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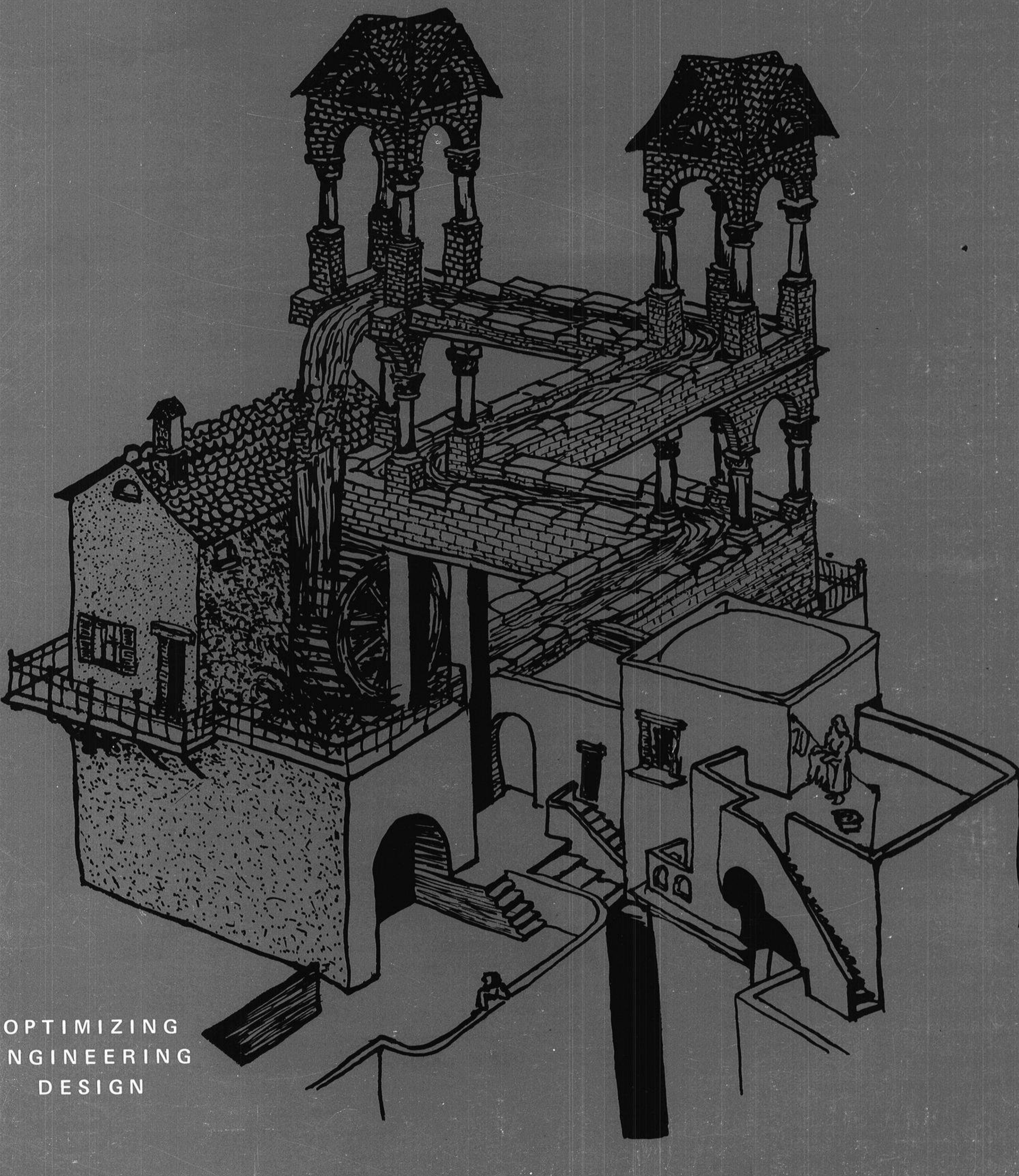
35 CENTS MARCH, 1970

wisconsin engineer



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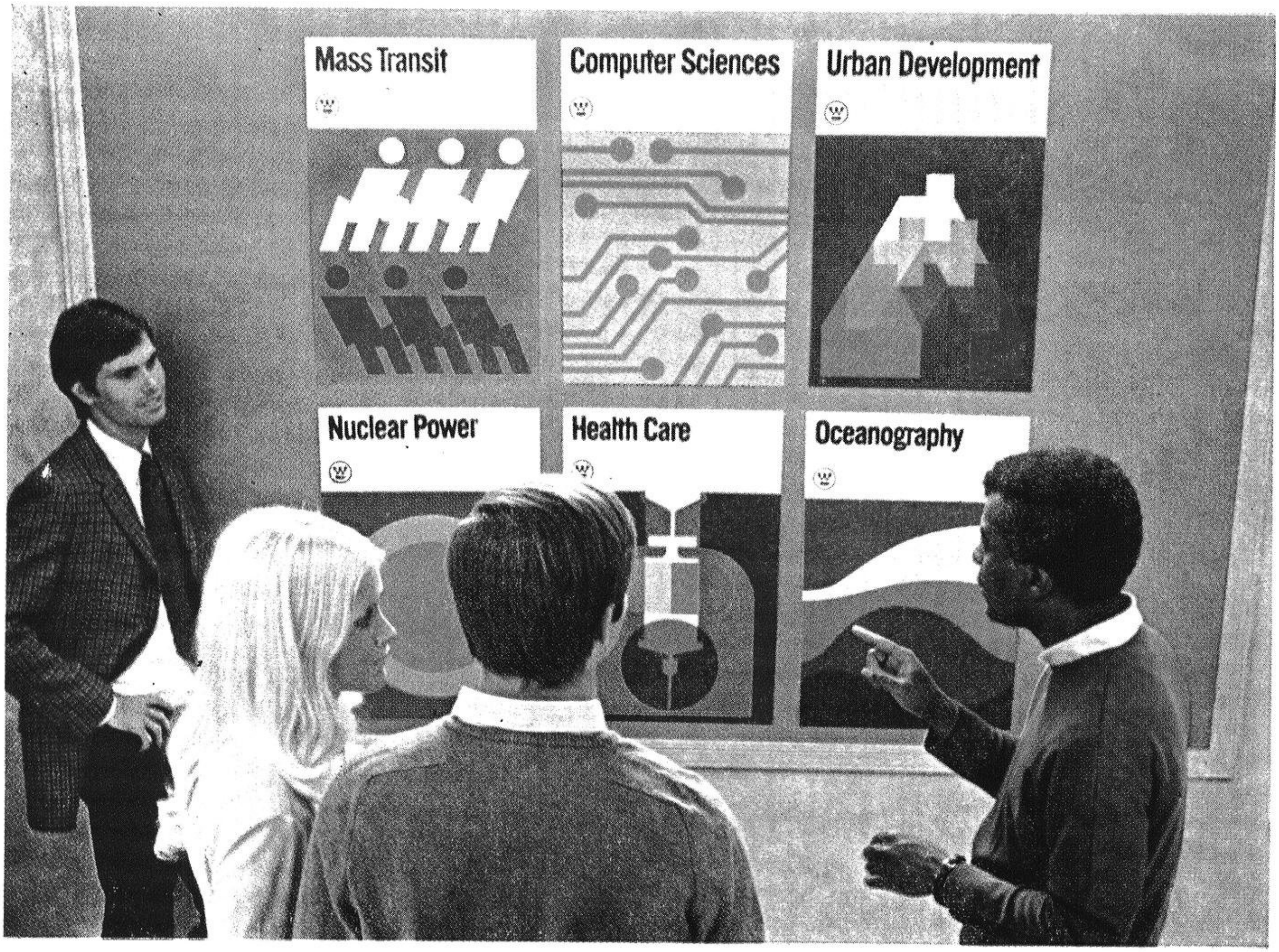

