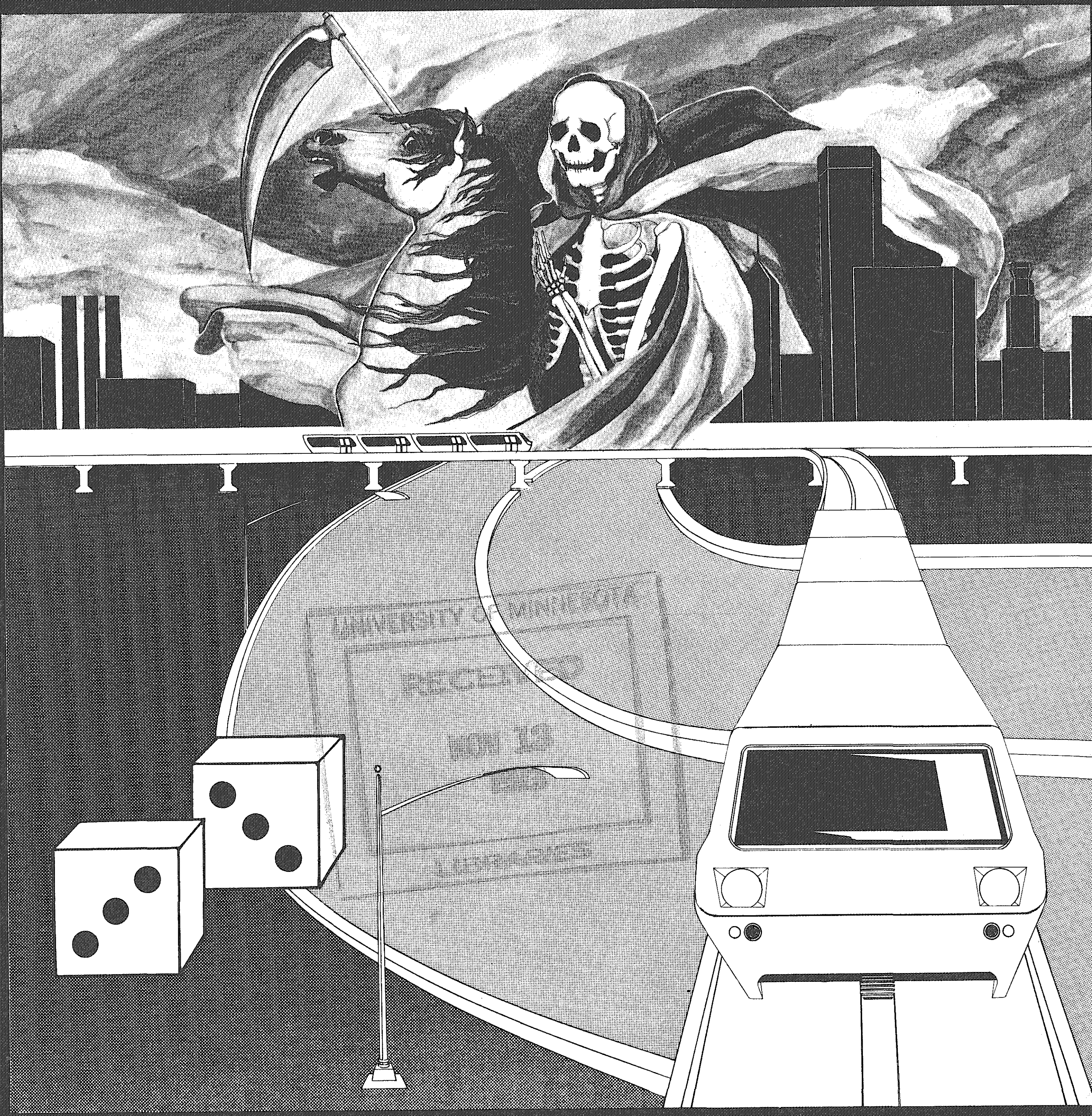
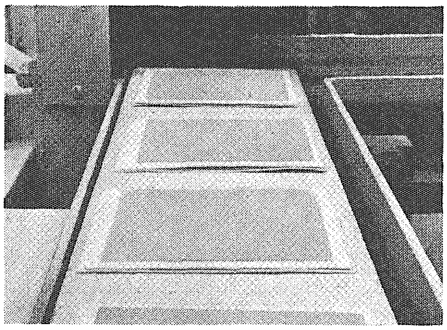
minnesota **Technolog** october 1973

# MASS TRANSIT: A WAR OF INITIALS
# THE CALCULATOR ISSUE

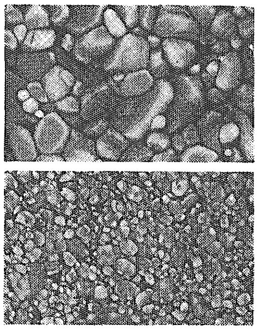
Hydrides · Clippings · Opinion



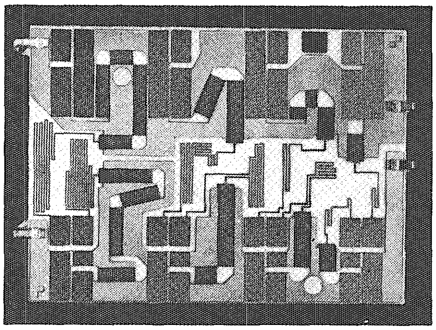
# WESTERN ELECTRIC REPORTS



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



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



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

## Smoothing the way for perfect thin film bonding.

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

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

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

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

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

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

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

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

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

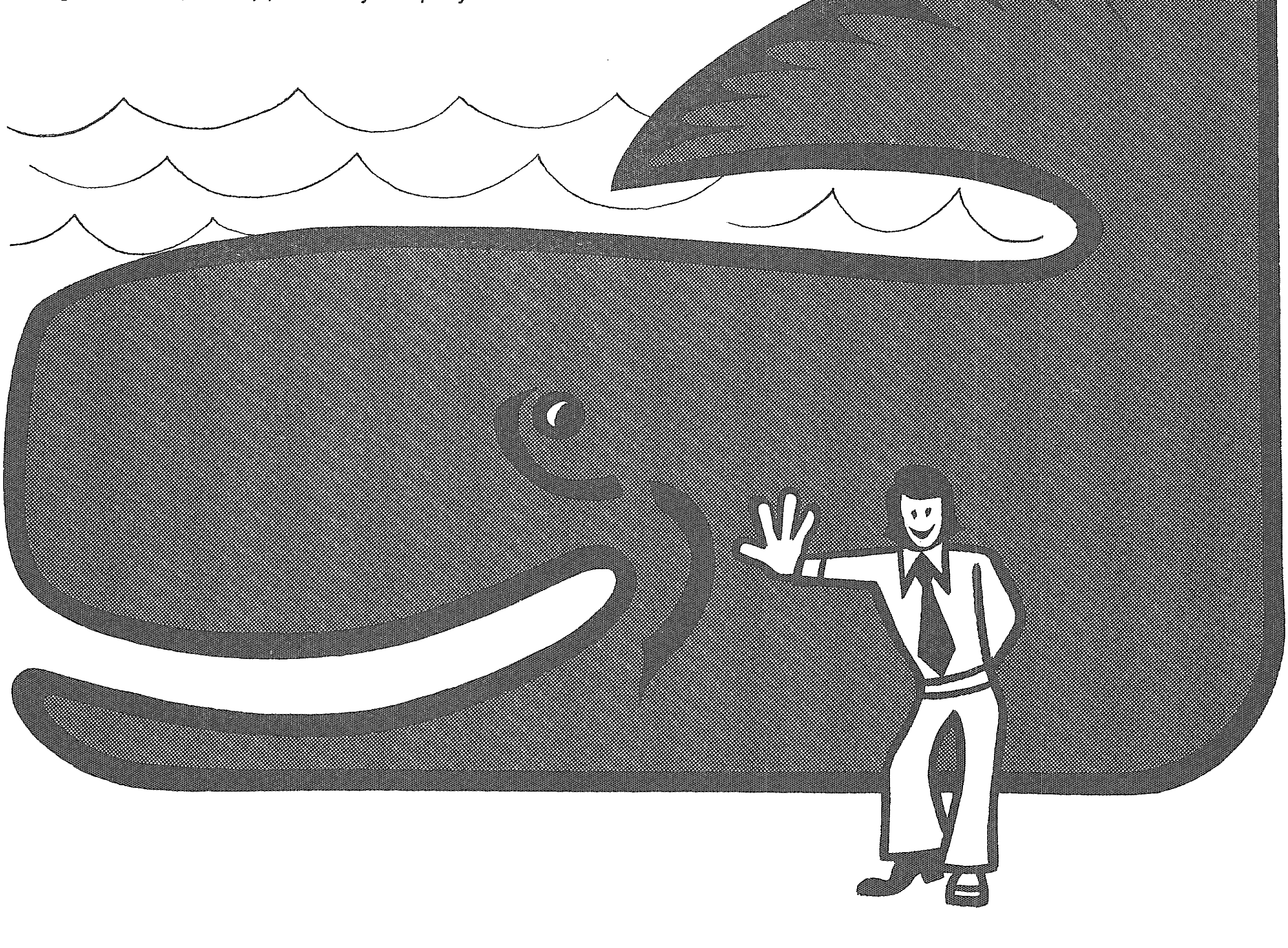
In developing this new process, engineers at Western Electric's Engineering Research Center worked together with engineers at the Allentown plant.

