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# A Search For Unity In Engineering

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Science Hall Historical

Josephson Junctions

Trash Removal and Recycling

# wisconsin engineer

PUBLISHED BY THE ENGINEERING STUDENTS of the UNIVERSITY OF WISCONSIN



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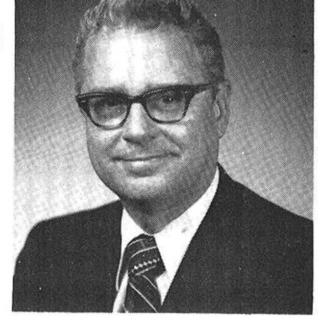
# Engineering: Unity and Ethics



Dean W. Robert Marshall

When I was originally requested to write the Dean's Page for the February issue of the *Wisconsin Engineer* it was suggested that I might address my comments to the question of whether or not there should be "a powerful regulating engineering association" to maintain strict codes of conduct and professional ethics for the engineering profession. Because of the complexity of this question, I responded by suggesting that the March issue of the *Wisconsin Engineer* might address itself to this topic broadly, with input from a number of engineers — not just the Dean. Apparently, however, this did not cancel the demand of Associate Editor Don Johnson for comments about this subject on the Dean's Page.

In preparing the brief observation set forth below, I have attempted to outline, in very abbreviated form, some history of the engineering profession's concern about unity in a broad sense with concluding observations on the subject of engineering practice, conduct, and ethics. The general topic of unity in the engineering profession has received so much attention over the past five decades that it is impossible to do justice to the subject in a synoptic manner; however, the efforts of the profession should be a matter of knowledge to all engineers—students and practitioners.

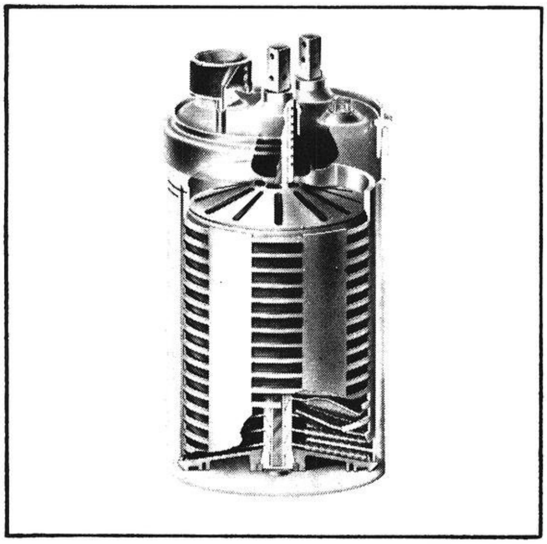
The engineering profession has long sought a goal euphemistically referred to as UNITY. Because engineering is both taught and practiced in a number of disciplines, it has been the dream of leaders of the various engineering disciplines to establish or create a unity or umbrella organization which would serve **in some way** the entire profession on matters of common interest. The first such organization was the American Engineering Council, formed in the early 1920's to advise the Government on engineering problems of national concern. Its first president was Herbert Hoover. The Council's existence depended substantially on the support of the Founders Societies, ASCE, AIEE, ASME, AIME, each one of which contributed funds in proportion to its membership for the Council's support and activities. The Council concerned itself in the '20's and '30's with major national engineering problems, such as the creation of standards, advice to Government agencies, etc. It did **not** concern itself in any legal way with professional ethics or professional conduct. The Council ceased to exist when the professional societies withdrew their financial support in the depression years of the '30's.

However, still in search of the goal of Unity, in the 1940's the engineering professional societies created the Engineers Joint Council, EJC, which was almost solely dependent on the professional engineering societies for financial support. EJC was intended to bring the engineering profession together on matters of common professional interest, but it did not — and was not intended to — concern itself with the ethical behavior or the competence of the engineering practitioners. Unity was concerned with achieving the appearance of a united front on those matters which dealt with the governmental utilization of the profession, international programs, economic problems of the profession, engineering manpower, etc. A collateral organization called the Engineers Council for Professional Development, ECPD, had been formed in the 1930's to give attention to maintaining minimum standards of engineering education and is the accrediting agency for engineering curricula. Although ECPD did not concern itself with regulating engineering, it did develop a Canon of Ethics for engineers which is currently undergoing revision and study in response to the current public alarm about the professions in general. The Canon of Ethics has no legal force. It is the engineer's personal responsibility to obey it.

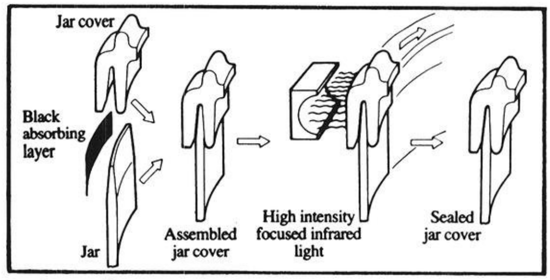
The problem of ensuring that the public health and welfare would be adequately protected when engineers practice their profession began to evolve into a legal process in 1917 through the creation of state boards for the regulation and licensing of engineers. State boards, created by law, were delegated to determine through examination and other means whether or not an individual is qualified to practice engineering in the given state. The boards are required to implement the state statutes which created them, to establish rules of procedure, and to develop adequate language in the rules to define misconduct, incompetency, etc. In the Wisconsin Statutes there are sections which deal with the questions of what is incompetency, misconduct, as well as unethical practice and behavior.

It would appear that the statutes and procedures of the individual state regulations for engineering practice are reasonably workable. Also, there is a continuing effort to bring uniformity among the state licensing laws. It does not appear feasible or practical at this time that a single national organization is needed or even workable to license, regulate, and judge the engineering practitioner. Our existing state laws and regulations provide all citizens with the opportunity for complaint or grievances if they feel that any engineer has stepped over the bounds of ethics or has been negligent or incompetent. However, let us recognize that in the last analysis regardless of laws or codes of ethics, the individual engineer must be aware of his responsibilities to society, and he must know his short-comings and limitations as well as his strengths.

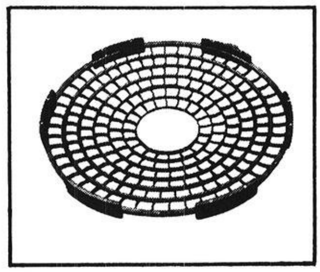
WE



A cutaway view of the new lead-acid battery. For use in the Bell System, four types—each with a different ampere-hour capacity—will replace the 60 configurations currently in use over the same capacity range.




In the sealing process, focused infra-red light is absorbed in a carbon black coating at the jar-cover interface, causing localized melting of the plastic.



The positive grids are designed so that as corrosive growth occurs the space between hoops remains constant. Thus contact with the paste is maintained and electrical capacity actually increases with age as corrosion produces additional lead-dioxide material.

# Developing a new lead-acid battery.

Every year, Bell System telephone companies spend over $30 million to buy and maintain the lead-acid batteries they use as intermediate sources of standby power during emergencies.

So they know just how susceptible all lead-acid batteries are to problems caused by corrosion. Problems such as gradual loss of capacity, short- circuits and cracking that could result in acid leaks and occasional fires.

That's why Bell Labs and Western Electric engineers recently undertook the first major improvements on what is essentially a 100-year-old design.

The result: a revolutionary, cylindrical lead-acid battery with a jar and cover fabricated from an improved flame-retardant, impact-resistant polyvinylchloride. The bond between jar and cover is leakproof due to a new infra-red sealing process.

Inside the battery are circular, cone-shaped grids cast of pure lead rather than a lead alloy, then stacked horizontally in a self-supporting structure. Positive grids are cast with large grain-size to minimize corrosion. They're then filled with a paste (tetrabasic lead sulfate) whose rod-like particles interlock for maximum mechanical stability.