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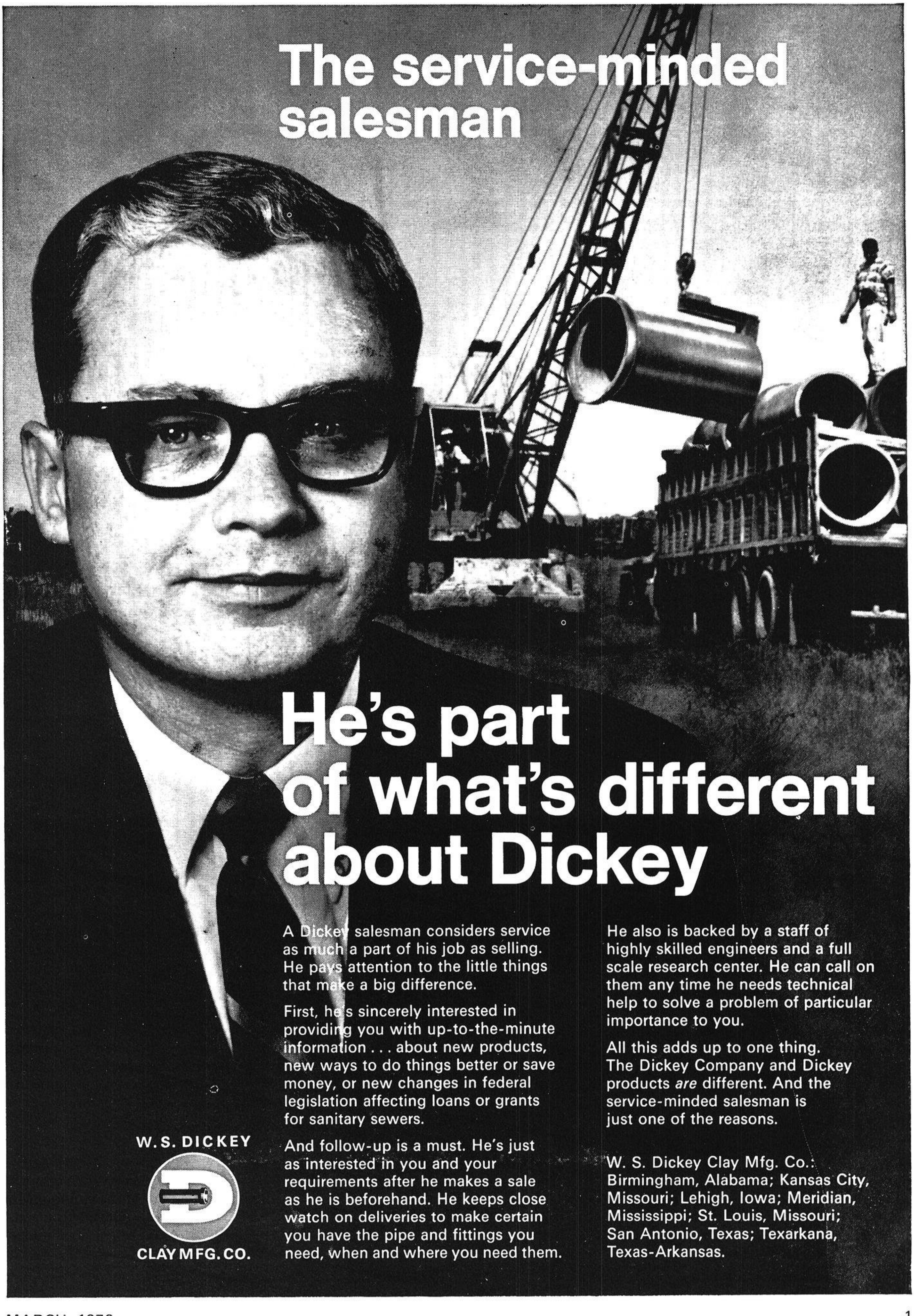
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"We are drifting toward a catastrophe beyond comparison. We shall require a substantially new manner of thinking if mankind is to survive." – (Albert Einstein)

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Editorial --

The University and Educational Reform

In its efforts to "shut it down," the Teaching Assistant's Association strike attempted, somewhat successfully, to stop the educational and research functions of the University — at least as far as the classroom and laboratory are concerned.

Noteworthy and unworthy philosophers have said that real education begins outside the classroom. In the words of Woody Guthrie, "Don't let your schoolin' get in the way of your education." Most often the schools, primary, secondary, and the University, have kept their students from obtaining real knowledge about the real world. Reality is not taught in the classroom.

One of the first things learned outside the classroom is the true nature of the University. The Moratorium and other related activities have evidenced and documented the University's unyielding complicity with the war machine. *Profit Motive 101* details the University's ties with and partial control by the state's big business and big money. The recent "anti-student" laws passed by both the state and federal legislatures clearly outline the limitations of so-called free speech, free assembly, and "pillar-of-democracy" dissent. One need not continue grumbling about a society and system that live by contradiction. The king stands naked.

The TAA strike has shown once again that the University is guilty of indecent exposure. Anti-Union? No, retorts the University, as long as it isn't our workers. Student participation? Sure, just not our students. Community voice? Certainly, but not here.

The University has continually characterized itself, most recently during the TAA strike, as a regressive rather than progressive institution, as it claims itself to be. Like Nixon and the War, like Business and Pollution, like Thurmond and Integration, like Industry and Sexism, like Hoffman and Seale, the University stands adamantly opposed to change.

This the TAA strike has once again shown: To the University, the winds of change are but mere whispers to be gagged. But to those whose lungs are exploding, it's a hurricane, the eye of which is the mind. Mouths, not minds, are gagged.

Jerry Gottsacker

[***]

Letters to the Editor . . .

Dear Sirs:

You insulted us in your November issue with Mr. Gordon's inane diatribe. For this you were forgiven. After all, you were making a bona fide attempt to introduce student and other avant garde literature to the engineering faction of our student body. That it was bad art, if art is what you call it, was on my part forgiven. Even baseball players get three strikes. However, to insult us again with highfalutin bruhaha from this very same third rate writer (?), to bore us with his mundane idiocy, to degradate your magazine not once, but twice with that folderol is uncalled for, and should be ceased. Posthaste. Send him a toothpick and tell him to pick his nose.

Sincerely,
Yehudir Mehunir & Henry Gordon

Dear Sirs:

Dr. Melius Mekas in an article in last month's JAMA magazine, the official publication of the American Medical Association, declared, "Magnanimous and inexorable though this fact may be, nevertheless, its inherent irrelevance must not be underestimated." He was referring, of course, to the unwarranted, unpleasant, unanimous, and unsophisticated rumors presently being circulated concerning premarital sex. The pope tells us it is a "no-no," the high schools tell us it is "sexual intercourse," the parents tell us "not in our suburbs," the university tells the dormies to be done by one a.m. Dr. Mekas goes on to add, "Continued normative behavior of this nature can cause, among other things, pregnancy and acute swelling of the mucous membrane. Tell that to Mr. Gordon. But please, don't print his stories.