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

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

**Western Electric**

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



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COVER DESIGN BY KATHY LOTHSPEICH

# Technolog editorials

## Beat Your Breast or Stuff It

We have a problem with these pages. We have to say something on them. The problem is not so much what to say, but how to say it.

The backbone of any responsible publication lays somewhere between the table of contents and the last advertisement on the editorial page. It is no accident that the newspapers and magazines with the strongest editorial pages are generally considered the leaders and spokesmen in their fields. The papers with the weakest editorial pages usually have nothing to say at all, even in their regular stories. With this realization, the editors of the Technolog desire a strong, responsible presentation on the editorial page.

In the "real world" a magazine, simply by being in business, sets itself up as an authority on something. It speaks with a greater weight than an ordinary person because of an often imaginary pedestal from which they address the public. This pedestal, or soapbox, is usually labeled as "expertise."

In a college publication like the Minnesota Technolog, the editors, like the audience, are students. In other words, we are your peers. It seems to be a strange tradition among American college students to ignore, deride or ridicule their own publications, probably because of this peer group situation. Any soapbox constructed by a student publication is usually well within the range of any thoughtful or vengeful student.

So the only claim to expertise that we will make will be due to hard work and research. Whether you agree or disagree with what you read in this year's Technolog, you may rely on one thing; that the reporting will be as accurate as possible. While other publications, student or otherwise, may imagine facts, make up quotes or use the excuse of "interpretive reporting" for little more than propaganda purposes, there will be no guesswork in this year's Technolog. We will get it straight and so will you.

As to form, your magazine ought to continue as a responsible voice in the I.T. community. It also ought to be interesting, easy to read and hopefully remembered. So instead of a tome-like presentation on our editorial page, we hope to be responsible by being irresponsible, irreverent and perhaps interesting. Please bear with us.

## $*$*$*$*

By all accounts this is the damndest magazine you ever saw. And if you saw our bank accounts you'd know how damned we really are.

Our vast reservoir of funds, accumulated through the 1946-1968 (post World War II — pre Richard-Nixon) years has been steadily drying up. But in the last two years, somebody apparently pulled the plug. All we have left to run the magazine at this point is a shoestring and a bathtub ring. We tried to hock the bathtub ring, but the pawnbroker wouldn't take it.

And printing is getting more expensive all the time. We are going to print an I.O.U. on the front cover but we couldn't afford to buy the ink. Environmentalists will be happy to learn that this issue of the Technolog is printed on 100 percent recycled paper, which was taken from every john in I.T., C.L.A., and the half of the St. Paul campus that uses indoor toilets. The staples for this magazine were tapped from wiring in various E.E. classrooms and bent into shape by hand. So for this year's E.E. classes you have an excuse for being in the dark.

Despite our poverty we will struggle on. Instead of our regular reporting, we have a special feature this month — a reprint of the entire works of the worlds greatest thinkers; people like Henry Miller, John Foster Dulles, Ms. Martha Mitchell and other highlights of the intellectual circuit. For a light touch we have included *Selected Off-Color Stories of Albert Einstein.* Note that every selection is on the required reading list of at least two of your courses.

In doing this we are taking revolutionary steps. So as not to incur an unburdenable expense, we are presenting these works in the form of a microdot which appears on the bottom of this page. For you to gain access to these treasures we are supplying an electron microscope for your use, located in the Technolog office, Room 2 M.E.. To get a glance at the works, you will have to be charged a nominal fee —25¢— to cover the cost of the machine operator. To get a photostat of the contents of the dot, so you can read it, we also have to charge you a nominal fee — $4,515.77. Normally that price would be far higher, but since we are a non-profit organization we can offer you this service at a slightly higher, but still ridiculous price. Didn't we tell you that printing is getting more expensive?

# Flash

The Technolog, for the first time in its history, presents a series of newspaper clippings for the express purpose — or as it were, the Tribune purpose — of enlightening its readers with the immense historical events taking place out there in the real world beyond University Avenue and Oak Street. The editors feel certain that these articles will form the framework of new visions within the old-style conceptual framework of understanding media, the world, and the cultural etcetera of the matter.

PARTY PLANNED

St. Paul Banana Boat Bugle, 31 September 1973.

The Minnesota Chapter of the Society of Really Dedicated Industrial Diabetics (SORDID) will be holding a Halloween insulin party at Folwell Hall sometime in late October.

NEW FOOD DEVELOPMENT

The New York Pioneer Press, 18 September 1973

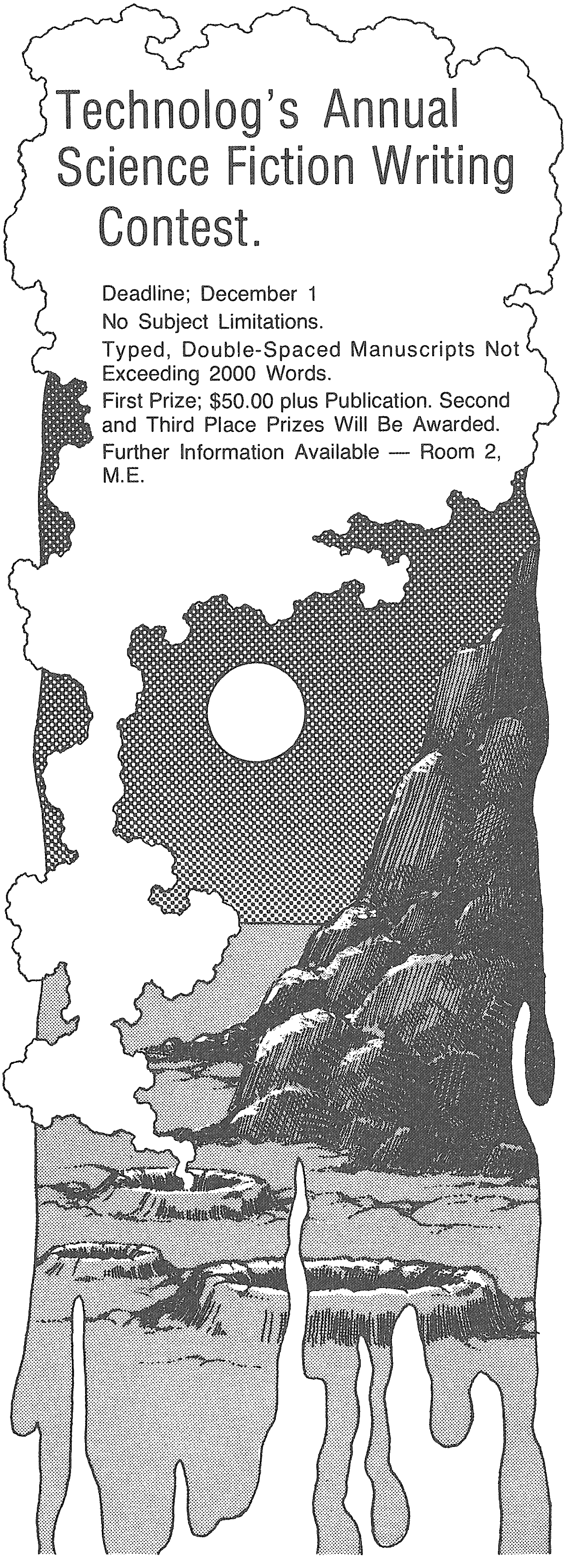
The MacRonalds Corporation announced today that the company will convert to an all-beef substitute program in their hamburger division by 1976. Although a company representative, Mayer Cheze, says he personally investigated the new Soylent Brown food substitute, company management directors rejected this product. According to Chairman of the Board Melvin Lard, MacRonalds will be using a team of Sanitation Engineers to develop its own new meat substitute.