These new features required new manufacturing techniques. For example, how could potential suppliers best mass-produce positive plates of the required grain-size and paste the grids rapidly and efficiently, given their conical shape and the new oxide material's crystal structure?

Western Electric's Purchased Product Engineering organization and Bell Labs set up a design capability line at a company subsidiary, Nassau Smelting & Refining.

Using machinery developed at Western Electric's Kearny Works, they refined production methods and materials that made it possible for a supplier to produce the new battery economically, in commercial quantities and to Bell System specifications.

And Western Electric plans to achieve still further savings through a continuing cost-reduction program.

**Conclusion:** Close cooperation between Bell Labs and Western Electric has resulted in the creation of a superior lead-acid battery. Its expected useful lifetime is at least 30 years—double that of even its best predecessors. It lowers maintenance costs substantially. And its unusual design virtually eliminates the hazard of fire due to mechanical failure.

**Western Electric**

**We make things that bring people closer.**

Comment

# "Engineers Stand Tall and Clean"

Roger E. Krempel
President, WSPE

National events of recent months, particularly the fee kick-backs and political contributions disclosed in the Agnew affair, have the public wondering if there is something lacking in regulation and ethical discipline of the Engineering Profession. Serious questions have been raised about the practices and conduct of at least a half dozen engineering firms. The questions in turn lead to increasing cries for a more pervasive, collective social conscience. Engineering students might well be asking themselves, "What kind of a profession am I getting into?"

WE IN THE WISCONSIN SOCIETY OF PROFESSIONAL ENGINEERS (WSPE) ADVISE THE BUDDING ENGINEERS NOT TO FLEE IN ALARM. ENGINEERING TODAY STANDS ETHICALLY TALL AMONG THE PROFESSIONS AND WILL DO SO IN THE FUTURE.

The more than 1600 members of WSPE recognize that as a representative portion of the 9000 Registered Professional Engineers of Wisconsin, they have a grave responsibility to the public and are dedicated to the advancement and betterment of human welfare. More specifically, they are concerned with those moral and ethical actions designed to protect the health and public welfare of the citizens of Wisconsin. The Society also recognizes the need of maintaining a strong organization providing service to the public, to the engineering profession, and to its members, if these objectives are to be attained. The objectives of WSPE closely parallel those of the National Society of Professional Engineers of which we are also all members.

It has been reported to me that some faculty members and students on the U.W. Engineering Campus have wondered whether it might be wise to have a more powerful professional society that would more closely regulate the first years of practical engineering experience after school as in the case of the American Medical Association, as well as maintaining strict codes of conduct and professional ethics, like the AMA and the American Bar Association.

To that suggestion I say "NO THANKS". With the exception of a few widely and sensationally broadcast corrupt acts the Engineering Profession stands tall and clean. The good works of the engineer are out where the whole world can inspect them, use and enjoy them.

If this accurately represents the feeling on campus, then we have less of a dilemma. While the UW Engineering campus does have registered engineers on the faculty it seems to me that only a very small number are active in our professional society. Recognition on the campus of the need for more professional development and involvement most assuredly is the key to a stronger profession morally and ethically.

For those who may not be aware of the status of our present laws, rules, and codes, a brief summary follows: Chapter 15 of the Wisconsin Statutes provides for the creation of the Engineering Examining Board. Chapter 443 of the Statutes is known as the Registration Law. WSPE feels that the law is weak. Great effort by WSPE has not, up to this point, resulted in any great strengthening of the law since it is still possible to become registered without an engineering degree or passing a written exam.

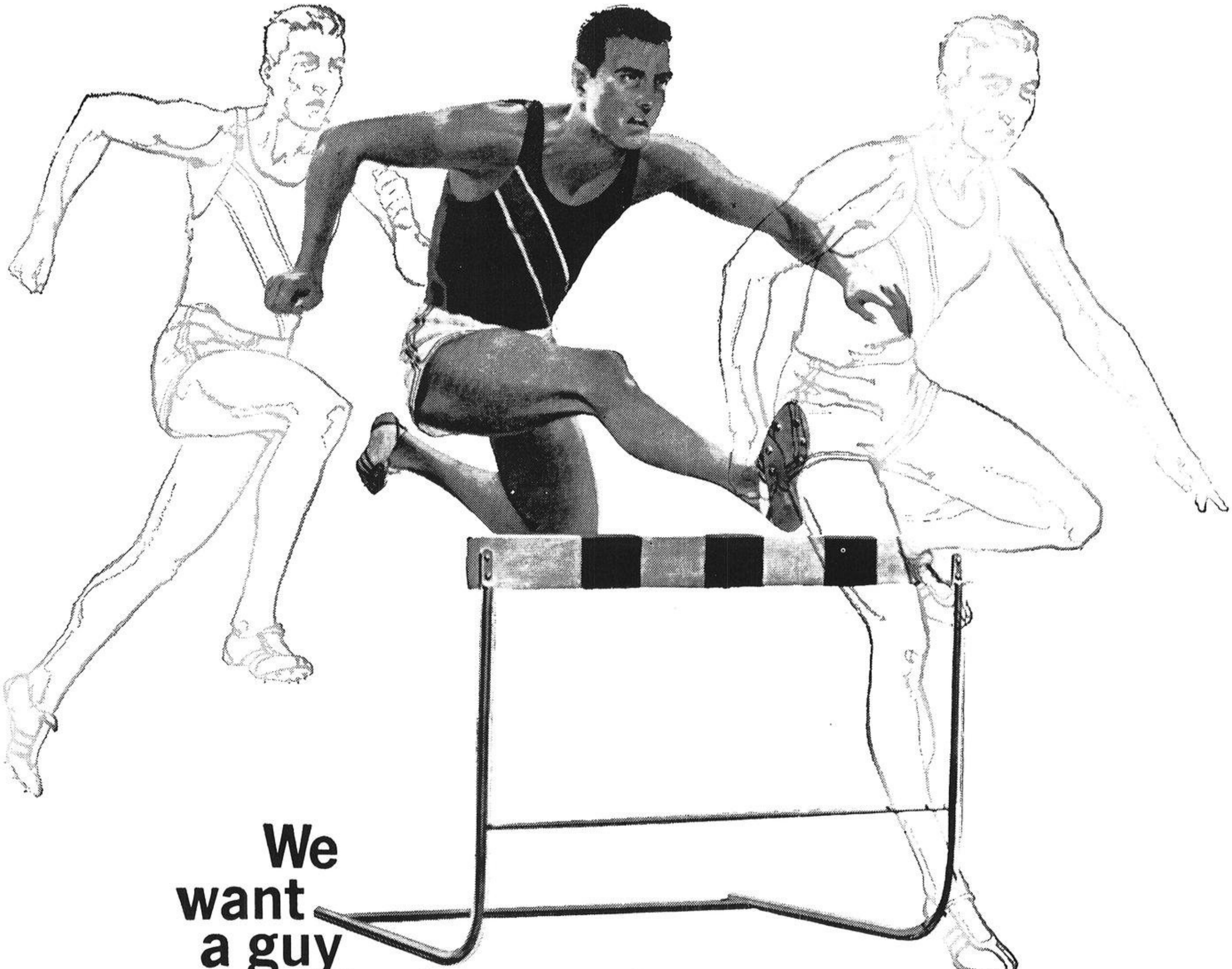
In addition to the Registration Law, an Administrative Code has been adopted by the examining Board which has the force of law in regulating illegal engineering practices. One section of this Code deals with professional conduct. Yet nowhere in the laws or Codes of Wisconsin is there any prohibition of improper solicitation of engineering work, the most reported improper act.