Sincerely,
Reverand Henry Gordon

Dear Sirs:

An example of historical incompetence is brilliantly depicted in Vladimir Roshonoxochov's annals of vernal equinox. In it, he declares, "If it was a week ago yesterday, it was a month ago today."

An example of Franconian riff-raff is Louis Schmolowicz's poetic cup-up, "one in ten grin tit rye."

An example of boring inanities is Mr. Gordon's latest number, "Binomial Nomenclature in the Year of the Catfish." As a lover of fish, I decry the slander. As a lover of trees, I deplore the waste of paper. As a lover of literature, I bemoan the death of talent. Put that in your mucous membrane and snort it, Mr. Gordon.

Sincerely,
Henrico Gordon, pHD

Dear Sirs:

As a layman, I must confess that I am incapable of remaining abreast with current literary vogues, however, I do read as many magazines as is possible. You see, I work and don't have as much time as Mr. Gordon apparently does to decry the inadequacies of our nasal passages. I never saw anything as ridiculous in my entire life!!! I showed it to the Mrs. and she put it perhaps better than I ever could when she said, "Is this guy," referring to Mr. Gordon, "the vanguard of the revolution or did he just get the mezzanine seats?" I think he's out in the bleachers. Hire new writers.

Sincerely,
Henthreery F. Gordon

Dear Sirs:

The Louis Schmolowicz Rest Home wishes to make an unprecendented step among campus organizations in general, and literary clubs specifically. We will analyze, in a Freudian vein, the works of Mr. Gordon, author of a story in one of your most recent publications. But first, some background concerning Mr. Gordon.

He's a weirdo. He's got real long hair and almost never washes it. He is always dirty. His clothes are as unkempt as his hair, only not as greasy. His armpits are unsprayed. His shoes have holes. When ladies pass him in the shopping centers, they almost invariably say "yecch." When babies see him, they start to cry. Phones start ringing; dogs start barking; rice sticks to the bottom of the pan. So, all in all, he is acutely anal retentive.

"Binomial Nomenclature . . ." shows Mr. Gordon's latent, or should I say blatant, schizophrenia. If he were a normally functioning human being, he would call a spade a spade. Under the dog leg of truth on the bark of reality, only the Rest Home will continue to exist. Give money to Chaing Kai-shek, not to slipshod polemicists.

Sincerely,
Heinrich Gordon
Pres. LSRH

The University of Wisconsin

COLLEGE OF ENGINEERING
MADISON, WISCONSIN 53706

ENGINEERING FRESHMAN OFFICE
ROOM 22, BLDG. T-24
262-2473, AREA CODE 608

February 23, 1970

TO THE MEN OF TRIANGLE FRATERNITY
& A GROUP OF INDUSTRIES
AN OPEN LETTER OF THANKS
FOR THE 3rd ANNUAL
ENGINEERING FRESHMAN HONORS AWARDS BANQUET

The third annual Engineering Freshman Honors Awards Banquet, held at the Cuba Club on February 21, was again an outstanding success. Most of the planning, financing, and executing was done by the men of Triangle Fraternity. The effort required of those of us in the Engineering Freshman Office was very small.

Our congratulations go to the freshmen who earned the award. Our thanks go to the men of Triangle, and especially to Mike Langley, the Awards Banquet Chairman, for a job well done. We thank Madison's Mayor William Dyke for his welcome words of wisdom. Our thanks also go to the following companies, and their generous financial support: AC Electronics, Allen-Bradley Company, American Can Company, Charmin Paper Products, Falk Corporation, General Telephone of Wisconsin, Gisholt Machine Company, Johnson Service Company, Kimberly Clark Corporation, Marathon Electric Company, The Trane Company, Waukesha Motors, Wisconsin Electric Power Company, and the Wisconsin Telephone Company division of the Bell System.

What has become an Engineering Freshman Office tradition is the result of the efforts of our friends, and we are grateful.

Sincerely,

Kurt F. Wendt

Kurt F. Wendt, Dean

Fred O. Leidel

Fred O. Leidel, Assistant Dean

oe

Solid Waste Disposal in Madison

(Editor's Note: Dana Yarger, a senior Civil Engineering student, wrote the following report as a concerned environmentalist and as a member of Engineers and Scientists for Social Responsibility. This report is one of a comprehensive set compiled by E.S.S.R. on the quality of Madison's environment.)

By Dana Yarger

To many Americans solid waste disposal is merely taking out the garbage. Whatever happens next is of no concern. The disposal process isn't a magic disappearing act, but, in reality, is moving the unwanted material from your home to someone else's land.

The disposal of solid wastes – garbage, refuse, and salvageable material – has not received much public attention because Madison has been relatively successful in hiding solid wastes from public view. We are aware of water pollution by the appalling "acum slick" on Madison's lakes from excessive algae growth. Although Madison's air is circulated by a relatively pollution free westerly wind, no one can help but notice the smoke from Madison's many sky-sewers. Public awareness of solid waste pollution, however, is at a low level; after all, no one goes for a picnic in a dump. The solid waste disposal problem surfaces only when we run out of people willing to let us bury our solid wastes on their land.

Increasing population and living standards only intensify the present solid waste disposal problem and the related problems of air and water pollution. A Department of Natural Resources publication states that "the problems of waste disposal endanger the public health, safety and welfare, create public nuisances, result in scenic blight and adversely affect land values . . . Immediate remedial action is needed to protect our valuable resources."

Solid waste disposal is a prime contributor to all other types of pollution. When refuse is burned in an open dump, solid waste disposal becomes air pollution. When solid wastes are deposited too near natural water or even in swamps and marshland, water pollution results. About 6 o'clock in the morning you probably have noticed the noise pollution associated with the collection of solid wastes. Solid wastes and litter also contribute to "sight" pollution: man's contrived "uglification" of the landscape.

Madison's Solid Waste Production

Figures obtained from the City Engineer's office indicate that Madison is well above the national average in solid waste production. Madison produced 150,000 tons of refuse in 1969, an increase of 10% over 1968. Less than 50% of this refuse was collected and disposed of by the city; the rest was disposed in city landfills by commercial haulers.

The average citizen of Madison is responsible for nearly 60% more solid waste than the average urban American. This high level of waste production is, at least partially, due to the exceptionally high standard of living enjoyed by Madisonians, but it would be even higher if Madison had industry proportionate to the average municipality of 170,000 persons.

The approximate composition of the solid waste produced in Madison is tabulated below in volume percent. About 75% of the waste is combustible.

Composition of Solid Wastes

Material	Volume Percent
Food wastes	15.3
Garden wastes	13.8
Paper	42.2
Plastics, rubber	1.8
Textiles	1.6
Wood	1.1
Metals	6.7
Glass, ceramics	10.1
Rocks, dirt, ash	7.2

(U.S. Public Health Service, Nov. 1968, *Madison Residential Refuse)*

Although not included in the above figures, another source of solid waste is the junked automobile. This problem is handled in Madison entirely by commercial salvage dealers. Nationwide the auto salvage industry took in 9,000,000 cars and trucks in 1968 for a gross income of $5 billion.