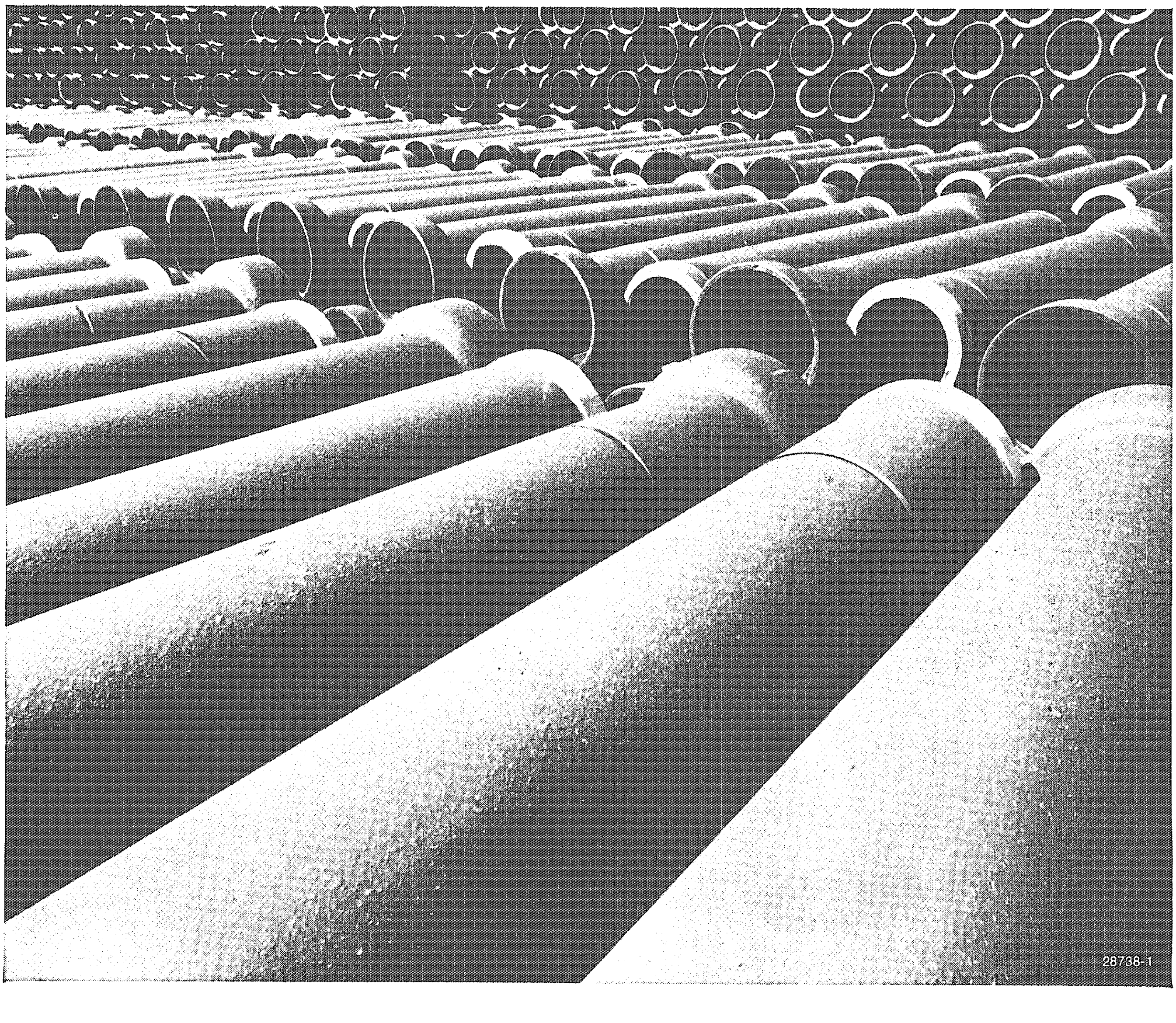
TWIN CITIES MASS TRANSIT

Minneapolis Scar, 16 September 1973

Riders are the key to the success of any transit system. Rail transit is predicted to attract 2.5 percent of all lungfish in the Twin Cities area. These lungfish are expected to take over all mass transit by the year 2000. The Nixon administration has stated repeatedly, "We not only do not believe in lungfish, we will not dignify them with being defined as even a menace." This statement has been opposed by several well-known officials, however.

Robert Pirro & James M. Young

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I.T. students are stereotyped. A part of the picture includes a sliderule dangling from their belts. This year it might be more fitting to picture them with a pocket calculator, the latest item in fall fashions. Although they have been on the market for barely two years, calculator sales could hit as high as 7 million machines by the end of 1973. Roughly 2.5 million were sold in 1972. Included in these figures are several thousand highly sophisticated scientific calculators intended for use by engineers and scientists.

Presently there are nine pocket sized calculator models manufactured by seven different companies aiming for the science and engineering market. As a consumer service, the *Technolog* has made a comprehensive survey of these calculators.

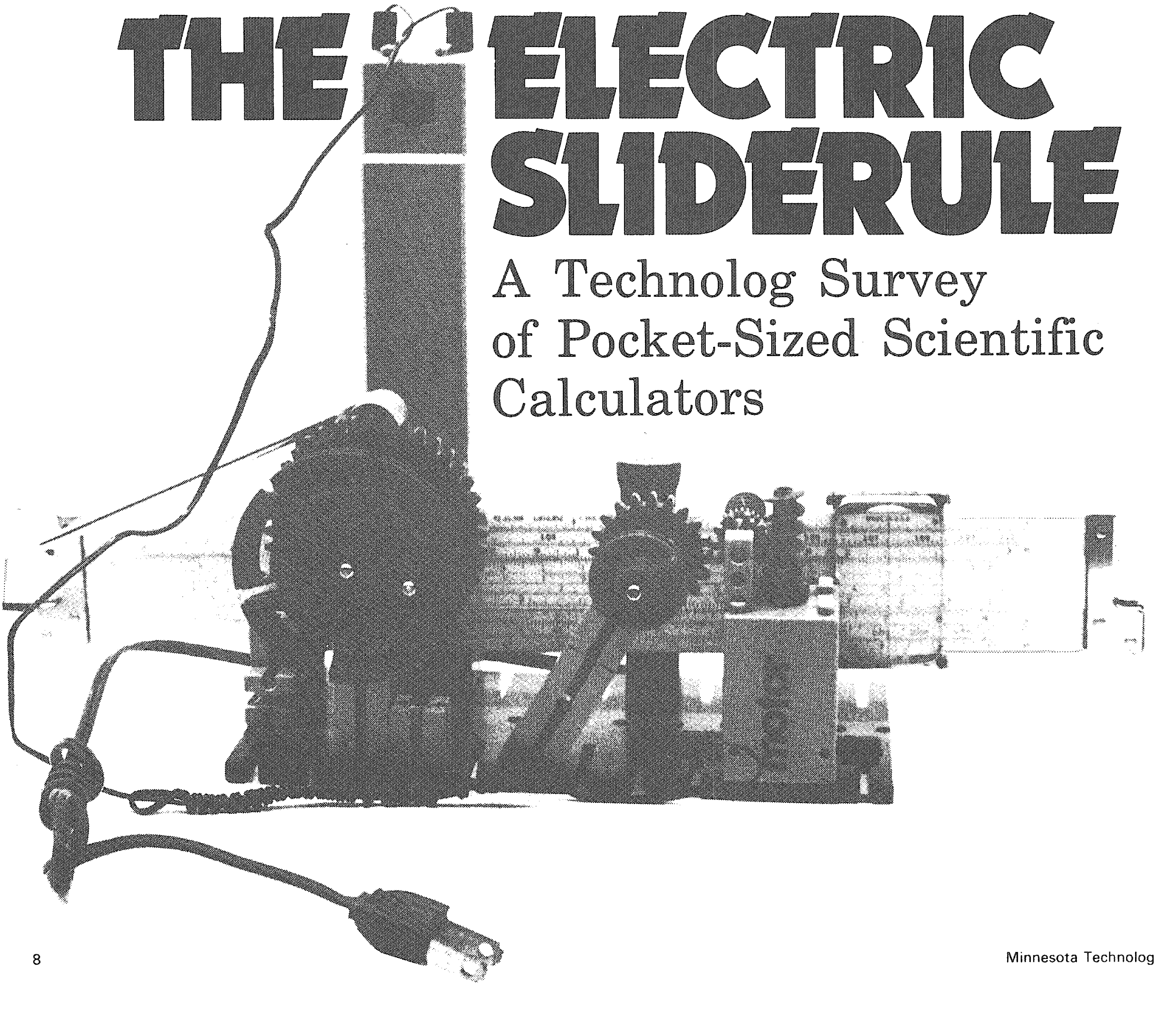
In choosing the models to review, all four-function machines were eliminated. These are calculators that do only adding, subtracting, multiplying, dividing and may have a memory or percent key. Although four-function machines are an improvement over a sliderule and even though they should be considered as a possibility when purchasing a calculator, a thorough job of reviewing the 100 or so models currently on the market is next to impossible. Therefore only calculators with special functions aimed at the engineer or scientist are included in this survey.