WSPE has adopted the National Society of Professional Engineers' Code of Ethics as its own and this code does have a section prohibiting improper solicitations of work. Section 11-b reads "He will not offer to pay, either directly or indirectly, any commission, political of securing salaried positions through employment agencies". We have no knowledge of any violations in Wisconsin of this section of our Code of Ethics.

On a much broader scope WSPE has been the leader in proposing an entirely new State Engineering Registration Law. The WSPE recommendations followed a lengthy Engineering Licensure study by a Blue Ribbon WSPE Committee.

There are those who doubt the value of a strong profession and suspect that it would lead to severe restrictions in order to create a shortage of engineers and thus lead to limited competition to achieve economic gain. We would be fools not to recognize this as a possibility in the minds of some. It is my conclusion that the Registered Professional Engineer, that is a member of WSPE, is truly dedicated to the advancement and betterment of human welfare, health and safety of the people of Wisconsin.

WE



# The Search for Unity

by Jeff Kratz and Don Johnson

"Engineers must defend the public safety. They cannot do it through an organization. They must do it on their own." According to Adolph Ackerman, a consulting civil engineer, the question of a unified regulating engineering society is an absurdity. He said that ethical questions, such as those revolving around the Maryland engineers involved in the Agnew bribery scandal, should be handled by existing societies and state regulating boards.

In a survey of educators and professionals, the *Wisconsin Engineer* asked if a powerful professional society could answer recent ethical questions and demands for a collective social conscience. We found a general feeling that a national organization would not necessarily solve problems in regulating the engineering profession. Discipline and responsibility, they say, should remain as localized as possible, and are ultimately matters that must be faced by each engineer individually.

Cass Hurc, secretary of Wisconsin's engineering licensing board, said the most frequent conduct violations involve "stamping" work or claiming credit for another's work, and not fulfilling public health, safety, and construction codes.

Currently, each state has a licensing board for engineers regulating conduct and ethical questions. When discipline is found necessary after hearing a case, the board either reprimands the engineer, suspends his license temporarily, or revokes it. According to the engineers interviewed, this sytem of regulation is sufficent and should not be changed dramatically. Hurc explained that the federal government could not pass legislation regulating the engineering profession because it would violate states' rights.

Professor Richard W. Heine
Metallurgical and Mineral Engineering

He feels that there is no reason why a national organization could not certify and list people who have met general requirements, but they should not have the authority to license or enforce any general engineering codes. "It is, after all, a vested interest group which would have difficulty being objective. There must be a separation of powers because rules will be more protective of the individual members than society at large. It is hard to take action against friends."

In the future engineers may be required to take refresher courses or in some way stay abreast of developments in their field, since "more and more people are questioning why engineers are not tested more often or made to update," according to Hurc. "If an engineer does not update he can become obsolete in a few years."

Here are some of the responses to questions surrounding a national regulating engineering society.

*Q: Should there be a probationary period of practical experience for graduating engineers? Is it possible that this may instituionalize the shortage of engineers?*

**Prof. Richard W. Heine, chairman UW Department of Metallurgical and Mineral Engineering:** There is now worry of this. Beginning engineers do very little original work, and therefore, the work they would be judged on at the end of the probationary period would be the work they did while following someone's orders. Any test at this time would have to be very general and would weed out very few people.

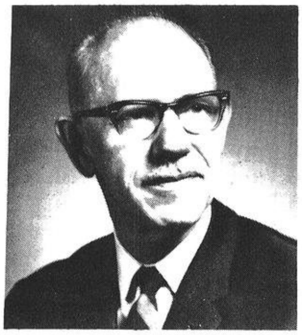
Professor Arno T. Lenz
Civil Engineering

**Prof. Arno T. Lenz, CEE:** Any tests you cold give would have to be technical in nature. Very few engineers would fail to pass. A strict probationary period would weed out almost nobody and would, therefore, make little difference.

**Prof. James R. Villemonte, chairman, UW Department of Civil and Environmental Engineering:** I think that the college engineering program should be set up to take six years, two general years to start, and then four years of engineering education. This would be enough of a probationary period. There should be no probationary period after an engineer graduates from college. He should be registered by the state immediately.

**Adolph J. Ackerman, consulting civil engineer:** The engineering societies and faculties could regulate the first years. If the system became recognized for producing superior graduates, it may be accepted. But a powerful society could not force the faculty if they did not want to participate.

*Q: How do you feel about professional societies providing more input into engineering college curricula?*



Dean Emeritus Kurt F. Wendt

**Heine:** We are not really ready yet, but I would like to see the engineering college as a professional school, like the medical school is today. In this case, the professional engineering societies would have a great deal to say in the development of the engineering curriculum.

**Lenz:** College faculties should get input from the professional societies, but they should retain control of the curriculum. The faculty has a legal responsibility to develop the curriculum, and the professional societies should be able to offer advice, but only advice. College students have changed since engineers in these societies were in college, and some of their ideas may not be practical today.

**Villemonte:** Professional societies should have no control over curriculum. Giving control to the professional societies would be the best way to encourage mediocrity and the status quo.

*Q: In response to questions that have been raised about the ethics of engineers do you feel a national organization with more power to enforce rules would be an answer?*

**Ackerman:** Engineering is an individual responsibility. You can't transfer everything in the way of professional performance to some nebulous body. The concept of trying to create a centralist structure for the engineering profession and trying to pass the buck for individual responsibility is an utter absurdity. How would you get the ultimate wisdom needed in such a body?

Adolph J. Ackerman
Professional Civil Engineer

We should put an engineer's name on his work and rely on a fundamental definition of responsibility rather than some nebulous concept of organization. It is a violation of ethics for engineers who design atomic energy plants not to be identified.

Engineers must defend the public safety. They cannot do it through an organization. They must do it on their own. As long as every individual has the freedom to dissent that's all you need.

**Dean Emeritus Kurt F. Wendt:** When we talk about a unified group, I am not talking about a regulatory one. We will be better off with various states making regulations. I would be very much afraid of a single all-powerful body that presumes to represent police and regulate the profession. I am for a strong unified engineering body that can speak for engineering as a whole, but a separate body, such as state licensing boards, regulating the practice of engineering.

We must be wary of a society with too many functions. It becomes too conflicting to act as legal counsel, judge, jury, and prosecutor all rolled into one. We must keep regulation separate from representation. I am proposing a dichotomy here. Split the responsibility. Create a powerful society, but take the punitive function away. A single society has some very great merits to it, if you don't saddle it with a regulatory function.

**Villemonte:** Enforcement should be in the hands of a state review board. This would be the same board that licenses engineers and they would have the power to revoke licenses when necessary. Present enforcement procedures be involved in enforcement of the rules because they are too involved and do not have a neutral perspective.

*Do you feel there should be some sort of unity organization for engineers as a whole?*

**Wendt:** We have suffered in engineering from the lack of a unified force. We have gained some benefits from specializations in societies but lack a place where we can feel total allegiance and can speak with one voice. A society is not a new idea. We have come close to having one several times.

**Heine:** I would not like to see engineers forced to belong to any organization. I am opposed in principle to being forced to do anything. Engineering is not that well organized, or professionalized, now, and I don't think I would like to see it get too organized. There are many non-engineers now doing engineering work, and I don't think there should be any law against this. There should be some sort of national organization to help engineering develop as a profession. For example, strong educational and training standards could be established. The present organizations have the capacity to do this.

Professor James R. Villemonte
Civil and Environmental Engineering

**Lenz:** I would be against one national organization. I think the smaller societies should remain because engineers in different areas have different interests. Perhaps there should have been only one organization to begin with, but its too late to start now because the smallest groups are too well established.