Nationwide the per capita generation of solid wastes increases by 2% each year. *(Heating, Piping & Air Conditioning*, March, 1968) Part of this increase is due to practices in the packaging industry. Many grocery items are "individually wrapped" which ultimately means wrapped two or three times. Also much of today's "throw away" packaging, such as plastic bottles, aluminum cans and glass jars, is practically indestructable. Advertisers tell us it's convenient to "throw it away" but never say where "away" is located.

Methods of Handling Solid Wastes

At present there are three basic operational pre-treatments for solid wastes – composting, incineration, and milling – but the residue from each process must eventually be dumped somewhere. Composting, which is widely used in Europe, is a method of producing organic fertilizers from the refuse after removing inorganic materials. Incineration is simply the burning of all combustible materials in specially designed furnaces to minimize air pollution. The ash and remaining non-combustibles then require disposal. Milling is the shredding of all refuse to reduce its volume. The end-product of each process, which then requires disposal, has been changed in composition and, most important, reduced in volume. Ordinarily this end product is buried in what are known as sanitary landfill sites. The reduction in volume of the solid wastes increases the effective life of the landfill site.

Madison until recently avoided any pre-treatment and merely dumped, compacted, and covered the refuse in one of the three sanitary landfill sites in the city. This type of disposal is the least expensive. Presently Madison is operating a pilot milling plant supported by $185,000 of city funds and $370,000 from a federal research grant. Known as the Heil-Gondard mill, the plant is being observed closely by municipalities throughout the nation. There can be up to a 50% reduction in refuse volume by milling and subsequent compacting in a landfill.

A comparison of milled and unmilled refuse indicates conclusively that the milled product is more acceptable. Along with the reduction in volume, milled refuse is more stable, and has less blowing of paper, few health hazards and less odor nuisance.

Handling Costs

For solid waste collection and disposal, U.S. cities spend $4.5 billion annually, an expenditure surpassed only by that for education and roads. *(U.S. News & World Report*, September 8, 1968) These costs will increase as an increasing population quickly exhausts local landfill sites and urban expansion forces the hauling of solid wastes to more distant sites. Collection and transportation costs will assume a greater portion of the total costs of solid waste disposal.

Through property taxes, Madison residents annually pay $2.7 million for refuse collection and disposal. This expenditure does not include additional amounts paid to commercial haulers by many businesses, the Dutch Elm disease control program, snow removal and disposal, weed harvesting in the lakes, and other solid waste programs. Madison employs about 90 men who use 40 trucks during a five-day week for municipal refuse collection and disposal.

A comparison of the costs and volume reduction for milling and incineration as compared with no pre-treatment is given in the following table. Collection costs, an additional $16 per ton, are assumed equal for each method.

	No Pre-Treatment	Milling	Incineration
Cost of disposal per ton	$2-2.25	$5-6	$8-12
Maximum reduction in volume	10%	50%	90%

Possible Uses of Refuse

As cities are forced to use more expensive solid waste disposal methods, reuse and recycling refuse becomes more economical. Dr. Barry Commoner points out *(Time*, Feb. 2, 1970) that there could be a profit in reuse: "Paper, glass, and scrap copper have long been re-used. Fly ash can be recaptured and pressed into building blocks; reclaimed sulfur dioxide could ease the global sulfur shortage." The heat from the burning of refuse could generate 10% of the nation's electricity.

The University's Forest Products Laboratory has produced a high grade bond paper from secondary fibers taken from milled refuse. The city is presently conducting a clean newsprint collection on the east side. Clean newsprint has a salvage value of $25 a ton. There are numerous other possibilities for reuse. For example, if 170,000 aluminum cans, (i.e., one per Madisonian), were collected per day at a salvage value of $200 a ton, the annual gross return would be $600,000.

Long Term Solutions

Madison is presently facing a short-term refuse crisis. The existing municipal landfill sites will be filled by 1972, and the city is desperately trying to acquire more land for a future site. The proposed sites are located in the surrounding communities of Fitchberg, Verona, and the Town of Middleton. Despite the public relations efforts of Madison officials, the residents of these adjoining areas do not relish the thought of a sanitary landfill next door. Yet Madison must acquire one of the proposed sites or face a genuine crisis.

Whatever the outcome of the immediate crisis, in the long run the only solution is a drastic reduction in the amount of solid waste produced. Eventually we must stop generating any solid waste at all. A completely closed system must be created – a system based on total recovery and re-use. The goal would be impossible to achieve on a local scale, but the impetus toward a national transition to such a system must start at the local level.

Some recommendations for immediate steps toward a waste-free society are given below:

1. A conscientious effort must be made by each Madison resident to reduce his personal refuse production.

2. The collection and disposal division of the Sanitation Department of the City of Madison should be converted into a public utility. Through revenue obtained by salvaging and through processing of the solid waste the department could reduce the net cost to the taxpayer.

3. Separate collection (perhaps monthly) of cans and bottles or collection stations for them should be provided by the city.

4. The city should support reasonable legislation to decrease the use of throw away containers.

5. The city should consider charging for waste disposal by a method similar to that for water consumption, namely, by the amount collected.

6. The city should provide equipment to enable collection vehicles to handle Dempsey-Dumpsters to facilitiate a more efficient handling of solid waste.

7. An additional effort should be made by the city to educate the public on the eventual favorable effect of increased property values near completed sanitary landfills.

8. A conscientious effort should be made by local citizens to encourage beverage distributors to use returnable containers.

9. Funds should be made available to the city engineer for his continued research in solid waste handling.

10. Professionally operated incinerators, or other pre-disposal treatment, should be required in apartment buildings over six units.

[***]


CAVU*

Progress Report:

E DAY

ROY JOHNSON

Despite the fact that April 22, 1970 also happens to be Lenin's 100th birthday, the Engineering Environmental Committee, headed by senior Civil Engineering student Bill Lauzon, is making final preparations for a comprehensive E Day program. Besides a number of static and dynamic environmental exhibits at Gordon Commons, a triple barreled series of discussions will be held in the Engineering Building until 4:30 Tuesday, April 21 and until 10:00 p.m., Wednesday April 22. Discussions will not only touch on the Engineering aspects of pollution but the sociological and biological problems as well. The object is to educate and inform as many citizens who are willing to attend.

Senators Gaylord Nelson and Mike Gravel (R-Alaska) and Boyd Gibbons from the President's Council of Environmental Advisers will be the featured speakers at the E Day Eve Rally to be held at the UW Stock Pavilion on Tuesday night, April 21 at 8 p.m. In addition, the Oz rock band and an environmental light show will provide entertainment. The rally will be broadcast live on WHA-TV. Tickets are available at the Union Box Office for $1 or call 262-1582 for bulk orders.

Enthusiastic environmentalists are needed to work on the East Marsh habitat of the UW Arboretum. Whether or not you can provide your own tools, call the Arboretum office at 262-2746 to schedule a convenient time throughout April and May. The habitat management you can provide is sorely needed to keep the East Marsh open to wetland wildlife.