Also, the more expensive models which do nothing more than the ones we review have been eliminated. For example, the Compucorp model is slightly larger in size than the HP-45 we review, it has no more functions than the 45, yet costs several hundred dollars more.

The major problem in trying to use a calculator instead of a sliderule is having it accepted for use on tests. Last year in most University freshman engineering physics classes their use was prohibited. However, instructors who do prohibit them usually deemphasize calculations on their tests by either asking for simple calculations that you can do in your head, or by having you give a general algebraic solution. This seems reasonable considering the disadvantage of students who do not own a calculator. Still, the total outlawing of their use would be contrary to the aims of the Institute of Technology which are to encourage technological advances and to train future engineers in conditions similar to the world that they will be working in. It is foreseeable that a calcula-

# THE ELECTRIC SLIDERULE

## A Technolog Survey of Pocket-Sized Scientific Calculators



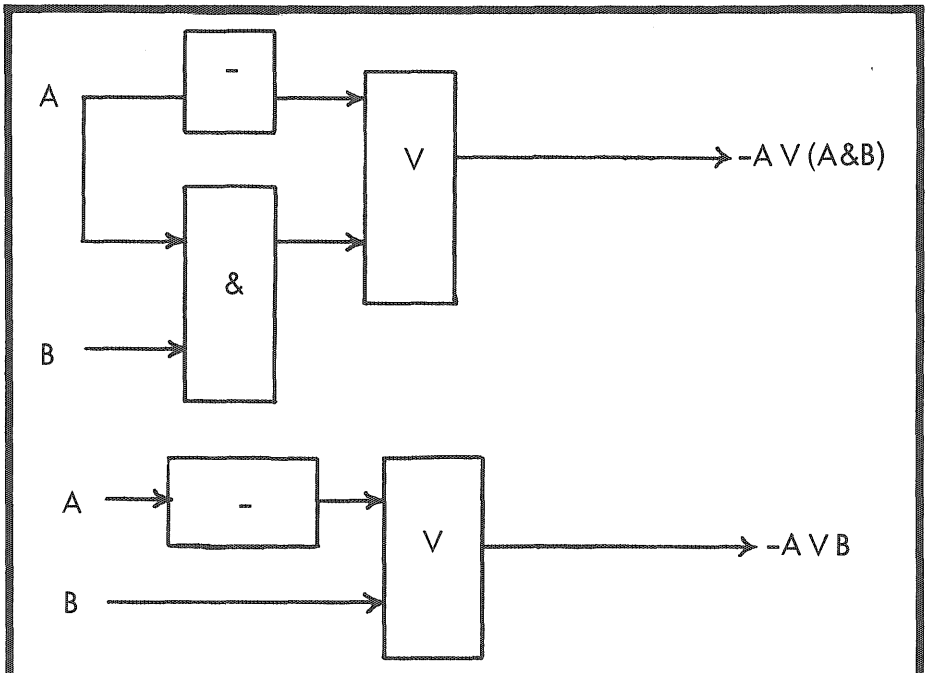



Fig. 1

tor could be considered a prerequisite to certain classes and someday perhaps even an I.T. entrance requirement. One electrical engineering professor has strongly urged members of his class to purchase a well known $300 calculator. This is reasonable considering that this is less than a quarter's tuition with the cheapest of calculators (around $50) costing little more than two textbooks.

Can a calculator buy you good grades? It can, but most people can see that it most likely would not. A calculator could give you a time advantage on a test, but as soon as the majority of people taking tests have calculators the advantage disappears. The true value of a calculator shows up in doing labs and homework problems. Labs typically have numerous calculations based on long lists of data. With the added efficiency a calculator provides, you can do more practice homework problems and get a better grasp of the material. Using a sliderule, when you get to the end of a problem and have the wrong answer, the tendency is to call it a sliderule error rather than go back and analyze what you did wrong. A calculator makes such work quite painless even though it will not find the difficulty for you. This poses a dilemma for some instructors — whether or not to assign more homework problems with more involved calculations.

Two advances in technology that have allowed pocket sized calculators to be built are miniaturized display systems and integrated circuit chips. The most popular read-out displays are the light emitting diode (LED) displays and liquid crystal. Previously only cumbersome mechanical displays or large, power consuming nixie tube displays were available but were out of the question for use in a small calculator because of their size and power consumption. Liquid crystal displays become brighter and brighter with more and more light shining on them. Therefore they are ideal for use in bright light, and in dim light manufacturers usually put on auxillary bulbs to illuminate the display.

Integrated circuits were developed in the early 1950s. They are small silicon chips with many microscopically thin layers deposited on them. These layers have characteristics similar to many thousands of transistors. By arranging the transistors in correct order, many flip-flop circuits can be made which can represent on-off, true and false or one-zero. Because it can represent true or false, a logic pattern can be built up to create logic paths. The most common logical gates are the **and** and **or** gates plus an inverter circuit. When an inverter circuit's input terminal is at a high voltage level, its output voltage is low, and vice versa. On the other hand, the **or** gate is so constructed that it can have two or more inputs, and have a high output even if just one of the inputs is high. If all inputs are low then the output is low.

The **and** gate must have all inputs high in order for the output to be high. In terms of basic logic, the inverter will always act like a negation of a statement, making a true statement false and rendering the false, true. The **and** and **or** gates closely follow the meanings of **and** and **or** in the English language and in basic logic.

Networks of logical gates can be formed by connecting outputs of some logical gates to inputs of others. For instance, in the drawing (see Fig. 1) where A is connected into both an inverter and an **and** gate, B is connected into the **and** gate and the outputs A and B are connected into an **or** gate, the network is at a high voltage level if the sentence A V (A & B) (read negation A or both A and B) is true, and the network is at a low voltage level if that sentence is false. Designers must be quite careful to keep things logically correct while efficiently minimizing cost and power consumption. The logical phrase -A V (A & B) is poor since the sentence -A V B is logically equivalent and would provide for a simpler circuit. After the basic logic circuits are drawn out they are translated into large diagrams that look similar to printed circuits. These diagrams eventually comprise the layers of the integrated circuit chips.

Two of the nine models we found are not expected to be on the market until late this fall or early next year. One of these, the Rapid Data model, looks quite promising. It will sell for $229 and can perform all the trig functions. Bowmar has a similar one in the works though at this time (October) they have provided no further information. So, if you're willing to wait for a couple of months you could buy one.

Among the other seven models that you can purchase now are the Texas Instruments SR-10, selling for $119.95 plus tax. One feature that makes it many times better than a four-function machine is its scientific notation capability. It will display an eight place number multiplied by 10 raised to the 99th or the -99th. The scientific notation is quite convenient because it allows you to do large and small numbers without scaling. Scaling is commonly used with sliderules and involves converting all numbers into scientific notation and then adding and subtracting the exponents. Since most physical constants are smaller than 10 to the 99th and larger than 10 to the -99th, this range provides for much flexibility.

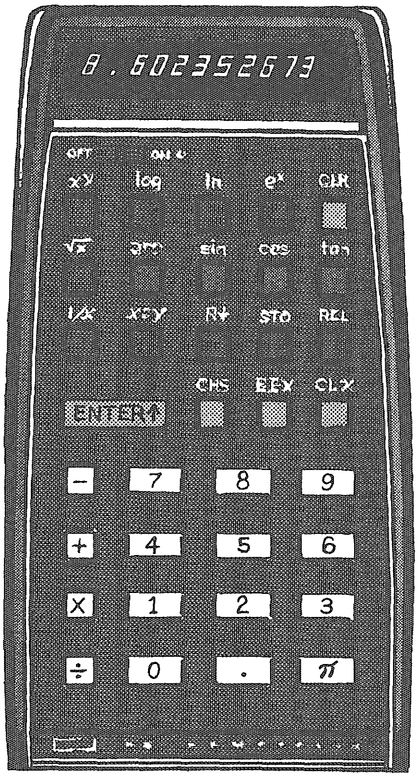
Texas Instruments advertising deserves first place for stretching the truth. In their advertisement they say, " . . . using simple methods, you can calculate transcendental functions, nth powers and roots and more." It is true that you can calculate these items but not by *simple methods*. For example, to figure the sine of 30 you must press 38 buttons and reenter a number once. The twenty page booklet they provide with the machine to explain these *simple methods* is interesting to read because they have collected many approximation techniques in one place.

The SR-10 has an LED display which works quite well indoors. In sunlight, such as in a car or next to a window in an airplane, the display becomes hard to read. This is true of all other calculators with LED displays. Three special function keys (square root, square and inverse) assist greatly in calculation. Another important feature is a floating decimal point. This allows you to enter numbers in any format and have answers come out displayed with the most significant digits. Power to run it comes either from AC house current or from a nickel-cadmium battery that can be recharged in three hours and which runs for six hours. It is important to check on this since some calculators use only non-rechargeable flashlight batteries and will not run off household current.