**Villemonte:** The small societies should remain. Every person practicing engineering should be licensed, and all licensed members should be a member of a national organization, but not necessarily the same national organization.

**Ackerman:** As far as a unity organization is concerned you would have to specify what a society would do that cannot now be done. You should consider what can be done to improve engineering conduct rather than bind yourselves to some nebulous concept that does not do anything anyway. WE

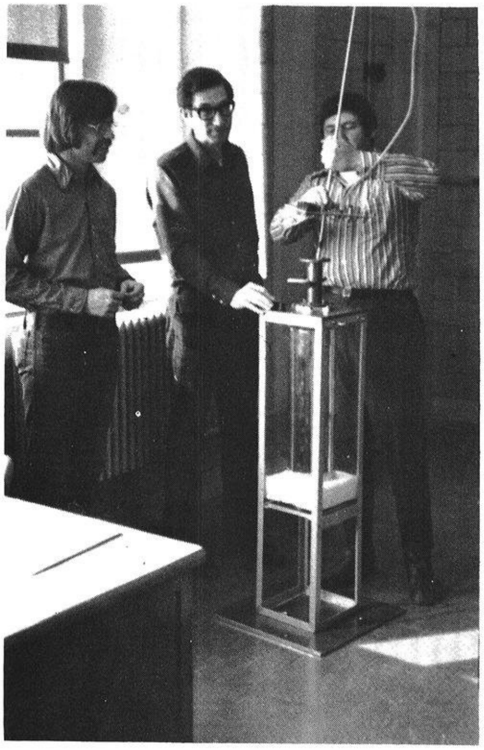
# A Better Way To Josephson Junctions

by Mark Holler of the Engineer Staff

Professor James Nordman of the ECE department and his assistants, Scott Owen and Stan Reible, are trying to make better quality Josephson junctions more consistently. As a result, they occasionally spend a Saturday in the lab around a liquid helium-filled dewar (an elaborate fascimile of a Thermos bottle) monitoring one of these junctions. Their experiment takes place in a copper screen room that surrounds the dewar to prevent any stray radiation from affecting the results.

These junctions are composed of two thin superconducting films of lead and niobium separated by an oxide barrier.

The experiment begins when liquid nitrogen is poured into the outer cavity of the double dewar used for testing. As soon as the pouring begins, a frost starts to cover the silvered glass and the bundle of wires sprouting from the top of the dewar. Once the right temperature is reached any nitrogen which might have entered the center cavity is blown from the flask in a flurry of liquid boiling to vapor.



Research team of Scott Owen, Prof. Nordman, and Stand Reible (l. to r.) inserts test probe into dewar. (courtesy, Bill Ardern)

Next, pressure is applied to a second dewar near the test dewar, that is filled with liquid helium forcing the helium through a vacuum-insulated tube and into the test dewar. When the test dewar is filled with the helium and allowed to reach a thermal steady-state the Josephson junction is about four Centigrade degrees above absolute zero.

At this temperature both the niobium and lead layers on either side of the 25A thick oxide barrier are in the superconducting state. Since keeping the dewar cold for a long continuous period saves the expense of repeated start-ups, the testing usually lasts all day.

To make Josephson junctions more consistantly Professor Nordman and his crew are using integrated circuit (IC) techniques. The use of niobium in fabricating the junctions has improved the reliability and the durability of the junctions. Also to eliminate some of the undesirable junction capacitance, thicker barriers of lower potential are being tried. The integrated circuit techniques and the use of niobium have both been successful, but the production of lower barriers continues to be elusive.

Originally the substrate for the junctions was a thin glass slide. The glass substrate worked well enough and still does when only one large junction is desired. Josephson junctions, however, cannot be made in quantity on a glass substrate because the glass is amorphous and does not cut predictably. A newer technique being examined mainly by Scott Owen, fabricates the junctions using standard IC step and repeat techniques on a silicon chip coated with a thin oxide layer. The $SiO_2$ substrate offers no new physical properties to the junction itself, but it does make a variety of well developed IC processing techniques, including cutting, usable in making Josephson junctions.

In processing a silicon chip, the first step is to deposit a 1000A layer of niobium. The process, which is called sputtering, is done in a low pressure argon atmosphere of approximately $10^{-3}$ torr. Inside the chamber there is an anode and a cathode with a bias between them of about 3000 volts. The 3000 volt potential causes the argon to ionize and the positive nuclei to accelerate toward the cathode where they strike either a sputtering cathode or a junction being sputter-etched depending on whether material is being deposited or removed from the substrate. The argon nuclei strike the cathode and dislodge the cathode atoms. In the first step the cathode is niobium.

A problem has been encountered in etching the niobium, since no common acid will etch the niobium, and the photoresist (a plastic film) decomposes during sputter-etching. Professor Nordman's solution to the problem of etching the niobium is an aluminum layer etched to the desired mask form using a standard integrated circuit photoresist technique. A relatively thick aluminum layer is sputtered over the entire niobium layer. The aluminum layer is then covered with photoresist and exposed to ultraviolet light through a mask with the desired circuit patterned in it. Polymerization takes place where the photoresist is exposed to the ultraviolet light making the

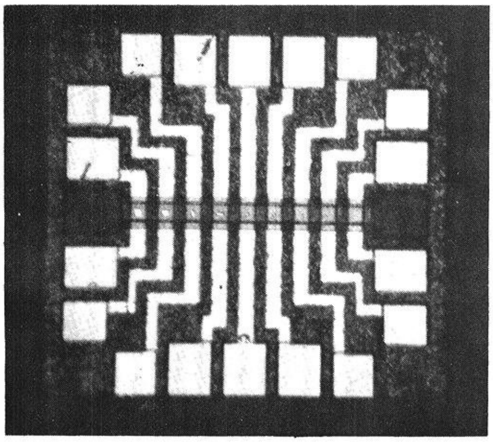


**Figure 1. A 1mm square chip containing nine test Josephson junctions varying in size and shape.**

exposed areas resistant to the acid used in etching. The unexposed photoresist is removed by developing and the aluminum under it is chemically etched away using a combination of phosphoric acid, acetic acid, and nitric acid. However, when desired, the acid-resistant areas can be removed using organic solvents such as acetone or xylene.

The entire chip is then sputter-etched until the exposed niobium areas have been completely removed. At this same time the aluminum protecting certain areas of the niobium will be nearly gone. Again the aluminum etch etches the remaining aluminum from the chip. A heavy oxide layer left by the chemical etching is removed by more sputter-etching.

The junction area is then formed by a small hole in a new layer of photoresist. More cleaning and oxidation in an oxygen plasma produces a clean niobium surface covered by approximately 25A of niobium oxide.

A 5000A layer of lead is evaporated over the whole structure and also chemically etched leaving small lead-oxide-niobium sandwiches, which are the junctions, along with leads which run to bonding or contact pads. Figure one shows a one millimeter square chip of nine test junctions varying in size and shape.

Mr. Owen typically makes 100 or more circuits this size on one substrate and is presently testing the junctions' quality and consistancy over a period of time.

Professor Nordman has worked with superconductive tunnel junctions for a number of years. During the 1972-73 school year he was in Grenoble, France at L'air Liquide Centre d'Etudes Cryogeniques comparing and extending work done by that laboratory and his own on the use of deposited semiconductor films instead of the oxide layer to separate the two superconductive films.

The semiconductors used are germanium and indium antimonide having theoretical barrier heights of 150-600 mV and 50-120 mV compared to the oxide barrier height of about 1 V. The barrier is sputtered on to a thickness of about 100A which is about four times larger than the oxide layer. Thickening the junction will decrease the capacitance and should not change the tunneling probability if the barrier height is indeed lower.

