Wallinger

President Reagan has brought about more change than any American leader in decades. Environmental policy is one area that is no exception. In fact, since Reagan took office in 1980, the federal role in environmental protection has seen not one, but two major changes in philosophy and direction.

Federal involvement in the environment began in the late 1960's. Before this, state governments had been responsible for protection of natural resources. However, as water and air pollution rose to alarming levels, Congress realized that the state programs were largely ineffective. In addition, some states felt a strong economy was more important than a protected environment, and thus implemented weak environmental programs to attract industry away from states with heavier environmental protection. In response to increasing public demand for environmental protection, Congress created the Environmental Protection Agency in 1970. Its purpose was to implement an effective, uniform environmental policy across the United States.

Throughout the 1970's, the development of a national environmental policy was brought about through congressional legislation, not presidential leadership. Major legislation which served to guide the EPA included the Clean Air and Clean Water Acts. In addition to investigating violations of these and other environmental laws, the EPA was given the power to create and enforce its own regulations.

Because of increased public awareness of environmental issues, the 1970's saw significant improvement in the cleanliness of our nation's water, land, and air. However, in the late 1970's, the economy slowed, and with increased competition from overseas, the United States no longer seemed the industrial power it once was. Many people blamed this partly on the vast and often inconsistent body of environmental laws and regulations which had mushroomed since the EPA was created. Also, the federal regulatory system itself came under heavy criticism because the majority of the people creating and enforcing the regulations were viewed as being either insensitive to or ignorant of the needs of industry.

Then, America sank into its worst recession since World War II. The American people wanted a fundamental change in their government, so in 1980, Ronald Reagan was elected president by a landslide. This victory was considered a mandate for a reduction in the size and scope of our national government. The belief was that people were willing to give up some protection of the environment in order to achieve a healthier and more secure economy. This is best stated in the 1980 Republican Party platform. "A healthy environment is essential to the present and future well-being of our people. (However,) it is imperative that environmental laws and regulations be reviewed, and where necessary, reformed to insure that the benefits achieved justify the cost imposed... Environmental protection must not become a cover for a 'no-growth' policy and a shrinking economy."

For the first time, a President was taking the lead in establishing environmental policy. Reagan's approach had a six-fold strategy.

During his first term, Reagan was fairly successful in achieving his environmental goals.

1) Reagan wanted to shift the responsibility of environmental protection to state and local governments. Then, action could be taken more quickly and efficiently since decisions would be made as close to the source of the problem as possible.

2) Remaining federal responsibility would be centralized in the White House to make policymaking more accountable to the people.

3) People appointed to key posts would be drawn from the private sector, and ideologically committed to bringing about the 'conservative revolution'.

4) Regulatory reform would be pushed to ensure that regulations were not excessively harmful to industry.

5) As much reliance as possible would be placed on having the free market allocate resources.

6) Cuts would be made in the EPA's budget to reduce its size and power and help balance the federal budget.

During his first term, Reagan was fairly successful in achieving his goals. Environmental offices in the Departments of Energy and Transportation were eliminated while environmental bodies that directly advised the President, such as the Council on Natural Resources and the Environment, were strengthened. Reagan found two very loyally conservative appointees in James Watt as Secretary of the Interior and Anne Gorsuch as Director of the EPA. Spending throughout the government on environmental concerns declined from 24% of the budget in 1980 to 12% in 1984.

EPA personnel was cut by 20% in the first two years of his term. Few new regulations were issued. Many existing regulations were revised or reinterpreted to lessen their impact on industry. However, Congress enacted none of the administration proposals for amending major environmental laws and stopped several administration initiatives, such as the plan to allow mineral and petroleum exploration in wilderness areas.

With the economic recovery, Reagan came under increasing attack for weakening the federal role in environmental protection.

Contrary to popular belief, though, Reagan's efforts did not consist entirely of lessening the influence of environmental agencies. His major accomplishment in strengthening the federal role in environmental protection was to set up the Superfund, used to finance the clean-up of hazardous waste sites. Also, the EPA began to hire special agents to act as criminal investigators in order to better enforce environmental regulations.

In 1983, as the economy recovered from the recession and people became more concerned about the environment again, the Reagan Administration came under increasing attack for weakening federal environmental protection capabilities. Congress stepped up its opposition to Reagan's policies. Finally, the crisis point hit when House investigations into alleged EPA illegalities forced the entire leadership of the agency to resign.

In response, Reagan forged a new federal commitment to the environment. His first act was to name William D. Ruckelshaus to replace Gorsuch. Reagan thought that Ruckelshaus, the original director of the EPA and an outspoken supporter of a strong federal environmental role, was the perfect man for the job.

The EPA had been had been bitterly criticized for "looking the other way" when companies violated the environmental laws passed by Congress. To reestablish credibility, Reagan and Ruckelshaus agreed that stricter enforcement was the most important priority of the new EPA. In Ruckelshaus' words: "We have got to show people that we mean business, that the regulations and the laws that are passed by Congress are statements of national public policy and will be carried out. With the... people we have in this Agency, my dreams can be carried out."

From 1982 to 1984, the number of cases referred to the Justice Department for prosecution increased from 20 to 31, and the number of defendants convicted jumped from 11 to 26. The number of special agents was expanded and they were made U.S. Marshals. This gives them the authority to carry guns on the job and make arrests.

Three other goals were outlined by President Reagan upon the change in leadership. These were: continue shifting protection of natural resources to the states, increase the size of the Superfund, and dramatically increase funding of acid rain research. To allay suspicions of the agency's operations, Ruckelshaus began running the EPA as a much more open and publicly accessible organization.