Most manufacturers run tests of all their chips before selling them. If trouble occurs on the SR-10, repair is available through TI Consumer Facilities, and is free during a one year warranty period. However, it is generally true of all integrated circuits that the mechanical body of the calculator has a higher chance of causing problems than the chip itself.

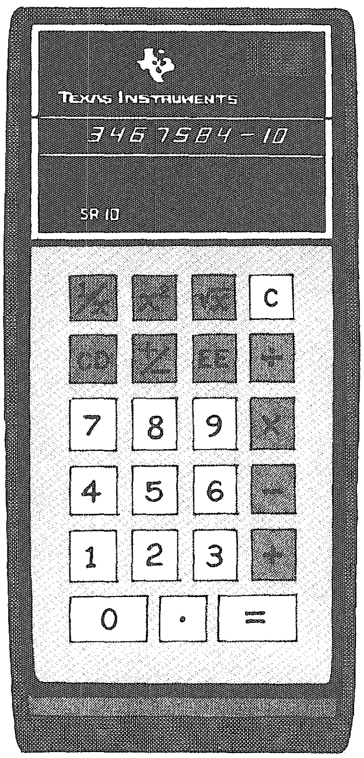
For people who like to build kits, MITS, Inc. has a model 150 listing for $99.95 that does square-roots, squares and reciprocals like the SR-10. Unlike the SR-10 it does not have scientific notation but it does have memory and percentage keys. It also offers both floating and fixed decimal point keys which are useful when working in dollars and cents. Like the SR-10 it has what is called algebraic logic. Algebraic logic allows you to enter your calculations as you would write them down. If you wanted to multiply three times four you would press the 3, X, and 4 buttons in that order. Keys for such functions as square roots operate on the number being displayed so that you do not need to reenter it. The calculator's memory allows you to store a number to avoid arranging all your calculations in a chain. It also has an eight place LED display and a one year warranty on parts. As far as service goes, since you are building it yourself they expect that you will service it yourself.

Another machine, the Panasonic 860, does square roots, has an automatic constant key and a pi key. A constant key differs from a memory key in that it cannot do calculations unrelated to the number being used as a constant.



Hewlett-Packard HP-35

Columbia S



Texas Instruments Sr-10

At $149 it is quite a steep price to pay for a pi key. It would be cheaper to use the old sliderule trick of dividing 355/113.

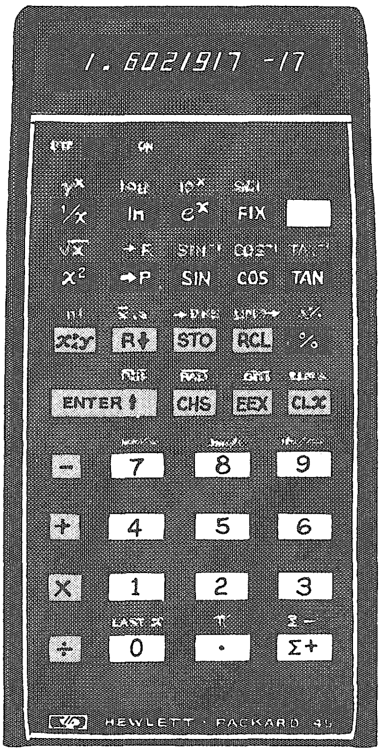
The Columbia Scientific Calculator, marketed by a large mail-order house, has algebraic logic and a square root key. If you can do without the scientific notation of the SR-10 this offers an outstanding value for the same price ($119.95) because it also has a square and reciprocal key, plus a memory and percentage key, and offers the ability to have an automatic round-off or round-down, 0 to 5 places. An automatic switch turns off the calculator if the display is inactive for more than 15 seconds.

Hewlett-Packard manufactures three different calculator models. However, you must pay dearly if you want to own the Rolls-Royce of pocket computers. The HP-45 and the HP-80 cost $395 plus tax and the HP-35 was recently lowered to $295.

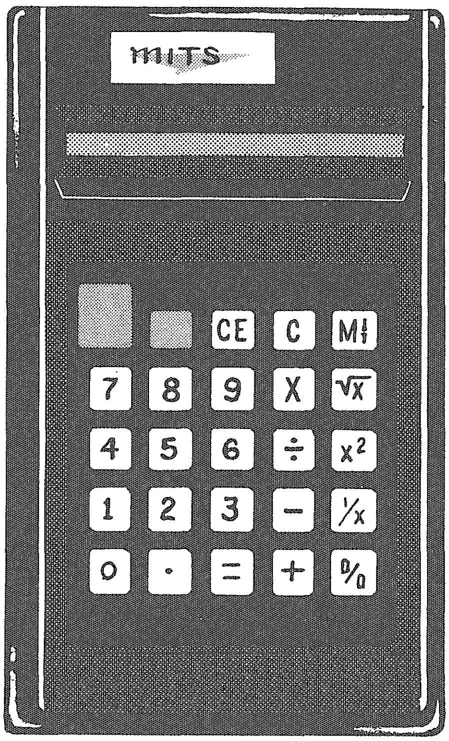
The HP-35 was introduced in the spring of 1972. It was the first calculator with special functions and it broke the five hundred dollar price barrier. In writing this article it is hard not to be biased towards the Hewlett-Packard line. As far as number of functions goes, they have left their competition far behind. So far no competitor has been able to come close to matching the Hewlett-Packard in price and size. In fairness to their rivals it can be argued that what the HPs offer is not really necessary. As one person with a four-function machine mentioned, the HP is just a walking math table in comparison to a four-function machine.

The HP-35 offers the buyer function keys that can do logs, natural logs, e to the x, square roots, all trig functions, inverses, x raised to any power, and has a 10 digit, 200 decade scientific notation LED display, allowing a 10 to the 99th to 10 to the -99th range. Not only does it have a memory, but it has a four register operational memory stack. This along with Polish notation allows you to do complex scientific calculations with maximum speed and efficiency. Reverse Polish notation (Polish notation for short) is a way of writing down mathematical expressions so that you are operating between two memory registers. The Hewlett-Packard has an operational memory stack of four-registers, named x, y, z and t. When you push a two argument function key like addition, subtraction, multiplication or division, the calculator will perform that function between the x and y registers, that is, (f (x,y)=x+y). It will display the answer in the x register and automatically roll down the numbers in the top registers so that you can continue performing one or two argument functions on your numbers. At any time you can enter new numbers into the operational stack and even juggle them around. This means that if you have a problem like ( (x+y) / (z+t) + (r-z/r) you can keep the intermediate results in the upper registers and they will automatically roll down when you need them. Contrary to what some manufacturers state, Polish notation is easier to use on scientific calculators with many functions. Canon and the makers of K & E sliderules have a desk top model that has many of the same functions though they use algebraic logic which makes the machine less flexible to operate. Of course in the case of two register machines like the SR-10 it makes little difference if it has Polish or algebraic notation. In such a case it's really a matter of personal preference.

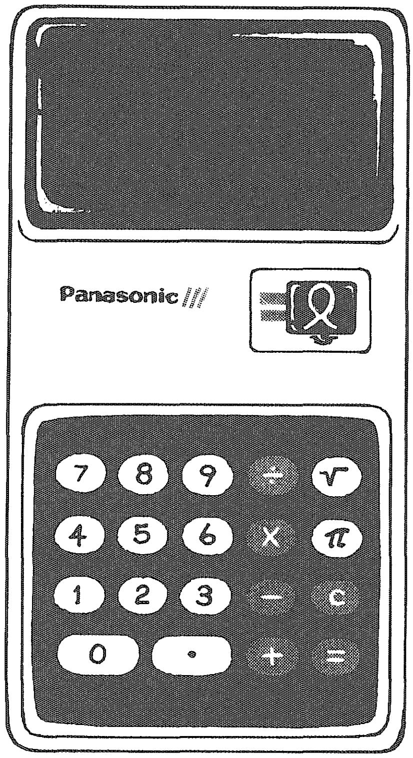
In the fall of 1972, HP-35 owners received a letter explaining that some idiosyncrasies had been discovered in their machines. The



Hewlett-Packard HP-45



MITS 150 (kit)