The original theory in this case did not predict all of the complexities involved. The first inadequacy came from not considering the amorphous quality of the semiconductor thin film. Other complications include the Shottky barriers which occur at the semiconductor-superconductor interfaces. Pinholes, as the jargon terms them, occur in the semiconductor film and allow unwanted tunneling, which shorts the junction.

One attempt to eliminate this was to oxidize the niobium through the pinholes to stop them up; however, this also oxidizes the semiconductor and introduces a series oxide layer in the junction which increases the capacitance.

Professor Nordman is now setting up a new high vacuum chamber which will use a 6 kW electron beam to "evaporate" the semiconductor, hopefully then depositing it in a continuous polycrystalline film.

The Shottky barriers which are a complex quantum effect of the joining of two materials may not be overcome by purifying the semiconductor film. A material other than a semiconductor may have to be used, possibly a modified oxide layer or a semiconductor layer with the boundaries modified.

Another member of the University faculty working with Josephson junctions is Prof. Alwyn C. Scott who is investigating the propagation of solitary waves along distributed junctions. One of the junctions made by Prof. Nordman and Mr. Reible is shown in Figure 2. The junction is a millimeter wide and a few centimeters long. The solitary wave or soliton, as it is more commonly called, can be described roughly as a nonlinear pulse. Prof. Scott and two others have written an extensive article on the state of the art which appears in the October, 1973 issue of the *Proceedings of the IEEE.* The article treats the soliton in minute mathmatical detail.

The distributed junction can also be used as a shift register with pulses entered at one end and then propagated or stored. Pulses are stored in loop currents, which have a magnetic field associated with them. The pulses or flux quanta can be shuttled at about 1/20 the speed of light.

The applications of Josephson junctions include detection and generation of radiation in the millimeter wavelength region and very fast digital memory the two logic states being the normal and superconducting states. Nothing yet discovered has a switching time faster than the Josephson junction's .01 nanoseconds. Plated wire memories have switching times near 300 ns and ferrite core storage is even slower with times around 1000 ns.

Metal oxide semiconductor or MOS circuitry has a considerable head start on the Josephson junctions in quality and price, but MOS devices have a limit on how well they can do. The Josephson junctions approach the theoretical time limit any switching device is capable of. They may not be used commercially for a while, but there is no doubt that they will be in the future. **WE**

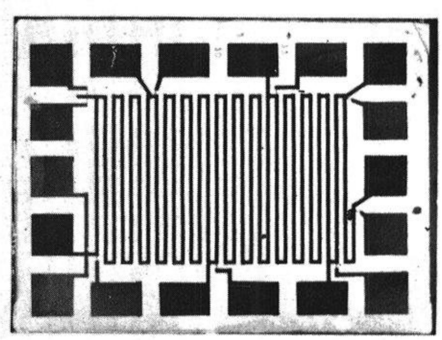
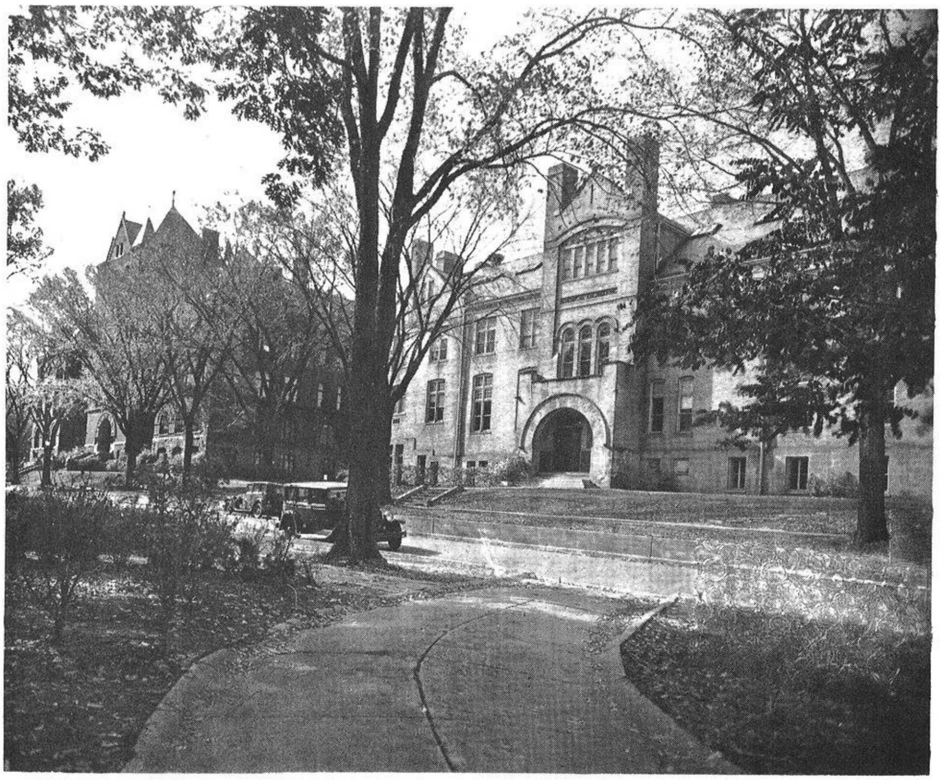


**Figure 2. Example of a distributed junction produced by Nordman and Reible.**

# remembering . . .

# Science Hall

*by Starr Eby of the Engineer Staff*



**Old Chemistry Engineering Building with Science Hall in the background on the corner of Observatory Dr. and Park St.**

Science Hall is more than just a red brick monstrosity at the bottom of Bascom Hill. It is a structual marvel and the oldest existing building in the world to use structural steel in significant amounts.

Completed in 1887, Science Hall was meant to last a long time. An original Science Hall, standing in the same spot as the present one, was completely destroyed by fire several years before, disrupting the university so much that it was feared that it would have to shut down.

Housing all sciences except pharmacy, Science Hall was the main building on campus. Yet in 1883, when Allen D. Conover, engineering professor, warned the Board of Regents that it was falling apart, nothing was done about it. Shortly after, flames demolished the structure.

The Madison fire department considered the alarm a prank, and didn't get there until it was too late. Students were unable to use the building's fire equipment, which was locked up to prevent vandalism. Along with the building, the $10,000 Lapham library, the university's art collection, and geological specimens, including the bones of General Sherman's horse were destroyed.