Engineers and Scientists for Social Responsibility (ESSR) and Students To End Pollution (STEP) are sponsoring a parade of low pollution transportation starting at 2 p.m. April 21 at the UW Library Mall. Everyone is urged to participate in the parade of steam and electric cars, bicycles, horses, stilts, roller skates, etc. The parade will move east on State Street to the Square and return by the way of Langdon Street.

Environmental Art will be on exhibit during the week of April 17-26 at campus and community centers. Exhibit hours are 4-9 p.m. Fridays, 12-5 p.m. Saturdays and Sundays, 7-9 p.m. Monday-Thursday, and 11-9 p.m. on E Day. Catalogs will be available at the Memorial Union in the Play Circle Lobby. Conservation groups, paper and power companies will have displays in the basement of Gordon Commons; medical aspects of environmental problems will be on exhibit in the lobby showcase of McArdle Laboratory; the Department of Landscape Architecture, Room 25 Ag Hall, will explain plans for an Environmental Awareness Center and a Madison transportation system.

[***]

The Changing Criteria for Optimizing Engineering Designs

Editor's Note: Our thanks to The Society of Automotive Engineers for their permission to publish this article by Professor Myers, 1969 SAE President.

PROF. P. S. MYERS

Engineers are accustomed to changing conditions. New materials are constantly being developed and the engineer must be aware of them and of their capabilities. New manufacturing techniques and processes are continually being evolved and if the engineer's product is to be competitive in cost, he must continually update his information on these techniques and processes. Changes in the marketplace occur with equal rapidity and, again, the successful engineer must be cognizant of the effects of these changes on his product. Thus, in spite of the conservatism usually ascribed to the engineer, he is familiar with and accustomed to change as a way of life.

However, the engineer is normally more sensitive to changes in physical conditions and parameters, such as materials, processes, etc., than he is to sociological, political, and humanistic changes. He is typically more "thing oriented" than "people oriented." However, the sociological, political, and humanistic changes taking place from now on may have more significance in determining what is or what is not an optimum design than do changes in materials, processes, and technology. Thus, I want to point out some of these other-than-technical changes I think are taking place today and to discuss how they may affect the optimum engineering design.

Four such changes seem to me to be especially significant:

- The growth in population and changing trends in population growth will have a profound effect.
- Important also is the increasing evidence that industrialized nations are already straining the limits of the "free" waste disposal facilities of the atmosphere.
- The changing attitude of people, particularly young people, will be of increasing significance.
- The continued changes in living standards, will have even more bearing on optimization of designs in the future than in the past.

Many other factors in this area of interaction between man and his environment will influence optimization of design in the years immediately ahead. But I shall review only these four as a brief prelude to presenting my specific thoughts about how these factors will bring about the significant changess that I expect to occur.

POPULATION CHANGE EFFECTS – The data on population growth (1) shown in Figs. 1 and 2 clearly establish, I think, that we cannot indefinitely maintain the present rate of population growth. Fig. 1 shows that world population is increasing at a dramatic rate. Note particularly the increase in absolute value of the population since logarithmic coordinates are used. Also verify my extrapolation of the curve to the year 2000 – just around the corner!

Fig. 2 shows the range of population density found on the earth at the present time. It is interesting to note that the United States is relatively thinly populated. Note particularly the value of 10 and 100 persons per hectare since I will refer to these values later on. Table 1 explores another dimension of the changing population trends. It shows the dates when we will reach a population density of 10 and 100 people per hectare. Many people feel these data indicate the need for drastic birth rate reductions. Unquestionably, the future society will be highly urbanized with traffic and waste disposal problems, living limitations associated with higher population densities, increased leisure time but decreased recreational space, etc.

I think it's clear that increasing population density, even if not maintained at presently projected rates, will vitally affect the criteria for optimizing engineering design.

NATURAL WASTE DISPOSAL FACILITIES – The earth is basically a closed system with waste disposal facilities very clearly limited. There is increasing evidence that the United States and other industrialized nations are already straining the limits of the "free" waste disposal facilities of the atmosphere.

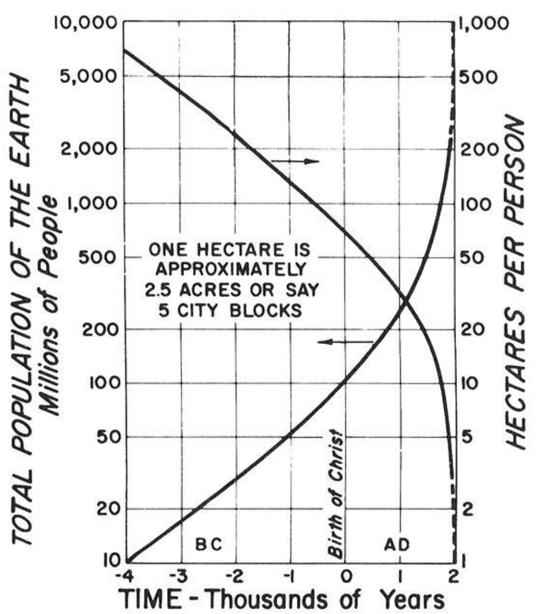


Fig. 1 – Population Growth

For example, Table 2 indicates the order of manitude of the energy that is to be rejected into streams from powerplants (2). Powerplants are estimated to cause about 70% of all thermal water pollution today.

Yes, we are indeed already straining, or exceeding, the capabilities of our natural waste disposal system. What will be the situation in another 20 or 100 years when our population has doubled or tripled? Certainly these changes will affect criteria for optimizing engineering designs.

MATERIALS AND SHORTAGES – Another fact that will influence optimizing designs is that the materials which can be recovered by known methods at reasonable costs are limited in amount. For example, imports today supply 75% of the United States' needs for 20 different metal commodities. At the same time, in 1966, the United States led in the production of 27 out of the 54 mineral commodities for which world production is shown by the Bureau of Mines. Thus, while we are not in critical supply of a large number of materials, it is certain that many materials will become increasingly scarcer in the future and that this trend will be hastened by the population increases previously mentioned. Future engineering designs, more so than in the past, will be faced with material shortages and higher costs for available materials.

ATTITUDES TOWARD MATERIAL THINGS – Rather subtle changes of attitudes will also have an influence. One of these is the attitude of people, particularly youth, toward material things. Arnold Toynbee, the famous historian, has come to the conclusion that in the United States and Western Europe young people are a bit saturated with technology. To paraphrase the point, the youth are saying – who wants more material things: Do these

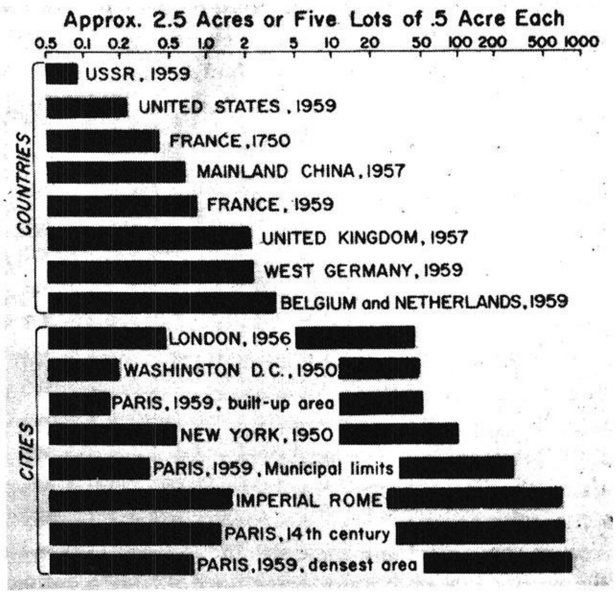


Fig. 2 – Persons per hectare

material things and the activities involved in producing them provide the satisfactions I want out of life?