Panasonic 860

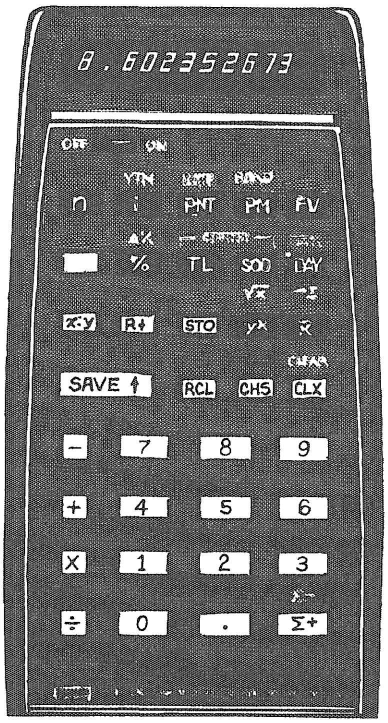
# A Comparison of the Pocket Computers

| | HP-35 | Panasonic 860 | HP-80 | MITS 150 |
|---|---|---|---|---|
| Price: | $295 | $149 | $395 | $99.95 (kit) |
| Delivery Time: | 1-2 weeks | in stock | 5 weeks | 2 weeks |
| Size (inches): | 5.8x3.2x1.3 | - | 5.8x3.2x1.3 | 5.8x3.3x1.5 |
| Weight: | 9 oz. | 18 oz. | 9 oz. | - |
| Power: | AC/DC nicad bat. | AC/DC nicad bat. | AC/DC nicad bat. | AC/DC AC opt. |
| Warranty: | one year | one year | one year | one year |
| Logic: | Rev. Polish | Algebraic | Rev. Polish | Algebraic |
| Memory: | one+four in stack | constant | one+four in stack | one |
| Display: | LED 10 place 200 decade | LED 8 place | LED 10 place 200 decade | LED 8 place |

| | HP-45 | TI SR-10 | Columbia S |
|---|---|---|---|
| Price: | $395 | $119.95 | $119.95 |
| Delivery Time: | 12 weeks | in stock | 2 weeks |
| Size (inches): | 5.8x3.2x1.3 | 3.3x6.7 | 3x5.6x1.3 |
| Weight: | 9 oz. | - | 9 oz. |
| Power: | AC/DC nicad bat. | AC/DC nicad bat. | AC/DC nicad bat. |
| Warranty: | one year | one year | one year |
| Logic: | Rev. Polish | Algebraic | Algebraic |
| Memory: | nine+one+ four in stack | none | one |
| Display: | LED 10 place 200 decade | LED 8 place 200 decade | LED 8 place |

Data is not available yet on the Rapid Data & Bowmar

errors were slight and cropped up only in certain numbers like taking the arc sine of .0002. If you would take the arc sine of .000200001 you would get a correct answer. In most cases the




Hewlett-Packard HP-80

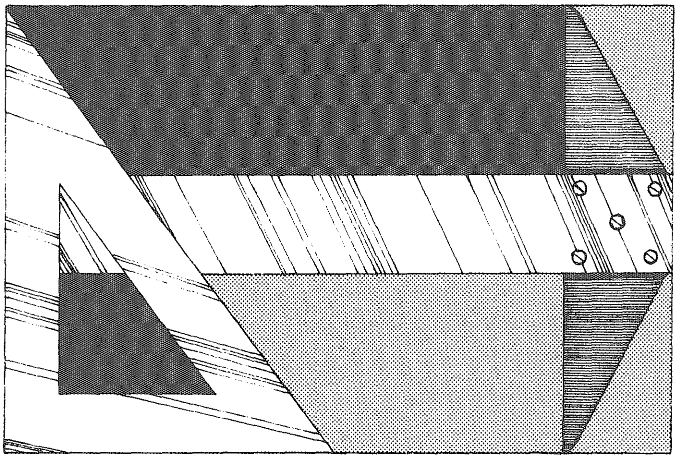
errors were from one-hundreth of one percent to a maximum of one percent. Free replacement chips were put in all old HP-35s upon request of the owners.

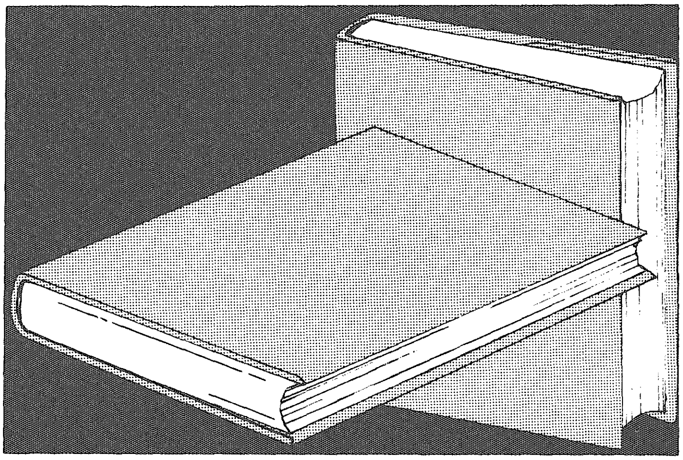
A year after the introduction of the HP-35, Hewlett-Packard produced a machine similar to the HP-35 but totally geared for business operations, the HP-80. The HP-80 retained the scientific notation, memory, square root, and x to a power functions of the HP-35, and added new features for businessmen like automatically finding the number of days between any two dates. It can also compute trend lines by the least-squares linear regression method, and set up amortization schedules using the sum of the digits method. The HP-80 has several specialized functions for figuring out complicated interest problems. The percent key is really unique because it offers a delta percent function to figure percentage difference between two values.

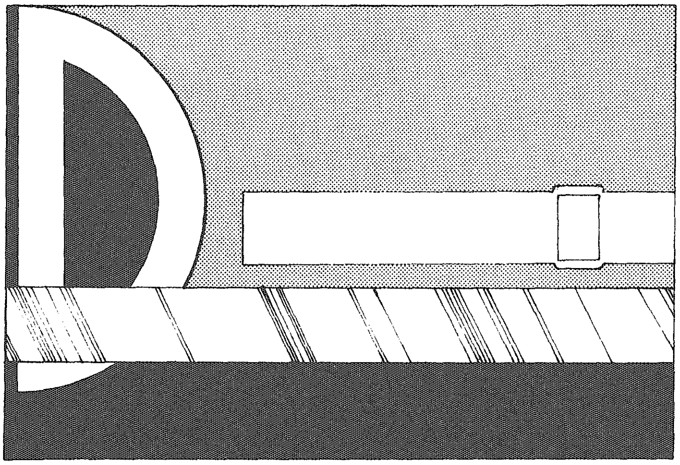
In June of 1973 Hewlett-Packard announced the HP-45. To give it more functions than the HP-35, one key was made into an upper case key, similar to a typewriter's, allowing each key to serve two purposes. The HP-45 does everything that the HP-35 does plus automatic degree conversions, automatic metric conversions, percent and delta percent, mean and standard deviation, factorials, rectangular to polar coordinate conversions, vector addition, and fixed or floating point arithmetic. Instead of having only one memory location, the HP-45 has nine addressable memory spots for storing intermediate results, and a memory spot that remembers what was in the x register last. Like the HP-35 it has a pi key and an LED display. At present it takes about 12 weeks to receive one.

Service on the Hewlett-Packards is available directly through several national repair firms. The major things that have needed repair have been mechanical items such as power cords.

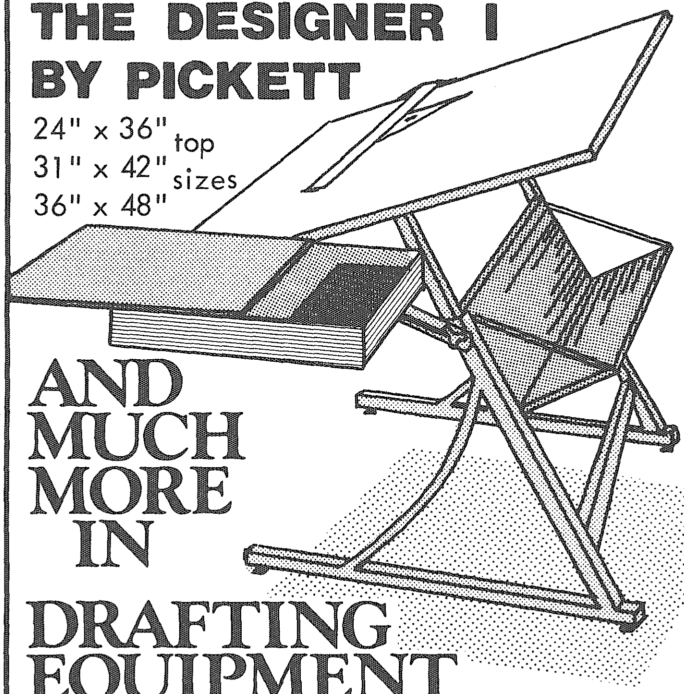
What does the future hold? It seems perfectly feasible that in a couple of years students will be carrying around Fortran programmable machines, and pocket sized computers will be as common as slide rules are now. When we reach that point, who knows what will come next?