Despite Reagan's efforts to cut government spending in other areas, he proposed some of the largest budget percentage budget increases of any agency for the EPA over the last few years. For the 1986 fiscal year, the EPA budget is $47 billion, which includes a 45% increase in the Superfund and a 12% increase in research and development. This is balanced by cuts in administration costs. Adjusting for inflation, the EPA budget today is approximately at the same level as when Reagan took office in 1981.

The EPA has also begun to take on a global role because of Ruckelshaus. Major projects with other countries include research activities, sharing of management techniques, and efforts to set up uniform standards on pollution control. The thinking is that it makes no sense to clean up our air and water unless the rest of the world joins us.

And yet, in line with his conservative philosophy, President Reagan continues to emphasize the role of free enterprise in environmental protection. The federal government has begun working with non-profit groups such as Ducks Unlimited by funding their efforts to protect wildlife areas. The Prudential Insurance Company donated 100,000 acres of wetlands and forest areas, worth $50 million, to the National Wildlife Refuge System, and the administration continues to solicit donations from industry. The use of 20,000 volunteers at our national parks saves $7 million a year. These projects and many others help to eliminate the confrontational attitude that often arises between business and government.

Protection of our environment is not a liberal or conservative challenge - it's common sense. — President Reagan

At the beginning of his second term, Reagan appointed Lee M. Thomas to be the new director of the EPA. Thomas intends to follow Ruckelshaus' lead and continue to strengthen the the EPA's protection of our nation's precious resources.

In his State of the Union address in 1984, Reagan summarized his views on the environment. "Preservation of our environment is not a liberal or conservative challenge - it's common sense... Now we must come to agreement on how to do it. And in coming together on that, we must keep in mind the word "balance", a balance between the desire to conserve and protect and the desire to grow and develop, a balance between the concern for the good earth and concern for the honest impulse to wrest from the earth the resources that benefit mankind, a balance between the overall demands of society and the individual demands of the free citizen.

"If we rid our minds of cant, of empty rhetoric, of mere politics, we'll strike that balance naturally and together."

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photo by Pat Davidson

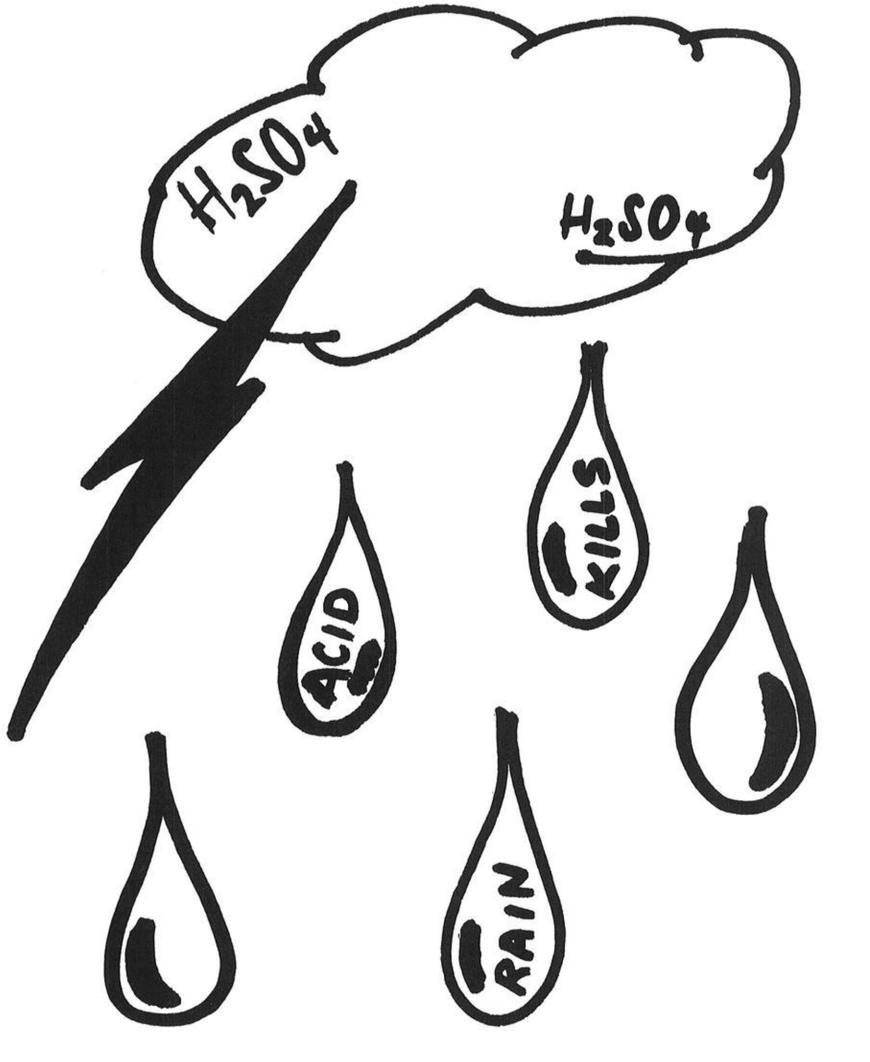
Environmental policy: Who's responsible for maintaining our environment?

Acid Rain: The End of our Environment?

by Fred Byars

The time: two decades into the future. The place: northeastern and uppermidwestern Uninted States. The problem: a dead environment. Lakes once teeming with gamefish now lay still. Cold, barren, leafless trees serve as the only tombstones to a once rich and vibrant forest. No plants or animals exist for hundreds of miles. A bleak picture, perhaps, but many scientists are predicting the destruction toll of acid rain to reach these extremes if drastic steps aren't taken to curb this environmental menace.