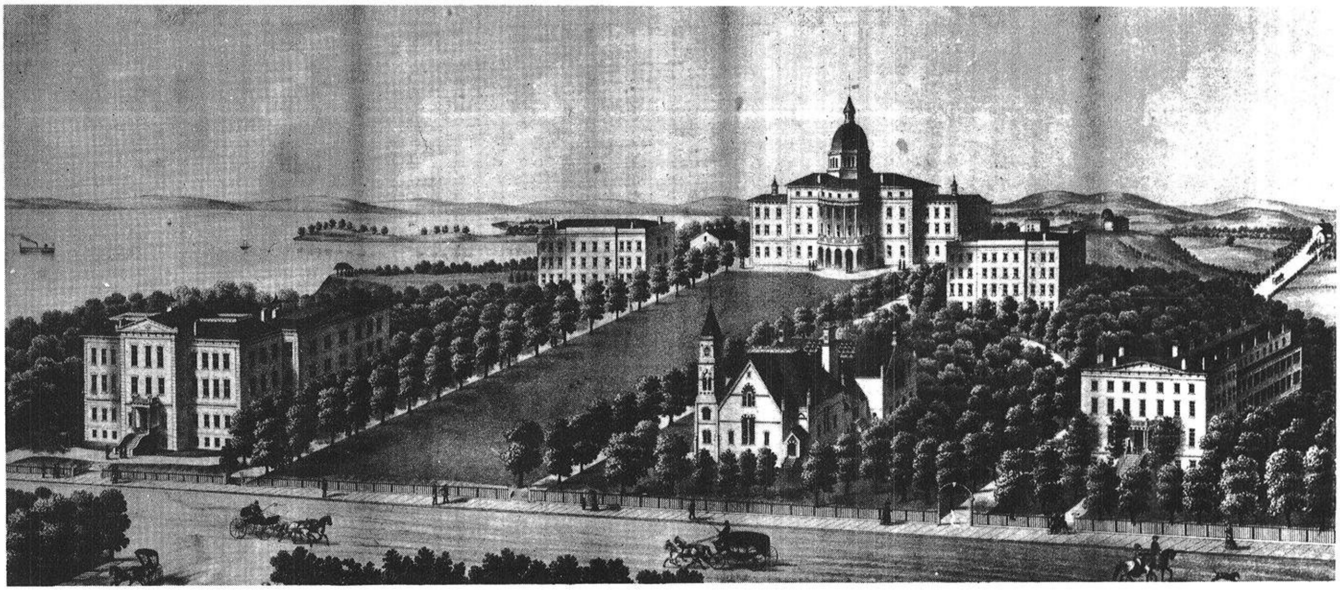
Students were urged not to transfer, and classes were held temporarily in the library, (now Music Hall), and North Hall, then a men's dormitory. Meanwhile, plans were brewing to construct a new, fireproof, Science Hall.

As usual, the university was low on funds. In addition to $41,000 coming from insurance on the old building, the university got $150,000 from the legislature. But this still was not enough.

Since all bids were too high, building started without a constructor. Civil Engineering professor Conover was appointed constructing supervisor. He was aided by Frank Lloyd Wright, who worked as a part time student assistant.

Midway through construction, the legislature discovered that the regents had incurred debts of $30,000 at Madison banks. Insensed at this ruthless overexpenditure, it confronted the regents. The regents didn't budge. They believed the state was obligated to give them however much they deemed necessary. Shortly afterwards, but not without much ado, the legislature passed a bill providing an additional $170,000 for the completion of Science Hall. A worthwhile investment, the hall is now valued at $2,254,510.

Science Hall was well built. In 1888, Sidney Dean Townly said "the whole building is fireproof, and it will serve it's purpose for many generations to come, for the only things that can destroy it would be an earthquake or a hurricane."



**This is an artist's drawing of the University of Wisconsin-Madison Campus in 1879. From left are: Ladies hall, South Dormitory, University Hall, Assembly Hall and Library, North Dormitory, and Science Hall.**

Iron, steel, hollow tile, and cement are the main constructive materials. The only wood found in the whole building is in the doors, windowsills and floors.

Steel I-beams provide the major means of support. Used only once before in construction, and then not very successfully, it was not known how strong they could be. The beams, finally ordered from the Carnegie Steel Company, were able to bear 52,000 pounds per square inch.

Cutting the I-beams presented a problem. Since steel saws and acetylene torches were unknown, the beams had to be trimmed by drilling many small holes, then bending them until they broke. The jagged edges can still be seen in the attic.

The walls, ceilings and roof are all of hollow tiling, and there's no lath or plaster in the building except in one room on fourth floor, which originally housed an art museum. The stairs are iron with slate treads, and the corridor flooring is encaustic tile.

Steam heat, both direct and indirect, warms the building. Two air pockets between the inner and outer walls furnish a warm and fireproof lining. As an additional fire precaution, a metal fire chute was included.

Science Hall, was designed by H.C. Koch of Milwaukee, in the Richardsonian Romansque architectural style, which went out with the horse and buggy.

In 1920, J.F.A. Pyre reported that it was "the largest, most useful, most expensive, and easily the ugliest building the university has yet acquired, and that Science Hall will doubtless stand indefinitely, a monument to the prosperity, progressiveness, bad taste and good intentions of the latter 80's." WE

*A Trashy Story*

# The Continuing Saga of Recycling Resources

**by Don Johnson**

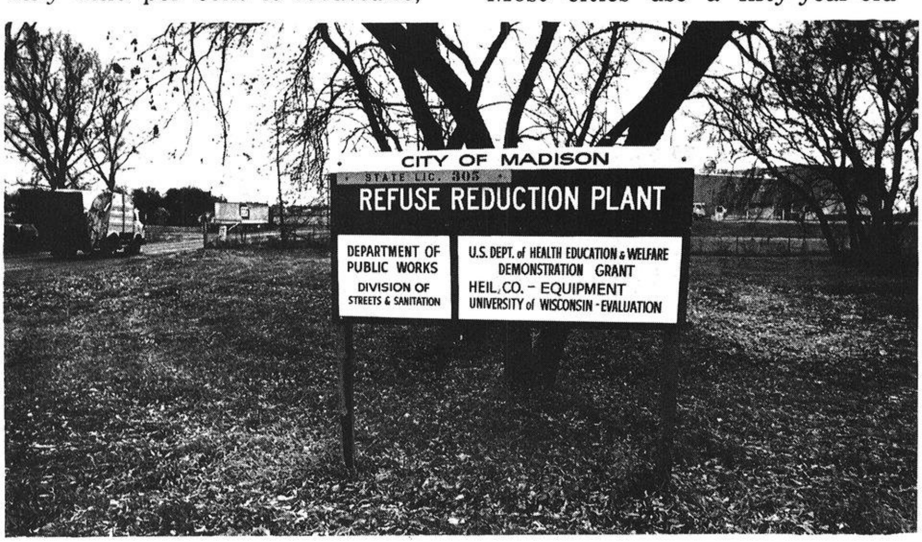
Trash, like death and taxes, is inevitable. And it must be faced daily, not once a year or once a lifetime. Within this decade solid waste totals will add up to eight pounds per person per day, or a ton and half per year for every man, woman and child in the United States.

Last year those pleading for federal aid to solve the nation's "disposal crisis" predicted our cities in the next ten years will smother in their own garbage and trash, millions of tons costing $7 billion a year to bury or burn. Kathie Kelly, author of *Garbage: The History and Future of Garbage in American,* predicts that by 1980 the "planned "obsolescense" mill will be cranking out 440 million tons of junk, automobiles, tires, appliances, cans, waste paper and plastics, while the factories continue to chew up our natural resources in order to keep up.

Though the U.S. has the highest-class trash in the world, only nine per cent is foodstuffs; over half is paper products. Packaging materials alone, expected to weigh in at 74 million tons in 1976, account for one fourth of solid waste. Garrett DeBell described America in *The Environmental Handbook* as a "nation knee-deep in garbage, firing rockets at the moon."

Trash is not found only in dumps. Along a one-mile stretch of ordinary two-lane highway, the Highway Research Board of the National Research Council found 770 paper cups, 730 empty cigarette packs, 590 beer cans, 130 soft-drink bottles, 120 beer bottles, 110 whiskey bottles and 90 beer cartons. Trash in all its shapes and forms is creeping up on the urban jugular from all sides.

In the face of pending ecodoom, cities have scurried from one disposal crisis to another. Many solutions have proposed dumpng refuse down old mines, compressing it into building blocks, incineration, and dumping at sea. Most cities use a fifty-year-old system, originating in Europe, called sanitary landfill which amounts to burying each day's trash. According to one public works director, "There will always be a (disposal) crisis because nobody **wants** a landfill." He explains that 40 to 50 landfill sites were considered at one time or another, but were rejected because of anticipated and actual public pressure, before his city settled on two sites.