In my own contact with college youth, I observe that they simply assume that their basic material wants will be met and, having made this assumption, proceed on to other matters that then become more important – civil rights, the Vietnam War, urban problems, poverty, etc. The situation is somewhat analogous to your **automobile.** Some of us untrustworthy people past 30 can remember back when the

Continued on Page 20

TABLE 1 – GROWTH RATES AND POPULATION DENSITIES
(At which, according to these rates, population density will reach 10 and 100 inhabitants per hectare)

Growth Rate and Date	No. of Years in which the Population Doubles	Date (A.D.) Density Reaches 10 Persons per Hectare	Date (A.D.) Density Reaches 100 Persons per Hectare
Average of 6 children per family (natural birth rate)	20	2050	2110
Average of 4 children per family	31	2105	2190
Average of 3 children per family	65	2235	2420
Present world view (average hypothesis)	40	2150	2270
Present rate in mainland China (1953-1958)	35	2135	2240
Present rate in United States (1950-1958)	47	2180	2320
Present rate in France (1955-1959)	105	2370	2715

What you need to fly 20,00 dragging a bomb on a 500-foo exploring for nickel.

Sound involved? It is.

Exploring for nickel is complicated and expensive.

To start it fast and efficiently, you start in the air.

You dip into your pocket and come up with over $300,000 for a plane you'd feel safe in flying 20,000 miles a year—at an altitude of 500 feet—going 120 mph.

Then into your pocket again for another $200,000. That's what it will cost you to modify your plane and install equipment you'll need to locate nickel if it's around.

The bomb is like a microphone. You let it dangle from a 500-foot cable. The sensing devices inside detect mineral deposits on the ground and relay the information up to the electronic equipment in the plane.

To be effective, it's got to be close to the grouhd. So be careful. If it gets snagged in an unusually tall tree, you're in trouble.

Of course, once you've acquired all this expensive equipment, you'll want to go to where the nickel is.

One of your best bets would be northern Canada. So dress warmly and bring lots of supplies.

Up there it gets down to 40° below, and you won't find many towns around.

You've got the equipment and you know where to go. Now you'll need men. Well-trained, experienced men.

If you can get five like the ones pictured below, that would be ideal.

From left to right they are: Trevor Blachford, data processor. Randy Dutchburn, navigator. Heikki Limion, group head. Bob Veale, pilot. Paul Wessler, equipment operator.

Bob, Paul and Randy work the plane hunting for the nickel.

When they land, they turn their electronic readings over to Trevor for interpretation.

Heikki, who is a geophysicist, studies the information looking for indications of possible nickel deposits.

Eliminate even one of these men and you've hurt your chances of finding nickel.

Well, that's it. Except for one thing.

Once you've found an indication of nickel, your work is just beginning.

You'll have to have experienced men to go in on the ground and examine the area. Then you'll have to send in more men to drill hundreds of holes for your evaluations.

So be patient. This takes a lot of time.

If the findings turn out negative, don't be discouraged. That's how it goes—99 out of 100 times.

But if, with a combination of effo and knowhow (and a nod from Lady Luck), you happen to find a worthwh deposit of nickel, there are a few thin you'll need to know: like how to min it, process it and get it to market.

Before we give you that information, there's a couple of thing you'd better check on.

Like putting your hands on a few dozen million dollars and a few thousand workers.

Once you've got these two thing worked out, you're ready to tackle th big problems.

Nickel helps other metals resist heat, cold, impact, pressure, abrasion corrosion... to advance engineering i vital fields—power, desalination,

niles at 500 feet in 40° below,
able at 120 miles per hour

tronics, transportation, aerospace.
We're doing everything we can to duce more nickel. Searching around world—Indonesia, Australia, temala, Canada. We've found ways xtract nickel from ores thought poor to mine a few years ago.
We count our blessings and respect surroundings. From nickel ores, we over platinum, palladium, twelve er commercially useful elements. ke iron pellets for steel. Convert smoke ur stacks to chemicals for other ustries. On sand left from processing we grow meadows of hay.
We are explorers. We're in 18 ntries. Miners, researchers, market ders. We bring opportunity to underdeveloped lands, new technologies, new payrolls, new tax income. Nickel in the ground is useless. We put it to work.

INTERNATIONAL NICKEL

The International Nickel Company, Inc., New York, N.Y.
The International Nickel Company of Canada, Ltd., Toronto
International Nickel Limited, London, England

TABLE 2 – ESTIMATE OF HEAT WASTED TO RIVERS BY POWERPLANTS

Year	Electrical Energy Required, billion kWh*	Heat to be Rejected to Rivers, billion Btu**
1958	728	1,164,000
1980	2161	3,458,000
2000	4463	7,140,00

*Estimate of U.S. Federal Power Commission.

**Assuming: Steam plants generate 80% of power needed; 5000 Btu of energy will be rejected for each kWh generated; and rivers will provide 40% of the cooling water needed.

Continued from Page 17

number of miles between a valve grinding job or a reringing job was an important parameter in our choice of an automobile. However, now most of us simply assume that the car is satisfactory from a mechanical standpoint and tend to concentrate on the remaining items – style, color, design, performance, etc. The acceptance of material things and their performance as a matter of course cannot help but have an effect on future engineering designs.

EFFECT OF LIVING STANDARDS CHANGES – Continued change in living standards, a direct result of engineering efforts, will coincidentally affect the future optimization of those efforts.

Our standard of living (based on consumer goods rather than living space available) has continued to increase and hopefully will continue to do so in the future. Simultaneously, the leisure time available has also increased. This increased leisure and the wherewithal to enjoy it have already had a noticeable effect upon both the products being designed and the design itself.

EFFECT OF THESE CHANGED CONDITIONS ON ENGINEERING DESIGNS

The effect of these changed conditions on engineering design will be many, varied, and often indirect. Let us look at what I think will be some of the changes that will occur.

CRADLE-TO-GRAVE DESIGNING – The first major change in optimizing engineering design that I expect to occur is what I would call the "cradle-to-grave" approach. In the past, engineering designs have been primarily (and correctly) concerned with the "birth" of the product. Raw materials were plentiful and relatively inexpensive. Disposal of the waste material produced during birth was not a major problem. Neither was the disposal of the packaging of the product or of the "body" when its usefulness was ended. Thus, the engineer quite properly optimized his design for these conditions and supplied the consumer with a product made primarily from new materials at the minimum possible "delivery" cost; this was good engineering for the conditions that existed then. This does not prove, however, that it is good engineering for today's changed conditions. For example, is an almost indestructible container the optimum engineering design taking into account waste disposal problems? Is an automobile designed with no thought of potential recovery and reuse of its materials, the optimum engineering design for today's conditions? Which is the most optimum engineering design – a nuclear power-plant producing no air pollution, but rejecting about 40% more heat into our waters or a coal-fired powerplant producing minimum possible air pollution and less thermal pollution? Should we be using waste heat from our powerplants to warm water in which we can grow food or to heat our houses? In view of our waste disposal problems, I do not think any future engineering design can be considered optimum unless it does consider the life-to-death history of the product.