Acid rain is just that: acid precipitation. It is formed when molecules of sulfur dioxide (SO2) floating in the atmosphere bond first with a single atom of oxygen (O), and then with a molecule of water (H2O) to form sulfuric acid (H2SO4). These sulfuric acid particles move through the hydrologic cycle and gather with other similar particles until they become heavy enough to tumble earthward as acid precipitation.



Rain in the northeast has an average Ph of 4.5. When Ph levels in lakes reach 4 they become void of aquatic life.

The earth's atmosphere in its "normal" state contains predominatly only two gases, oxygen and nitrogen, with trace quantities of such elements as hydrogen and argon. So where do the sulfur dioxide particles come from? The presence of sulfur dioxide in our atmosphere is due mainly to the waste emmisions released when coal is burned to produce electricity. Power plants in the United States emit nearly 30 million tons of sulfur dioxide annually. Ohio leads in emmision outputs with an average of 64 tons of sulfur dioxide for every square mile of the state each year. West Virginia follows closely with 43.3 tons per square mile, and Pennsylvannia has 33.1 tons per square mile. The impact of these emmisions is devastaing.

From ice core samples dating back 100 years, scientists know that the Ph of the water then was approximatelty 6.5 (7 is neutral, and lower numbers more acidic). Today, "normal"rain is classified as having a Ph of 5.6. Most of the rain that falls on the northeastern U.S.,however, has a Ph that averages 4.5. As this rain falls into our nation's lakes and streams, the Ph begins to drop, and several stages of destruction occur. When the Ph reaches 6, the reproductive systems of the fish are disturbed enough to make their eggs far to sensitve to ever reach the hatching stage. While some of the sturdier strains of fish may survive, a Ph of 6 will mean comlete extermination of some of the more fragile spieces of gamefish, such as the large and smallmouthed bass. Trout might survive until a Ph of 5.5, and the "rough" fish such as bullhead and white suckers might survive until a Ph of 5, even though at this point reproduction would be impossible. By a Ph of 4.5 the lake would be void of all life.

In Ontario 48,000 lakes are already sensitive to acidification and by the year 2000 up to half of these lakes could become uninhabitable for all aquatic life. In Nova Scotia nine major rivers have been destroyed, and eleven others are in acute danger. In the Adirondack waters of the northeast 24% of all the lakes are approaching the critical point and another

photo by Gary Webster

Industrial emissions from coal-burning power plants are a major source of acid rain constituents

21% are nearing dangerous levels.

These are astonishing facts, but there's more. The damage of acid rain reaches far beyond the shores of the lakes and streams. The acid in the rains flows through the soil and chemically liberates thousands of particles of metals, such as aluminum and mercury. Highly toxic combinations of these and other elements seep through the soil, to the roots of trees and plants, cutting off their supply of food and in effect strangling them. The rain itself attacks the leaves of the plants and trees, stripping them of their protective outer layer and critically damaging the photosynthesis processes. In a study done concerning the effects of acid rain on vegatation by Hubert W. Vogelmann, chairman of the botany department at the University of Vermont, the changes in the environment were measured for twenty years. At the end of this time Mr. Vogelmann commented, "(Twenty years ago) the trees were luxuriant, the forest was fragrant, and a walk among the conifers gave one a feeling of serenity. But you wouldn't believe it today. The forest is collapsing. It looks like somebody dropped a bomb up there." Nearly half the red spruce in the region are now dead. Vogelmann's luxuriant and primevil forest of the mid-1960's is now one of the naked dried up tree skeletons. Studies also show that acid rain has a devastating effect on sugar maples, walnut, and apple trees, putting quite a few wood products industries in danger.

However, there is a glimmer of hope. New research projects are leading to ways of combatting our "environmental AIDS". As public awareness increases the move towards a cleaner atmosphere is gaining momentum. The new Clean Air Act regulates the amounts of emmisions a power plant can eject to a level that the Environmental Protection Agency and the particular state's legislature deem within the limits of safety. Power plants begining construction from now on will have to be equipped with "scrubbers": a lime spray that is injected into plant emmisions. The spray neutralizes up to 90% of all sulfur dioxide leaving the plant.

New ways to deal with the problem once it has already occured are also begining to surface. Lakes already dead due to high acidification are now being sprayed with lime to neutralize the acid and bring the Ph level back to normal. Once the Ph has been normalized, rebirth of the lake can begin with restocking and revegitating. In the near future, alternative energy resources such as solar, wind, hydroelectric, and geothermal will be implemented to help relieve the load on our coal burning plants. As research increases, our environment can find comfort in knowing that help is just around the bend.

While enjoying the next sunset, take time to observe the beauty of the trees, the grass, the wildlife, and all of the nature around you. Now picture the dust bowl days the western plains experienced in the 1930's: a world without color or creativity; a world of gray indefinite shapes. Now place yourself in the latter conditions. Is acid rain going to be the end of our environment?

The Love Canal

by Clement Audu

One of the main tragedies in the disposal of hazardous wastes has been the incident at the Love Canal waste dump, which resulted in health and psychological problems, as well as the relocation of hundreds of people.

Consider a brief history of the Love Canal. In the 1890's William T. Love, a wealthy man decided he would construct a canal upstream of the Niagara Falls, harness th power from the flow and subsequently release the flow back into the Niagara River downstream of the falls. Construction of the canal began, but by the time the canal was one mile inland and 100 feet wide, William Love had exhausted his funds and had to abandon the project, without realizing that his misfortune was in future to become that of hundreds of people as well. Many families built homes around the edges of the canal as they were quite scenic at.that time.