One city engineer said his department spends 35 per cent of its time studying potential sites. It takes months to investigate the bedrock conditions, the effects on the water table, the volume involved, and the drainage problems. What appears to be a cheap disposal operation may actually be the most expensive when auxiliary costs are considered. Filling a hole or ravine by casting refuse down a steep slope will only create an incubator for flies, rodents, odors, and disease-bearing insects. It may take two years just to prepare a site.

In Madison, Wis., a three-year project, backed by a federal grant, developed a system of grinding the refuse with a hammer mill, the first of its kind in the United States. The mill chews up some 25 tons of refuse an hour—spitting out that which it can't handle, such as an automobile engine block—reducing the original volume by one half.

The hammer mill consists of a vertical shaft. Its 48 hammers rotate at 1,450 revolutions per minute, smashing just about anything smaller than a two-foot square chunk of concrete into bits.

No one is claiming that pulverizing is going to solve the problem, but city officials say it is a step in the right direction. Tests reveal that the "milled cells" are not flamable, and they do not attract flies, or rats. Residents near Madison's Greentree landfill, which receives only milled refuse, explain they would have objected strongly to its location if the trash were not milled.

According to Robert K. Ham, a University of Wisconsin civil and environmental engineering professor, the milled refuse is more compact, no longer requires a daily cover of top soil, and doubles the life of a landfill. Ham, who was one of the chief engineers in the project, says this system was the first in this hemisphere. "Now there are at least thirty to forty similar installations throughout the country." Kenneth Brunner, supervisor of Madison's mill, points out that if the mill had not been in operation Madison's landfill sites would have been filled a year and a half ago.

The city has also installed a million dollar machine to grind up automobile graveyards. The shredder has a capacity of 400 cars a day and reduces a 3,500 pound car to fist-sized fragments in 45 seconds. It drives hammers, weighing 340 pounds each, which literally beat and pound the car to shreds.

Other cities are making attempts to chop, condense, and bury their junk. Cities from all over the United States, Europe, and Australia have made inquiries about Madison's operation, and fifteen have installed mills in the last three years. Cities like St. Louis, Pampano Beach, and Great Falls have developed similar systems since Madison began hers seven years ago.

In spite of such pioneering efforts to compact and bury it harmlessly, the mountains of refuse still seem unconquerable. Madison, with a population of 200,000 generates 600 tons of refuse each day. The mill chops up only 225 to 250 tons of it. Brunner figures the mill would be able to handle 500 of those 600 tons if the plant were enlarged.

Edwin Duszynski, Madison's public works director, comments,

**Interior of hammer mill at Madison's Refuse Reduction Plant.**

"Milling should not be considered a panacea. It costs money, is not practical for low tonnages (to keep costs down the mill must be kept busy), and requires backup provisions like any other process involving mechanical equipment."

Brunner complains that the average citizen is not aware of the disposal problems for all the garbage he generates. "The resident sets out a few bags each week and the next time he looks they're gone," and he doesn't know where. Ham, who was a member of the Wisconsin governor's task force on recycling solid waste, says "The public seems to think that we should be able to recycle all of our refuse."

Some citizens, however, insist that recycling is the only logical solution. A midwestern naturalist, George Knudsen, saved his family's trash for four years, compacting it, and storing it in his rec room. He is proud of his results, announcing that 465 compacted tin cans will fit in a small cardboard box. When Knudsen gave talks during the first year of compacting and storage, "I could take the whole darn works with me in the back of my car." He found that his family generated 800 to 1000 pounds of trash each year which took up 30 to 50 cubic feet of space.

"Our whole pile for any one year was comparable to an average pile in front of one home for a two week collection. Anybody that does this can use his cotton-pickin' brain to figure out a way to compact it and then to have it recycled." He used a sledge hammer on his basement floor to pound out tin cans, and insisted that his family use returnable containers no more frequently than the average, as an example to others.

"Everything was sorted—glass, plastics, cans, paper—in the hopes that someday recycling operations will begin. The more metal we recycle the less we have to destroy the natural topography of our country. Why the hell not use them over and over rather than once and then burying them; We could save 95 per cent of the energy used in the production of aluminum if it were recycled. Sure we have returnables, but they won't be here tomorrow. Some people say that we can't recycle everything. That's the biggest bunch of hog wash I ever heard!" Knudsen eventually found that even his trash pile was getting unmanageable, and tried to dispose it through recycling operations in the area. But "a lot of valuable materials got thrown out." He plans to publish the results of his private study next year.

Any small child knows there is a lot of "good stuff" in a trash pile. Now the solid waste experts agree. The potential value of recoverable materials and energy discarded annually in the nation's trash and garbage is more than $1 billion, according to a study published by the National Center for Resource Recovery, much of which is lost forever by burning or burial.

As author DeBell wrote, "The principle of recycling is to regard wastes as raw materials to be utilized; this is the only ecologically sensible long term solution to the solid-waste problem."

The point has been well taken. At the International Transporation Exposition in Washington, D.C. recycled municipal wastes were used to construct a new hard surface for parking lots and roads.

Recycling efforts have also uncovered a place in garbage history for Madison. In 1968, the city began the first full-scale newspaper recycling program in the nation. Twelve tons of newsprint a day are hauled to Chicago. The papers which are separated and tied by homeowners and put out with their trash, go to a plant in Alsip, Ill. just outside of Chicago to be reprocessed into new newsprint. The *Chicago Sun-Times* is printed entirely out of this paper. The paper recycling project went from a cost of $27.81 per ton in 1968 to $9.12 per ton in 1970. By 1971 the city was making a net profit of $2.06 per ton.

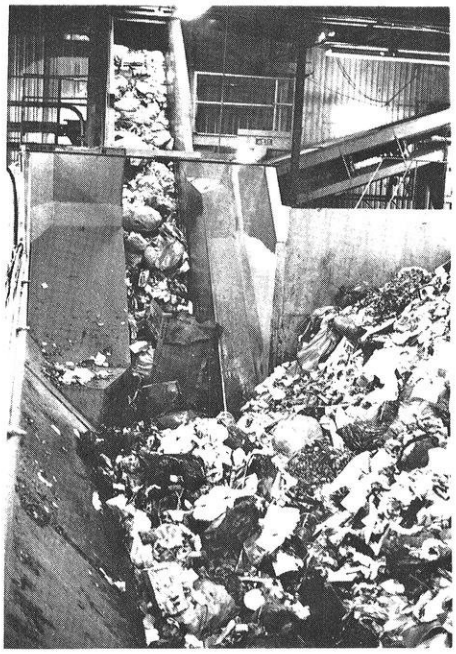
For every ton of newsprint recycled, 17 trees are saved. In one year alone 1,773 tons of paper from Madison's residents were picked up, saving 30,000 trees.

Using an electromagnet, 95 per cent of all ferrous metals are also drawn off the city's milled refuse, equaling five per cent of the reducible solid waste, or fifty tons each week.

This month efforts will begin to recycle cardboard from Madison's refuse, which may be sold for $72 per ton. While looking out at heaps of garbage going through a milling machine, Brunner says excitedly "there is a virtual goldmine lying out there with so much in valuable resources." He is studying methods to remove aluminum from the scrap to be sold for $200 a ton.

Landfill sites themselves are being recycled. In Allentown, Pa. a landfill site was turned into a 37½ acre park and recreation area. Hemstead, N.Y. and Toledo, Ohio have turned their landfill sites into municipal golf courses. Writing in "*Parks and Recreation*" magazine, Francis Duane, past president of the American Society of Golf Course Architects, says "Now, our troublesome garbage heaps may provide us with tomorrow's recreation centers. Landfill sites, which are unfit for construction, have exciting potential as parks, golf courses, and even ski hills."