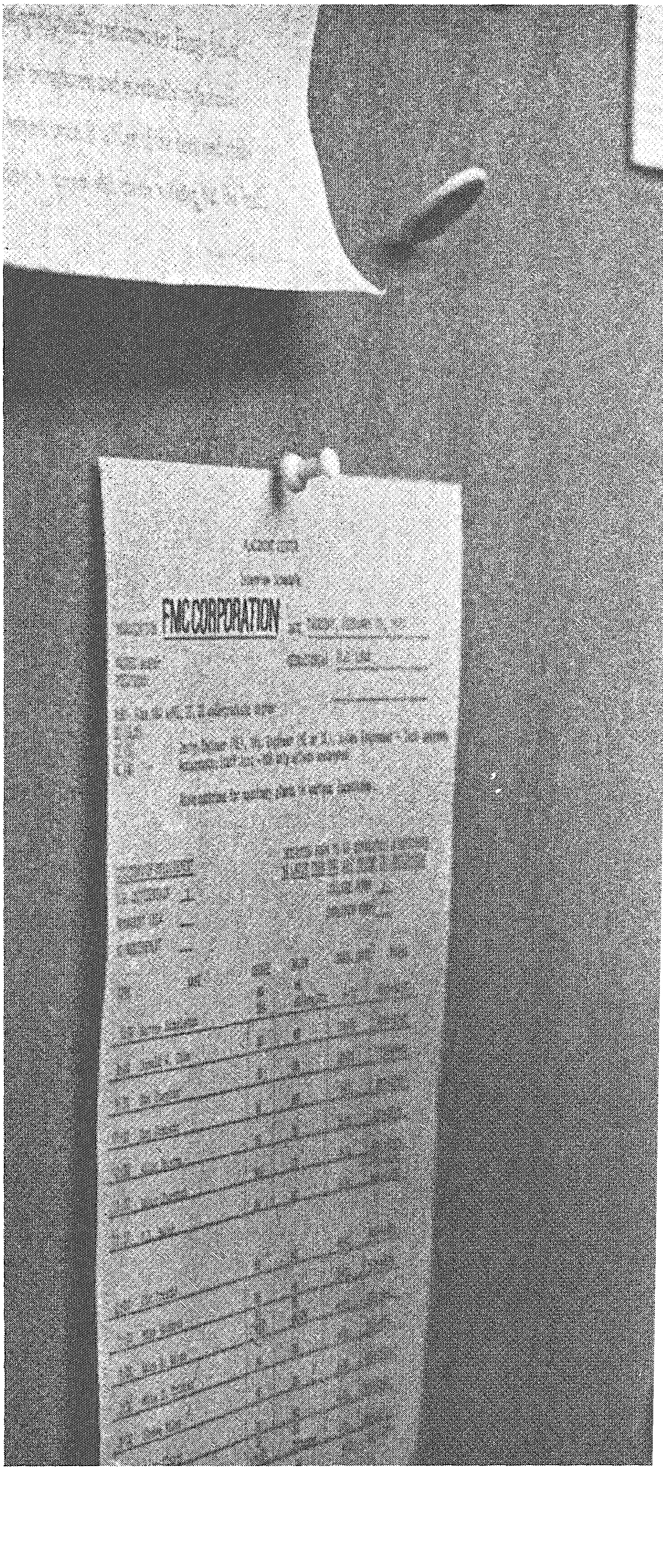








# Don't let our name confuse you.



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

We'll understand.

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

But sometimes it's just plain hard to remember.

Perhaps we should explain how it came about.

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

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

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

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

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

FMC

# TOWARDS A HYDROGEN-POWERED FUTURE

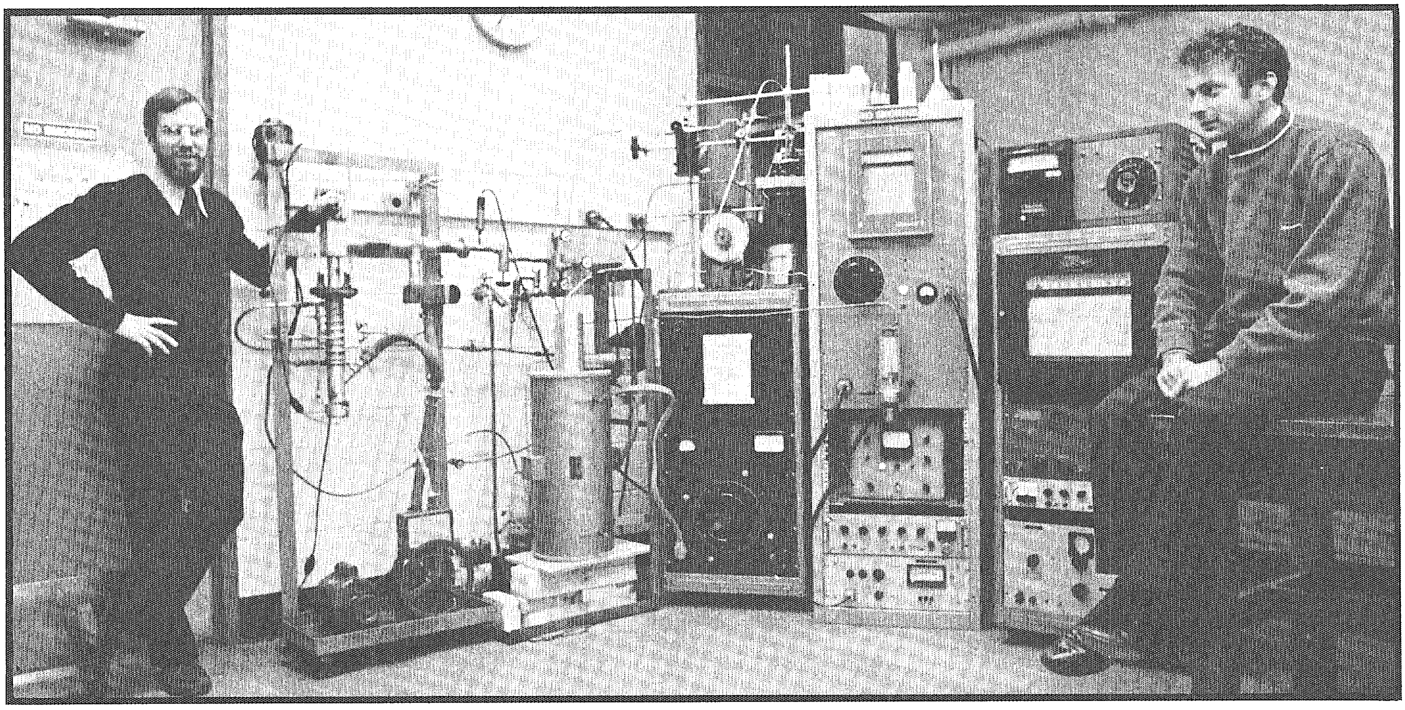
by Paul Burtness

There is only so much oil on this planet, a fact that is obvious upon a moment's reflection. But it is also a fact which seems to be casually disregarded during rush hour when thousands of cars pour out of the downtown areas, burning up years of stored solar energy as their fuel in a matter of hours. Oil companies and Arab sheiks may not be helping our energy crisis any, but the roots of our fuel problems lie in depending on a rapidly dwindling power source that once used can never be recovered and furthermore, degrades the environment when it is used.

Even though mass transit systems relying on centralized sources of electric power may relieve some of the demand for petroleum, there will be a long-term need for some sort of compact, portable source of energy for ground vehicles. And despite the enthusiastic claims of electric car proponents, the best — in terms of compactness, price and feasibility — source of energy seems to be some sort of oxidizable fuel.

To a growing number of scientists, the resolution of the dilemma between reliance on oxidizable fuels and a finite supply of those fuels is to change from a "petroleum economy" to a "hydrogen economy" in which hydrogen would be both a versatile, pollution-free fuel and an efficient, economic means to transport energy from one spot to another. The "hydrogen economists" have taken into account all the logical parameters, such as availability, compatability with present energy-use systems and environmental impact, and have produced convincing reports on how industrialized nations can make the transition from petroleum gluttony to a hydrogen-powered future. (See *Science,* 29 June 1973 or *Scientific American,* January 1973.) Of course there is an "illogical" parameter that is more difficult to take into account, that being the inertia of an industrial economy spoon-fed on oil during its infancy and now thriving on petroleum with a voracious appetite.