MORE EFFICIENT ENGINEERING – The second major change that must occur in optimizing engineering design is more efficient engineering, that is, making less material and/or energy do a lot more work. To an engineer this is just "doing what comes naturally." My only point is that the engineer is going to have to emphasize and re-emphasize this point and accomplish it both naturally and unnaturally. Take the area of communications, for example. Currently, the majority of our voice communications are via a copper wire. The scarcity and increased cost of copper is well documented. Must we not make more efficient use of our copper, or better yet, find some way to satisfy our communication needs without using copper. Table 3 shows efforts and progress made in this direction. The first four techniques shown in Table 3 are used today. All except the fourth require a copper line. The last three techniques are experimental in nature. Both the techniques being used and the techniques being proposed show the trend toward more efficient use of materials. The same trend can be observed in communication receivers, that is, T.V. and radio sets. We started out first with the rather bulky vacuum tube, graduated to the transistor, and are now moving toward the integrated circuit concept. Again, we find more efficient use of material.

There is some question in my mind, though, as to whether or not we have managed the same efficiency increases in the transportation field; do the trains, cars, and planes use a decreased amount of material per passenger today? It might be argued that planes, because of their much higher speed, represent a more efficient use of material. Should we really be taking a different approach anyway, and assume that with increased population densities transportation of the voice and image will be more efficient than transportation of the person and that all business conferences will be by picture-phone? In any event, I am certain the final solution will involve less material doing the same or a better job – that is, more efficient engineering.

Likewise in the field of thermal pollution, we need to consider possible better engineering solutions. For example, I understand Long Island Lighting Co. in New York is selling heated water to help the growth of oysters. Do we know enough about the ecology of our water sources to "engineer" a better solution to the thermal pollution problem? In view of our thermal pollution problems is an all electric home the "best" engineering solution to an environmental control problem?

TABLE 3 – TRANSMISSION FACILITIES

Transmission Method	Maximum Frequency Used	Voice Circuits per System	Maximum Voice Circuits per Route
1. Carrier on paired cable	260 kHz	12-24	1,200-2,000
2. Digital on paired cable	1.5 mHz	24	4,800
3. Carrier on coaxial cable	2.7 mHz 8.3 18.0	600 1860 3600	1,800 5,580 32,900
4. Carrier on microwave radio	4.2 gHz 6.4 11.7	600 1800 100	3,000 14,000 400
5. Satellite	30 gHz	1500	20,000
6. Millimeter wave guide	100 gHz	5000	250,000
7. Optical guide laser	1,000,000 gHz	?	10,000,000

DESIGNER-SOCIETY INTERACTIONS – The third major change in optimizing engineering design is increased interaction between the designer and his design and society (government). You may properly question whether or not this is optimization, but I do not think you can realistically question whether or not it will occur and increase. As our population density increases, the necessity for group action in judgment and decision increases. It seems certain that this interaction will increase.

EFFECTS OF THESE CHANGING DESIGN CONDITIONS ON THE ENGINEER AND HIS WORK

The changes in design conditions mentioned above will inevitably call for different and additional skills on the part of the design engineer. Let us look at how these changes may affect the engineer and his work.

HUMAN RELATIONS AWARENESS – If the engineer optimizes his design for these new conditions, he must be increasingly aware of the social effects and responsibilities of his work, and of the inevitability of the interaction between the engineer and society (government). I am sure that any engineer who has been involved with safety or pollution over the past several years recognizes this interaction!

This changed situation will call for a changed attitude on the part of the engineer. For example, a study by Harrison, Hunt, and Jackson of the "Profile of a Mechanical Engineer" (4) found that the favorite college subjects of the engineers studied were math (79), physics (34), thermodynamics (34), machine design (76), mechanics (20), chemistry (8), and humanities (6). The summary statements of this study are "engineers seem to have relatively little human relations interest . . . nor are many engineers cultural enthusiasts . . . social science interest is seldom high."

The engineer in his usual forthright manner admits his lack of interest in society and its problems. For example, a recent survey conducted by the editors of *Machine Design* (5) produced the self-ratings as shown in Tables 4 and 5. A similar study among Purdue engineering alumni, by Professor Le Bold reportedly produced comparable results.

TABLE 4 – STRONG CATEGORY

Characteristic	Rating (40 maximum)
Technical Ability	40
Desire to Excel	20
Persistence	13
Honest and Readiness	11
Cooperation, Logicalness and Calm Temper	8
Creativeness	5

TABLE 5 – WEAK CATEGORY

Characteristic	Rating (40 maximum)
Ability to Communicate	28
Drive	18
Social Amenities	16
Culture (attributed to limited education in humanities and arts)	14
Creativity	10
Community Interests	10
Keeping up with Current Knowledge	3

The engineer is in a unique position to play a major role in solving the problems of society, for almost all of these problems involve technology and economics. Yet, at the same time he is being asked to lead in sociological and political areas in which he has little or no formal training and not very much interest. Similarly, he is being asked to engage in pursuits which are in conflict with his private interests and tastes and which, in the past, have not contributed to his professional standing and success. The reluctance of engineers to lead in these areas is understandable!

In defense of the engineer, literary intellectuals have not been any more enthusiastic about learning engineering than engineers have been about learning outside their field. According to C.P. Snow, above all, literary intellectuals balk at the idea that, for their own sake, they need to know about science as much as, or more than, most of the scientists already know about art. One must conclude that all of us are deficient in overall knowledge – it is simply a question of what areas are we deficient in. This point is illustrated in Fig. 3 which presents an analysis of the different fields of studies covered by different curricula. The lack of training of almost everyone in the biological fields is immediately evident. The concentration of physical science curricula on the physical sciences and of the social sciences curricula on the social sciences is also very evident.

However, it does no good to argue about who is "educated" and who is "uneducated" or who is "uncouth" and who is "couth." The cold hard facts are that in the future world, if the engineer is to optimize his design, he is going to have to be more aware of and alert to the social and sociological implications of his new design. He can do this only if he has knowledge in these fields.

In addition, the engineer can no longer afford the "luxury" of not being able to communicate with individuals who do not have technical training. Every engineer in the future must be an educator! Who besides an articulate engineer, having a human relations awareness, can convey to a typical nontechnically trained governmental body, the engineering information essential to reaching a wise decision?

To emphasize this section of the paper, governmental activity and regulations have recently increased dramatically in the fields of safety and pollution. Is there a fundamental incompatibility in these fields between social and engineering needs that has resulted in this regulation? Or was it a partial failure on the part of the engineer to sense and anticipate human needs almost before the individual himself was aware of them and then a further failure on the part of the engineer to articulate in simple understandable terms the problem and what he was doing about it?