About ten years ago many residents noticed strange liquids seeping out of their basements and walls.

Many years later, Hooker Electrochemical Co. (now Occidental Chemicals) bought the canal and converted it to a waste dump, using it for many years. After the canal was relatively full of wastes, Occidental filled and covered it (land reclamation) and sold the "new" land to the local school board which built a school on the land. But about ten years ago many residents noticed strange liquids seeping out of their basements and walls. The local health board was called in to investigate, but it informed the residents that there was no real cause for alarm, as the board believed the leaks were rather harmless. Many residents began experiencing illnesses, most accompanied by headaches, not long after noticing the leaks. This time, the state health board decided to investigate as to whether there was any connection between the reported illnesses and the chemical leaks. The state health board did find relations between the two. Due to the seriousness of the incident, President Carter and Governor Cuomo of New York met on this issue, and 239 houses were listed as being in a danger zone, requiring the evacuation of the residents.

Mass hysteria developed among the residents living around the boundaries of the danger zone. Due to their close proximity to the danger zone, they were uncertain as to how much they had also been contaminated. These residents were intially informed that they were safe, only to be later told that they too would need to be relocated. Between 800 and 1000 houses were included in this second danger zone. But not all the residents in the danger zones agreed to relocate. A few, notably the elderly and poor, elected to remain behind in their old homes, risking further chemical contamination.

The frightening reality of the Love Canal episode is the fact that there are 100 pounds of dioxin buried somewhere underneath the canal. One hundred does not seem like much until one considers that the LCL (lowest lethal concentration) for humans is 3x10 -9 moles per kg! Also important to note is that Hyde Park landfill, which is close to Love Canal, has 2000 pounds of dioxin buried there, which makes the area very unsafe as the dioxin leaches out into the water supplies of surrounding communities.

Love Canal and Hyde Park landfills are not the only land fills around the Niagara area. There are an estimated 200 waste dump sites in Niagara and Erie Counties alone. Also included are two licensed dump sites in the Niagara area, which by being licensed, have attracted hazardous wastes from various parts of the US. Although hi-tech disposal methods and processes are employed in these licensed sites, their safety record will be tested with time.

Not only the lands around Niagara Falls are contaminated, but the Niagara River is also affected. There are sixty points of entry of chemical wastes into the river, and although each source discharges chemical wastes below the maximum limit allowed, the sum of all sixty discharges exceeds the limit. It should also be noted that eighty percent of the inflow into Lake Ontario comes from the Niagara River. Consequently, it is the communities around Lake Ontario that will with time experience the effects of chemical contamination of the Niagara River.

Chemical contamination has affected the residents physically psychologically and socially. Liver and kidney problems have been reported. But most notable were the many complaints about headaches. Other medical complications might not be evident for many years since some of the carcinogenic chemicals that leaked out give rise to illnesses with long latency periods. Psychological effects result from the uncertainty and worry by the residents as to how contaminated they are, what kind of ailments they may contract, and how long they might live. The social complications of the Love Canal incident were manifested in divorces, loneliness, and loss of friends and relatives. School enrollments dropped sharply as many families relocated elsewhere. A church had to close down because all its members had left. The social fabric of the area around the Love Canal was destroyed. The few remaining behind had to contend with living in a virtual ghost town.

Chemical contamination has affected the residents physically, psychologically and socially.

The Love Canal episode is one of the worst known cases of inadequate containment and disposal of hazardous waste. However, there are numerous other haz-

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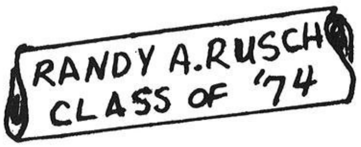
Alumni News

by Tim Cartwright

Randy A. Rusch, a graduate from the University of Wisconsin-Madison, received a bachelor degree in Applied Math- Engineering Physics in May 1974, and he obtained a masters in Electrical Computers two years later. Rusch said his interest in engineering was sparked in first grade when President John F. Kennedy announced the start of a space program that would put a man on the moon.

"I would give a ten to one preference to someone who has co-op experience."

Growing up in near by Fort Atkinson, Randy furthered these interests by attending the university and challenging himself against the best students in the state. Once on campus, he busied himself with schoolwork, employment and IEEE. The choice to continue on towards a masters degree was benifical to him as he received many employment offers after graduation.



He accepted an offer from the Delco Division of General Motors. According to Randy, this decision was influenced by a high school hobbie of tinkering with cars and also a tremendous growth potential within the company. When he joined the company, automobiles had relatively few electronic devices compared to today's cars. The demand and need for more circuitry was increasing, and Delco had the resouces to become a leader. To date, Randy has been with the company for nine years and is currently working with IC processing and wafer fabrication.

The WE asked Randy the following questions:

Q: What do you feel your company has accomplished towards reversing the ill-effects of industry on the environment?

A: "I think that we have always had those (problems with the environment). Even before the Industrial Revolution we had disease just from the horse manure in the streets and things like that. There have always been problems no matter what mode of transportation and living is in state. I think that as the population and the number of cars grew, pollution became greater. I really do believe it is a problem. I am not opposed to the pollution devices we have put on (to cars). It's one of those things where, when we're challenged, engineers can meet the challenge."

Randy has been with Delco for nine years and is currently working with IC processing and wafer fabrication.

Q: What steps does your company take in combating pollution?