Garbage issues are not wasted on the politician. They can nearly break him (N.Y. Mayor John Lindsay and the 1968 garbage strike). A "bottle" law in Oregon, taking effect in October 1972, was a "rip-roaring success," says Orgon Governor Tom McCall. The



**Trash being conveyed to shredder**

law prohibits the sale of soft drinks and beer in nonreturnable bottles and cans. Snap-top cans and throwaway bottles are banned. The law is primarily aimed at curbing litter and encouraging people to return bottles rather than strewing them along roads. According to the U.S. Environmental Protection Agency the beverage container portion of litter decreased by one-half, during the winter following enactment. Senator Mark Hatfield (R-Oregon) has introduced a bill patterned after the Oregon law, banning throwaway containers nationwide.

In Vermont a law went into effect last September requiring a refundable deposit of at least five cents on every soda or malt beverage container. Wisconsin is currently considering similar bottle bills, requiring all beverage containers sold in the state to have a refund value of at least five cents, and banning pop top cans. Other bills will require the state government to use paper products containing recycled materials, and create a solid waste recycling authority.

Individual cities are making an effort to control waste disposal problems at the source. A Madison City Council member, Alicia Ashman, proposed two years ago to restrict the sale of nondegradable, nonreturnable bottles and containers in the city, including metal, glass, and plastic. The proposal was defeated by one vote. An alternative ordinance was passed instead declaring that all Madison stores selling soda and beer are required to offer returnable bottles besides nonreturnables if they were not already doing so.

Ashman suggests, "People are coming to see there is a finite figure in the amount of resources and a limit to how much trash you can produce." Using the pocketbook approach, Ashman, proposes a "user fee" or tax levied on nonreturnable containers purchased by the consumer, and hopes for the day when Madison will include everything—from soft drink to ketchup bottles—in a nonreturnable container ban.

The emphasis in solid waste legislation has moved from disposal to recycling and controlling sources of trash. Wisconsin's *Blue Book* reports "Some authorities suggest that we will have to give up any hope of solid waste recycling as a profitable enterprise and think of it instead as an essential public service whose costs are preferable to the costs of our current problems of increasing volume, dwindling disposal sites, pollution and wasted natural resources."

Faced with the prospect of being buried under their own mountains of trash, Americans have no choice but to consider their own solid waste as a valuable resource to be mined and used again. Rather than toss this magazine on top of your ton-and-a-half trash heap, Recycle it.

WE

Packaging engineer from Michigan State University. She has recently been making cartons of merchandise identify themselves electronically to the computers.

Mechanical engineer from Michigan Technological University. She designs intricate machines that spool film and must operate perfectly in the dark. Turning on lights to check them out would spoil the film.

Chemical engineer from University of Rhode Island. She investigates possibilities for easier conversion of exposed film to finished pictures.

Industrial engineer from University of Wisconsin. She has devised work-shift programs that take into account not only production requirements but also personal preferences in working hours.

Mechanical engineer from Clarkson College of Technology. She combines physical and fiscal planning for new machine rooms where movie film acquires its sound stripe.

Chemical engineer from Youngstown State University. She recaptures silver and other film ingredients from waste.

Mechanical engineer from University of Minnesota. She designs and troubleshoots hydraulic systems, bearings, and shaft seals. She is a specialist on friction, wear, and lubrication.

Industrial engineer from University of Miami. Now production supervisor responsible for bringing together people, parts, and tools to satisfy demand for those new Kodak movie cameras you see on TV.

Architectural engineer from Tennessee State University. She works on interior design of Kodak marketing and distribution offices throughout the U.S.A.

Mechanical engineer from Rochester Institute of Technology. With full responsibility for scheduling and cost control, she designs equipment that provides production machinery with such essentials as compressed air.

Industrial designer from Pratt Institute. She uses form, color, and graphics to relate the technology of the personal camera to people and their sense of the appropriate.

Chemical engineer from State University of New York at Buffalo. She is studying technical factors in photo-processing plants that will be handling future films.

Industrial engineer from The Pennsylvania State University with a mathematics degree from Hunter College of C.U.N.Y. Mathematically she analyzes the problem of maintaining proper color in photographic paper.

Chemical engineer from Youngstown State University. Photographers don't mix chemicals much anymore. She makes a better product by the ton, packaged so it's never even seen.

Electrical engineer from South Dakota School of Mines. Her machines are three stories high, a football field long, and work to the tolerances of an expensive watch in depositing emulsion layers on color film.

This picture could be misleading. Engineering jobs at Kodak are not restricted to ladies. Whatever your sex, if you want to know about current opportunities in Rochester, N. Y., Kingsport, Tenn., or Longview, Tex., for mechanical, chemical, electrical, or industrial engineers, make yourself known to Eastman Kodak Company, Business and Technical Personnel, Rochester, N. Y. 14650.

Or just tell your placement office of your interest.

Kodak

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# Manufacturing. Is this the kind of engineering for you?

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

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

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

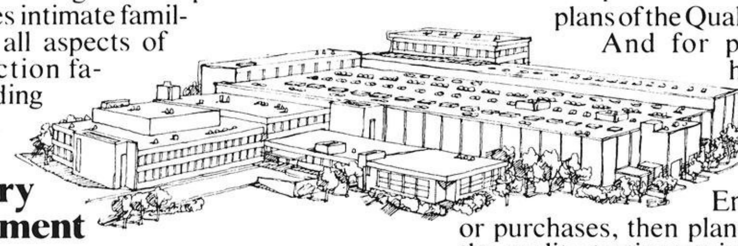
Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

This ad outlines the major types of work found in the Manufacturing area at GE. Other ads in this series will cover the two remaining areas.

We also have a handy guide that explains all three areas. For a free copy, just write: General Electric, Dept. AK-2, 570 Lexington Ave., New York, N.Y. 10022.

## Manufacturing Engineering

Manufacturing engineers plan and specify exactly how a product will be manufactured. They consult with design engineers to make sure a product design is producible efficiently and at competitive cost. They develop, design, provide and maintain the machinery, tools, processes and equipment needed to manufacture a product. And they plan and detail all the interrelated work procedures to be followed during each step of manufacturing. Requires intimate familiarity with all aspects of the production facility, including automation programs.



## Factory Management

Factory managers supervise a factory's work force, materials and machines. Their job is to meet production schedules while maintaining product-quality standards, plant efficiency and a favorable working environment. To do this, they consult with, and implement the plans of, manufacturing engineers, quality-control engineers and materials experts. They also deal directly with the factory's production workers on a regular basis. Thus, good interpersonal skills and the ability to manage large numbers of people are vital.

## Quality Control Engineering

Quality control involves four kinds of specialists. The Quality Assistance Engineer works with marketing, engineering and manufacturing to coordinate the overall design and maintenance of all quality-related activities. The Quality Control Engineer takes quality standards established for a product by the marketing people, then plans and specifies all test requirements, inspections, audits and personnel needed to meet these standards. He also works with manufacturing to make sure production facilities are adequate to meet quality standards. The Process Control Engineer is responsible for implementing the plans of the Quality Control Engineer. And for providing technical help to manufacturing to resolve quality problems. The Quality Information Equipment Engineer either designs or purchases, then plans the maintenance of the quality-testing equipment.

## Materials Management

Engineers in Materials Management plan and control the flow of materials throughout the business cycle. They make sure all raw materials, parts, subassemblies and finished products are at the right place, at the right cost, at the right time. This involves scheduling factory production, planning and forecasting material requirements, and determining inventory levels. Also purchasing materials, directing material flow during manufacturing, and warehousing and shipping finished products. Requires knowledge of products, processes and ability in areas such as logistics, mathematics and computer applications.

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