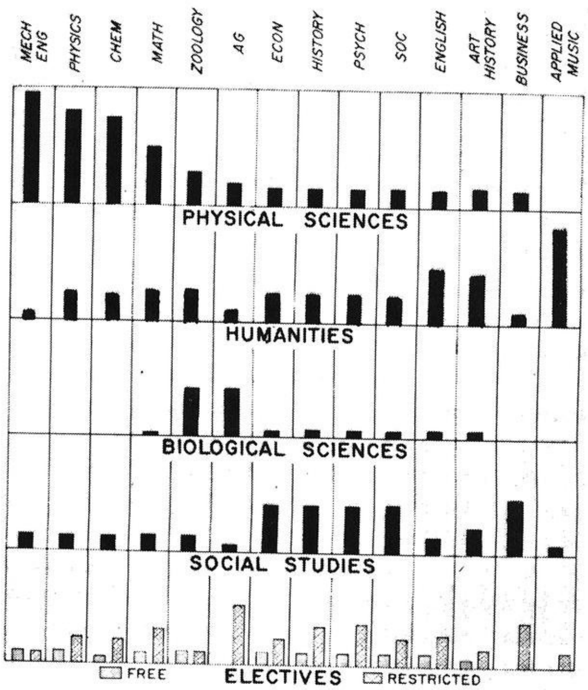


Fig. 3 – Fields of study covered by various curricula

POLITICAL INVOLVEMENT – The second effect that the engineer is going to notice is his required involvement in politics and governmental decisions. Some minimum involvement by engineers is absolutely necessary and inevitable – only the engineer has the technological and economic knowledge necessary to solve the problems. In addition, I am egotistical enough to think that engineers have a contribution to make in their own right and would be contributing members in finding a solution to the problems of society even without their special skills. In addition to this, because of the increased interaction between the engineering design and society, I think that company attitudes towards participation of engineers in society's decisions will change from a "hands off" or neutral attitude to encouraging and almost requiring participation. It is not accidental that so many lawyers participate in government – it advances their careers to do so. This has not been true of engineering in the past, but I think it will be so in the future. The optimum engineering design will have to consider, more than ever, the sociological and political implications as well as the engineering implications.

PREPARING FOR CHANGE

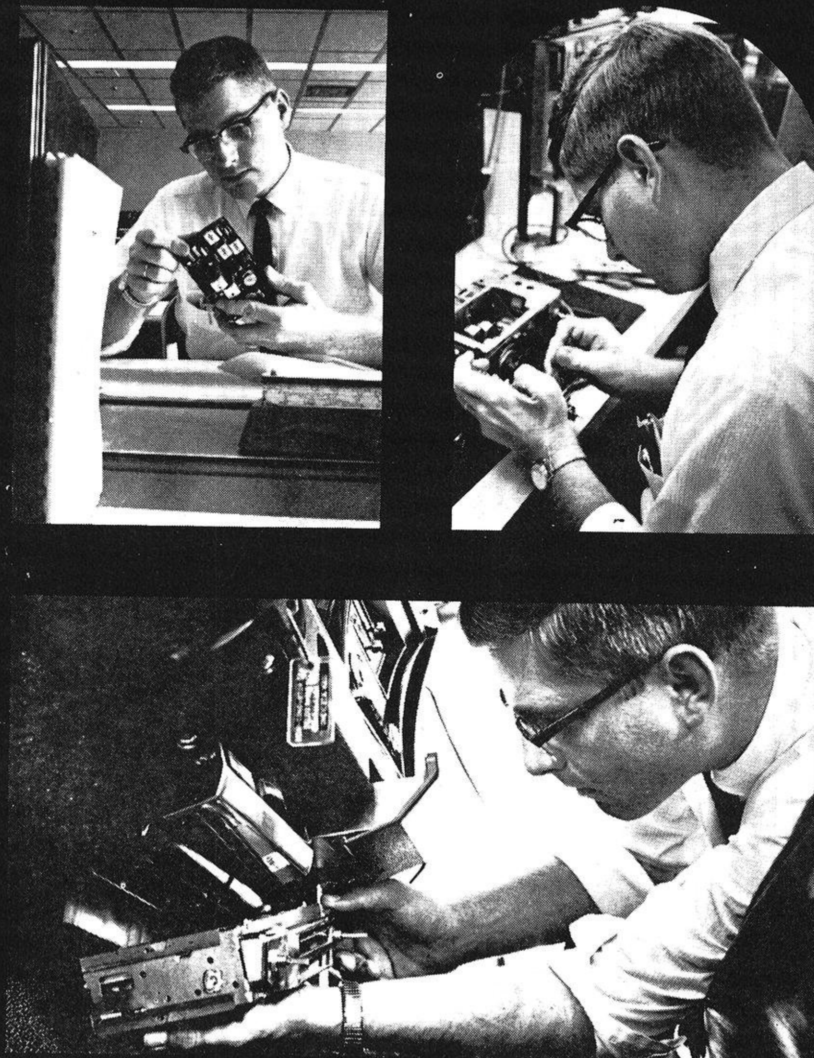
I hope that by now I have convinced you that, like it or not, the criteria for optimizing an engineering design are changing and that you will need new and additional skills. It goes without saying that these new skills must not be acquired at the expense of the traditional engineering and economic skills. Acquiring these new skills, some of which will seem foreign, will not be easy and will require both initial and continuing education in the new fields, as well as in the traditional fields for engineers. However, the engineer is already rising to this challenge. For example, Walter Rosenblith, chairman of the M.I.T. Faculty says, "I expect that fewer and fewer of the engineering graduates will be willing to work on problems with little or no social relevance. They will ask, 'What is this highway going to do to people?' rather than merely, 'How do we design it?' Our students are gaining a consciousness of their ability to affect man's environment, and they will be looking forward for ways to use their skills towards this end." As I pointed out to you earlier, today's students assume (you and I are perhaps less certain of the correctness of their assumption) that a reasonable living standard will be theirs and they are truly concerned with other and additional problems.

If the engineer is going to truly optimize his design in the future, he is going to have to be more of a decision maker and less of a hired hand. To quote Douglas Brown, an economist and Dean of the Faculty at Princeton, "To perform this function in the implementation of the vastly expanding science in an anxious world, the engineering profession must enlarge its concept of its role. It must throw away the last vestiges of its evolution from a craft and take on the full responsibilities of a learned profession. The central attribute of a learned profession is responsibility, not for a segmented detail of the problem, but for an effective solution of this total problem. This means that for the profession of engineering, the days are past when each specialist can withdraw into his specialty and become a servant of someone else's grand design. Rather, the professional engineer must assume the initiative in helping to solve problems which in the past have been shrugged off as political, economic, social, or headaches for business and government." Can the engineer measure up to this challenge? I think he can. Some engineers are already meeting this challenge. Some of the younger engineers (especially students) **must** meet this challenge if we are to solve our problems of war, waste, famine, and poverty.

[***]

REFERENCES

1. "A Look at World Population the Day After Tomorrow." UNESCO Courier, February 1967.
2. Frank C. Di Luzio, "Water Use and Thermal Pollution." Power Engineering, June 1968, pp. 444-446.
3. R.A. Kelley and F.T. Andrews, "Challenge in Transmission," Science and Technology, April 1968, pp. 55-62.
4. Ross Hanson, Winslow Hunt, and Theodore A. Jackson, "Profile of the Mechanical Engineer." Personnel Psychology, Vol. 8, Winter 1955, pp. 219-234.
5. Machine Design, January 17, 1963.
6. A very good reference is: "Engineering: Its Role and Function in Human Society." Ed. W.H. Davenport and Daniel Rosenthal, Oxford, England: Pergamon Press, 1967.



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The problem: minimize the part the internal combustion engine plays in air pollution.

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