A: "With the car there are a lot of pollutants. Arsenic and things like that entering the environment could be catastrophic. I would say that my management

does not just pay a lib service to 'don't put bad things into the streams and rivers'. It is beyond lib service, to the point where we have to go to training on a monthly basis. There is a true commitment from my company. We have to live here as well."

Q: Do you have any advice to give to students?

A: "There are two things I wish would have done (when I was in school). I tried to get through college with no debts, so I had alot of part-time jobs. As I look back, if I had the chance to do it again, I would have become more involved in organizations, groups and things like that. I would have also become more involved the co-op program. Today, I would give a ten to one employment preference to someone who has done a co-op with us or another company."

(continued from 20)

ardous waste dump sites which are potential "time bombs" waiting to unleash suffering on surrounding communities. No amount of monetary compensation is enough to make up for the medical, psychological and social horrors of victims of such incidents. As such, only persons with great scientific and technological expertise as well as much foresight and compassion for humanity, ought to be given the task of designing effective and efficient hazardous waste disposal systems. Until such effective and efficient systems are devéloped, we must continue to live with the fear that many of the present hazardous waste sites could very well provide the next "Love Canal".

Information for this article provided by Prof. DeWitt, IES Dept., UW Madison.

Research Literature: the Inside Scoop

by Pat Davidson

Does it ever seem like you keep reading the same sentences when reading your textbooks or research articles? Many times they are vague and you are never quite clear as to what they are alluding. I recently got the inside story from my thermodynamics TA. He gave me a paper that will help all of us the next time we start reading those heavily foot-noted fifty page chapters. So here goes...

Keys to the Reading of the Research Literature

ITFM	REALLY MEANS
1. Typical results are shown	The best results are shown.
2. It has long been known that	I haven't bothered to look up the original references.
3. ... of great theoretical and practical importance.	Interesting to me.
4. While it has not been possible to prove and provide definite answers to these questions.	The experiment didn't work but I figured I could get a publication.
5. The system was chosen especially the predicted behavior.	The fellow in the next lab had already made the system up.
6. Three of the samples were chosen for detailed study.	The results of the other samples didn't make sense.
7. ... accidentally strained during mounting.	Dropped on the floor.
8. ...handled with extreme care throughout the experiment.	Not dropped on the floor.
9. Agreement with the predicted curve is:	
excellent	fair
good	poor
satisfactory	doubtful
fair	imaginary
10. It is generally believed that...	A couple of other guys think so too.
11. It is clear that much work will be required before a complete understanding...	I don't understand it.
12. Unfortunately, a quantitative theory to account for these results formulated.	Neither does anybody else.
13. Thanks are due to Joe Glotz for the assistance with the experiment and to Dr. Doe for valuable discussion.	Glotz did the experiment and Doe explained what it meant.

Keep these in mind the next time you would like to know what the author is really saying.

Seek and Find

by Charles Spengler

This is the engineers word search!
Good luck.

Digital,IBM, computer, railroads, chip, triangles, engineer, tripods, disk, trifids, Hook's Law(hookslaw), who, friction, doctor, matrixes, rocky, algebra, horror, differential, thermal, equation, expansion, shuttle, fuel cell(fuelcell), dorm food(dormfood), letters, science, time, lab, Young's Modulus(youngsmodulus), stress, strain, force, area, harmonic, torsion, cross products(crossproducts), fun, all, work, and, no, play, makes, johnny, a dull(adull), boy

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D I G I T A L R E T U P M O C G H M E S T
O I A R E A A F Q N I O H W S H U T T L E
C L S L S W I S U A G M S T R A I N D J E
T A D K S A T R A E L I E E M C A P R S A
O B N R E I N F T A L G N M R E S T F G L
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D O U W T K R R O R D O E B E T S I B M W
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Seek and you will find.

Engineering Briefs

compiled by Nicholas Denissen

Chemical Engineering

The developement of a new Chemical Engineering Bioseparations Laboratory, under the direction of Prof. Lightfoot, should provide a basis for improved teaching, service, and research and add new dimensions to the department's already significant activity in this important area. The laboratory will be a specialized unit operations facility designed for undergraduate and graduate teaching and as a service facility for local industry. It will also serve as a source of data for the ongoing research in bioseparations.

Initial funding for this laboratory has been recieved from Amoco Corporation and the College of Engineering. The initial emphasis will be on the scale-up of protein fractionation by high performance liquid chromatography, membrane-based separations, and selective dissolution and precipitation. The department's first application is expected to be the fractionation of crude ligninases in sufficient volume to support the current research program on enzymatic pulping at the U.S. Forest Products Laboratory in Madison.

Agricultural Engineering

The Department of Agricultural Engineering has hired three new faculty members during the past year. Roger Tormoehlen is working in the area of farm safety education and will be working with rural residents throughout Wisconsin to improve safety awareness. David Kammel has been hired as an Extension Specialist. Dr. Kammel has begun a research project designed to reduce stray voltage problems on dairy farms. Kevin Shinners has assumed a teaching and research position in the power and machinery area of Agricultural Engineering. Dr. Shinners has conducted research in the area of forage harvesting.

The Agricultural Engineering Department recently received a grant to update laboratory equipment in its Power and Machinery Laboratory. Funds will be used to modernize undergraduate laboratory equipment and to purchase data processing equipment for the laboratory.

General Engineering

Professor Edward E. Daub, of the General Engineering Department, is currently doing research involving strategies for learning technical Japanese. The Department believes it is important for students to have the oppertunity to learn a skill that is that is in increasing demand by corporations. In addition, Professor Daub is undergoing research in issues in the dialogue between science and theology. This research stresses the need for people of all fields to work together in solving the social and political problems we are currently facing.

Professor Gretchen Schoff is also conducting research involving communications. She is researching the design of in-house industry writing seminars, technical reports, memos, and letters in industrial settings. In addition to this, she is working on operators and service manuals for all kinds of products.

Metallurgical and Mineral Engineering

Professor Y. Austin Chang, Chairman of the department, is extensively involved researching applications of the principles of physical chemistry to materials of technological importance. This includes studying the effects of magnetic interaction on the low-temperature phase equilibria of iron alloys; battery alloys of lead with small amounts of other elements such as tin, calcium, selenium, tellurium, etc.; defect structures of chalcogenides; low-temperature oxidation of low-melting alloys for electronic devices; interaction of structural materials with sulfur and oxygen at high temperatures; phase equilibria of II-VI and III-V binaries and of ternary metal-oxygen systems; computer graphics in representing ternary phase diagrams. This research is carried out by experimental investigastions with thoeretical modeling and computer calculation.

Biomedical Engineering (Biomedical Engineering Center)

The application of problem solving skills of the engineer to problems in medicine and biology is the concern of biomedical research. Computerized tomographic imaging system and the implantable pacemaker are some of their recent developments. The Biomedical Engineering Center (BMEC) serves as the focal point for collaboration in biomedical engineering.

The University's Center for Health Systems Research and Analysis (CHSRA) was founded to improve health policy, planning, and delivery through the use of systems engineering techniques and technology. The faculty consists mainly of Industrial Engineering Department's faculty, but also includes an array of faculty and staff from economics, business, jour-

nalism and mass communications, political science, sociology, psychology, edidemiology, and health administration. They have an impressive record of research accomplishments, such as the development of a computer-based suicide detection system which predicts whether or not a patient is suicidal, a study of information needs of mental health policy makers, a study of the role of state government policy in health promotion, and an emergency medical services evaluation project. Their current research is in patient management and policy, and health care policy.

Energy Research (Applied Superconductivity Center)

The Applied Superconductivity program was founded about 12 years ago at University of Wisconsin. Their research involves applications in which the disappearance of all electrical resistance is vital. This mainly includes magnetic field devices and Josephson logic and quantum effect devices. The faculty are from Engineering Mechanics, Nuclear, Metallurgical and Mineral, Mechanical, Chemical, and Electrical and Computer Engineering. They are funded by the United States Department of Energy, the Wisconsin Electric Utilities Research Foundation, the National Science Foundation and the Electric Power Research Institute at $1.6 million a year.

[redacted]

TECHNOCROSS

Solve the puzzle and win a prize! The first two readers submitting correct solutions to the Wisconsin Engineer office will be awarded a prize worth $12.00.

The grid that looks like a crossword puzzle will be a quote from a book once all the letters are filled in correctly. It reads across only, with black squares separating the wo [redacted] tell you w [redacted] to solve [redacted] he quote [redacted]

S [redacted] he blank [redacted] ch letter [redacted] he puzz [redacted] ou know [redacted] ds: as n [redacted] re-veal [redacted] ck-ward [redacted] the grid. As a [redacted] title of the book from which the quote is taken is embedded in the first letters of the definition words.

Good Luck!

1 B	2 U	3 C	4 X	5 U	■	6 X	7 G	8 P	9 Y	10 H	11 Q	■	12 K	13 A	14 Z2
■	15 K	16 Z1	17 R	18 C	19 U	20 T	■	21 O	22 X	23 Q	■	24 B	25 O	26 T	27 A
28 E	■	29 V	30 U	31 W	32 E	33 S	34 M	35 G	36 U	37 L	38 D	■	39 G	40 N	41 S
42 S	■	43 A	44 T	■	45 J	46 E	47 V	48 H	49 I	50 Z2	51 S	■	52 R	53 B	54 W
55 A	56 C	57 G	58 Y	■	59 J	60 K	61 Z	■	62 Z	63 B	64 Z1	65 J	66 N	67 T	68 X
69 E	70 I	■	71 J	72 X	■	73 U	74 F	75 T	76 Z	77 N	78 L	79 B	80 Q	81 T	■
82 S	83 X	84 M	85 N	86 G	87 R	88 G	89 D	90 P	91 Z2	92 A	■	93 N	94 T	■	95 D
96 M	97 Y	98 U	99 T	100 J	101 X	102 M	■	103 F	104 T	105 Z1	106 U	107 C	108 A	109	110 Z1
111 O	112 G	113 T	114 C	■	115 S	116 Z2	117 Z	118 O	119 C	120 Z1	121 K	■	122 L	123 Y	124 S
■	125 B	126 P	127 R	128 C	129 T	130 I	131 Z	■	132 C	133 Z1	134 I	135 V	■	136 L	137 U
138 L	139 W	140 J	141 S	142 Z	■	143 T	144 J	■	145 R	146 Q	147 B	■	148 P	149 F	150 Y
151 D	152 T	153 C	154 F	155 S	156 B	157 U	158 A	■	159 G	160 R	161 B	■	162 C	163 H	164 J
165 X	166 B	167 L	168 W	169 R	170 T	171 G	172 I	■	173 R	■	174 A	175 V	176 F	177 K	178 L
179 C	180 C	■	181 U	182 X	■	183 E	184 Z1	185 O	186 I	187 L	188 H	■	189 C	190 X	■
191 N	192 N	193 C	■	194 B	195 X	196 C	197 I	198 S	■	■	■	■	■	■	■

A. Chemistry basics — 108 55 158 174 27 13 43 92

B. Sort of wastes eliminated by kidneys — 63 79 161 166 194 125 147 151 24 55 1

C. Milwaukee employer — 128 3 196 193 179 132 114 180 107 18 162 189 153 56 119

D. Risky; highly uncertain — 89 151 95 38

E. Short messages — 28 69 32 46 183

F. Worst part of a semester — 149 74 176 154 103

G. Julius Caesar's last words (3 wds., Latin) — 171 57 88 39 159 86 7 112 35

H. Surname of two Scottish polar explorers — 10 163 188 48

I. Dwarfed — 172 130 49 70 186 197 134

Pages of the Past

[redacted]

by Paul A. Stone

During a recent excursion into the attic above the WISCONSIN ENGINEER office I came accross an old, dust covered trunk. Visions of lost treasures flashed through my mind. Upon opening it, I was not disappointed: I found a set of bound volumes of the WISCONSIN ENGINEER dating back to it's conception in 1896. In this and future issues of the WE, I'd like to share some of these "pages of the past" with you. It's interesting to note the type of things engineers were concerned with almost 100 years ago! So here it goes; lets take a look at our beginnings: the WISCONSIN ENGINEER - Volume 1, Number 1, June, 1896:

(continued on 26)

J. Big rock envisioned by Kubrick	45 71 164 144 65 140 59 100
K. Burnt residues	12 177 60 15 121
L. First nuclear-powered sub	136 122 187 138 167 37 178 78
M. Ill	102 96 84 34
N. Texas NASA center	192 93 66 40 191 85 77
O. " ____ is found lying with the wife..." (3 wds., Deut. 22:22)	118 25 185 109 21 111
P. Skin eruptions	148 90 8
Q. Deep, profound	146 23 126 80 11
R. Water pipeline	87 52 169 173 127 160 17 145
S. Both Marxist and deceased (3 wds.)	198 41 82 33 141 124 42 51 155 115
T. Farm product of Idaho (2 wds.)	94 104 67 99 129 170 75 152 26 113 143 44 81 20
U. Pertaining to atmosphere 25 to 250 miles overhead	30 137 36 181 19 106 2 73 5 98 151
V. Fabric joint	135 175 47 29
W. Shindig; blowout	168 54 31 139
X. A French engineer's magnum opus (2 wds.)	4 68 182 72 83 6 165 190 195 101 22
Y. Like warm honey or old brie	150 9 97 123 58
Z. Bestows; delivers	142 62 117 76 131
Z_1. Left out	120 16 64 110 105 184 61 133
Z_2. Tear apart	50 116 91 14

[redacted]

(continued from 25)

The [redacted]

PUBLISHED QUARTERLY BY THE STUDENTS OF

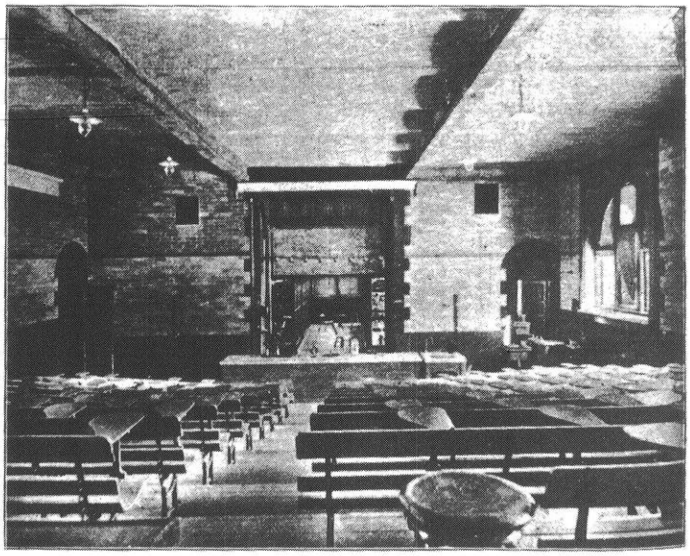
THE COLLEGE OF ENGINEERING, UNIVERSITY OF WISCONSIN.

Vol. 1. Madison, Wis., June, 1896. No. 1.

Wit [redacted] gineer comes out for its trial t [redacted] lism. While, as with any new [redacted] stments will no doubt be founc [redacted] rds of encouragement receive [redacted] ation of this number, have led u [redacted] an interested and friendly inspe [redacted]

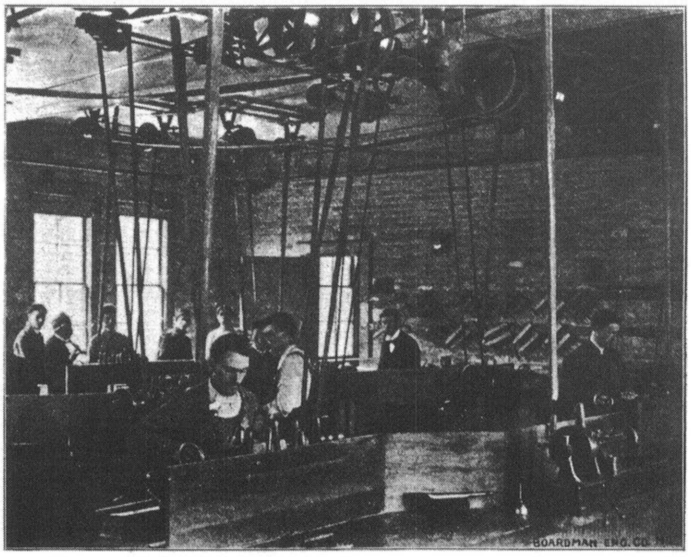
It has for some [redacted]e of many students and alumni of the College of Mechanics and Engineering that they might have a representative among the periodicals issued by technical schools of the country; and that, if possible, they might take, as an institution, some more active part in the dissemination of engineering knowledge and experience. It is the aim of this journal to fill that want in so far as it may be able. It is desired more especially to make known the results of original investigations by students and others connected with the University and to publish communications of general interest from graduates who are engaged in the practice of their profession. From time to time will appear short notices of matters of unusual interest connected with the University, and space will also be allotted to alumni notes. Let it not be understood from this that our pages will be restricted entirely to the use of those connected with the University. Articles of merit will be gladly received from any who may see fit to contribute. A general index to periodical engineering literature is designed to be a special feature of the magazine. Our reasons for undertaking this work will be given more in detail in the introduction to that department.

The loyalty of our alumni and students to "Old Wisconsin" is proverbial and it is hoped that this publication may still further strengthen the feeling of brotherhood among them and prove a source of mutual benefit, while at the same time contributing something of interest to the profession at large.



PHYSICAL LECTURE ROOM.

The Physical Lecture Room contains seats for 200. Its equipment is the most modern. The lights are connected with a stage dimmer by the use of which they can be regulated to any desired degree of illumination. By means of curtains controlled by a hydraulic device the room can be darkened on turning a valve. There are two stereopticons, the screens for which can be raised or lowered at pleasure. The lecturer's table is fitted with a small Pelton-wheel for operating light machinery. There are numerous other conveniences, all of which help to make this an ideal lecture room.



WOOD SHOP.

The Wood Shop is in the second story of the Machine Shop. There are thirty-two lathes all of which were built at the University. There are also the same number of benches so that sixty-four students may work at one time. The freshmen begin their shop practice here, the work being elementary, consisting of carpenter work, turning and later some pattern work. Each is required to use his own patterns for the exercises in moulding. Blue prints of all the exercises are furnished and the students are required to follow the drawings.

Engineer's Library
Nuclear War: the Grim Realities

by John Hilgers

graphic by Jeaneen Haley

Today, nearly everyone is has an opinion about nuclear arms control and nuclear war. There is much debate as to whether civil defense should have been discontinued and how much good it would have been had there been a nuclear war.

"The Effects of Nuclear Weapons" published by the United States Atomic Energy Commission in 1962 is a book which answers these questions. While finding a copy of this work may be difficult, it may well be worth your time. Even though this book is twenty years old, it was published after most of the U.S. above ground nuclear testing was done, and it will give the reader a fairly good understanding of the short term effects of a nuclear burst.

The book will give the reader a fairly good understanding of the short term effects of a nuclear burst.

Each section of the book is divided into two sections. The first section deals with the concepts of the topic, contains many interesting pictures and illustrations, and is written for the general reader. The second section is devoted to the scientific aspects of the topic and may be omitted without loss of continuity. The scientific aspects section is often empirical and deals with many equations and graphs. This makes it easier to get a general overview and still be able to get specific information on subjects of particular interest.

The report starts with a general description of nuclear devices and then deals with the differences between nuclear and conventional explosions. Following the description of the process of energy release in fission and fusion reactions is an explanation of the different types of detonations.

The types of detonations are related to the height. A surface or "dirty" burst is (as the name implies) both highly radioactive and close to the ground. It is defined as a nuclear detonation which is close enough to the ground to suck a significant amount of debris into the fireball. Here they are mixed with radioactive residue from the reaction. The relatively large size of the debris causes them to fall to earth quickly and this forms a locally high radiation area to form around the target.

An air burst is comparatively "cleaner" because fallout must be formed from particles already in the atmosphere: usually water molecules (rain) or dust. The lack of debris also causes the fallout to remain in the atmosphere long enough for some of the more unstable isotopes to break down into safe elements. The remainder of the residue is scattered over a large area, and its effect is greatly reduced.

A surface or —dirty— burst is both highly radioactive and close to the ground.

There are also high altitude, underground, shallow and deep water blasts which are covered in detail. Next the air blast and shock wave are covered. The book describes in great detail the predicted damage to housing, industrial structures, commercial and administrative structures, transportation, utilities, and communication and predicts their useability after a nuclear burst.

The next topic is radiation. A nuclear device releases a substantial amount of nuclear radiation in a burst. The nuclear radiation has a much more limited range than the destructive thermal radiation. Most persons receiving a fatal dose of nuclear radiation are killed by the thermal and blast effects. The thermal radiation is capable of causing fires out to a distance of twenty-five miles from a twenty megaton bomb.

The book describes in great detail the predicted damage to housing, industrial structures, commercial and administrative structures, transportation, utilities, and communication.

The last and probably most far reaching problem is the effect of fallout. Both worldwide and local fallout are discussed in detail along with the impact of strontium-90 fallout. Strontium-90 is treated by the body as calcium and is stored in the bones.

Many long range problems are covered in the book, but the more modern theories such as a nuclear winter or a nuclear ice age are not considered. "The Effects of Nuclear Weapons" is still a great introduction for further reading on the subject of nuclear weapons and their effect on our society.

Just One More

After jumping ship in an effort to obtain psychological asylum in Madison, WI, these two sailors were inadvertently returned to their ship, the U.S. Coast Guard #104. WSA has issued a subpoena to the captain of the ship requesting to speak with the sailors. It is not clear what action Hoofer's would take if the ship tries to leave Lake Mendota without acknowledging the subpoena.

WE Photo Library

Lisa Dickson, Georgia Tech '83, Major Appliance Business Group, General Electric Company

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