The beauty of the hydrogen economy lies in the properties of the gas that make it an almost ideal fuel. Hydrogen is as abundant as seawater, can produce heat, electricity, is used in many industrial processes, and is per-



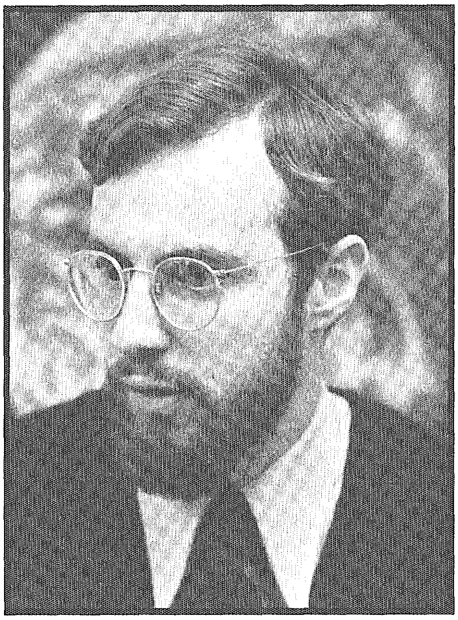
fectly recyclable. Burning hydrogen with oxygen produces only water vapor. Combustion with air at high temperatures, as in an internal combustion engine, also produces small amounts of nitrous oxides, which are hazardous pollutants. Utilizing hydrogen in a fuel cell leaves only water vapor. Water vapor released to the atmosphere eventually finds its way back to the ocean where the hydrogen originated, thus completing the cycle.

In a sense, we are currently recycling the carbon that was locked in the earth by burning coal and oil. But this carbon won't be available as a fuel for another hundred million years or so, if at all, whereas the hydrogen recycling process may take less than a year.

It should be kept in mind that in a hydrogen economy, hydrogen serves as a secondary source of energy, just as electricity is a secondary energy source. As such, hydrogen is not a solution to our energy crisis, which is a shortage of primary energy sources like oil or coal, but is a better way of utilizing primary energy sources that may be developed in the future. The most likely candidates for future primary energy sources are nuclear fission, fusion and solar energy. They would be used to produce either electricity for electrolysing water or high temperatures for disassociating water directly.

Hydrogen would seem to be a logical fuel for the future energy demands of small vehicles. Yet, there are some drawbacks to hydrogen that make it impractical, at least as a fuel for cars, trucks and buses. Hydrogen is an extremely explosive substance and great care must be taken in handling it. Current methods of storing hydrogen do not lend to its practicality either. Pressurized gas tanks may be convenient for laboratory use and cryogenic containers serve well as repositories for huge amounts of hydrogen rocket fuel, but most engineers seem to agree that neither method is practical for use in small vehicles.

There is an alternative method of storing hydrogen currently being developed that has the potential of making hydrogen-pow-



*Jeffrey Garry*

ered vehicles practical. Metallic compounds known as hydrides have the property of being able to absorb large amounts of hydrogen and release it at a steady rate under controlled conditions. Scientists familiar with the hydride storage concept say the system's promise lies in its ability to store hydrogen at densities exceeding liquid hydrogen with a far greater degree of safety than either pressurized gas or liquid storage.

Before a practical hydride storage tank for cars can be developed, however, a great deal of basic research into the largely unknown properties of hydride compounds must be carried out. Some of this basic research is being done by two University of Minnesota scientists, Louis Toth, a materials science professor, and Jeffrey Garry, a materials science graduate student.

Toth describes their work as a "systematization" of the known properties of hydrides. By experimentally determining the properties of a large number of hydride compounds, they hope to refine theoretical models of hydrides, enabling scientists to predict how a specified compound would behave under certain conditions and also determine the composition of a hydride that should meet an arbitrary set of qualifications.

Although their work may eventually have some bearing on the energy crisis, Toth says the hydride research had its beginnings in a long-term project studying

**Hydrogen is not the solution to our energy crisis,**

**but it is a better way of utilizing our primary energy sources.**

*Professor Louis Toth*

the behavior of transition metals as they are infused with small, light atoms.

Hydride compounds form when small hydrogen atoms diffuse into the spaces between atoms of a metallic crystal. The amount of hydrogen that will enter the crystal depends on the type of metal, its temperature and the gas pressure around the crystal; the ratio of hydrogen atoms to metal atoms may be as high as two or three to one in some hydrides, which accounts for their ability to store hydrogen at densities in the same range as liquid hydrogen.

Toth and Garry's research, which is funded by National Science Foundation grants, consists of forming hydrides under carefully controlled conditions so that the exact composition of the com-

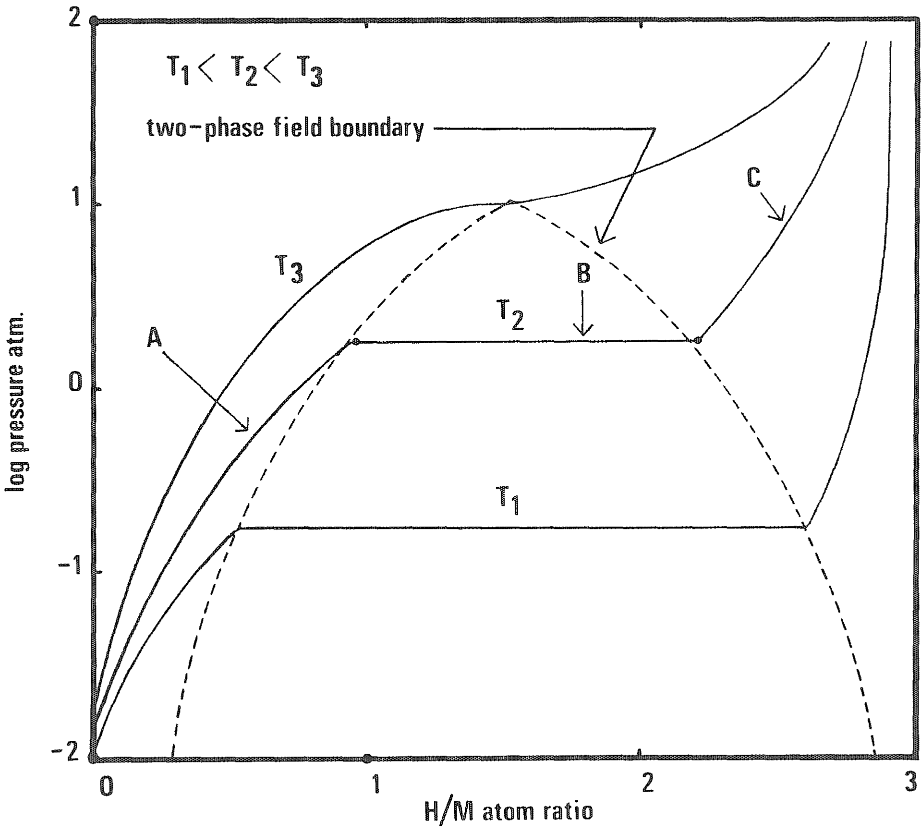



*Figure one. This graph summarizes the behavior of a two-phase hydride compound being hydrided. During the interval labeled A, the substance exists as a metal. During the interval labeled B, a two-phase substance, consisting of a metal and a hydride, exists. During the interval labeled C, the substance is a pure hydride.*

pound can be pre-determined. The sample hydride is then put in a low temperature chamber where its heat capacity is measured. Once the heat capacity of the hydride is determined, basic electronic information, such as bonding strength between hydrogen and metal atoms, can be determined. The sample is subjected to an X-ray diffraction test to discover its crystal structure and is also examined under either a light or electron microscope.

This line of research is complicated by the nonstoichiometric nature of most hydride compounds. This means that the ratio of hydrogen to metal atoms in the hydride does not have to be an integral value and can vary over a large number of values. So rather than testing a small number of hydrides, such as $MH_1$ (a metal hydride) or $MH_2$, Toth and Garry need to run many tests on compounds such as $MH_{.5}$ , $MH_{1.2}$ or $MH_{1.75}$. Garry points out, however, that the nonstoichiometric nature of some hydrides enables them to better withstand the stress of absorbing and releasing hydrogen, an important property for a fuel storage device.

Toth estimates that two or three years of research will be necessary before they can predict exactly how metals will behave as they are hydrided and about two more years of work before a hydride can be designed to meet specified conditions. Until that is possible, devising a compound for a hydrogen storage tank is only a matter of "guesswork", in Toth's words.

The behavior of a hydride that makes it a potential hydrogen storage device is illustrated by the graph in Figure 1. The graph and information concerning it are based on a report written by Jeffrey Garry on the storage of hydrogen in hydrides.

Starting with a pure metal or metallic compound at a constant temperature, as the pressure increases the amount of hydrogen dissolved in the metal also increases. At the point where the curve intersects the two-phase field boundary, portions of the metal become a hydride. In this state large amounts of hydrogen can be "pumped" in or out of the hydride with little change in pressure or temperature.

The ideal hydride compound for a vehicle's hydrogen storage tank would be one whose temperature curve, at slightly above room temperature, would have a wide two-phase field at a pressure slightly above normal atmospheric pressure. These conditions would enable it to operate without complex temperature and pressure controls. Other necessary properties of a hydride compound intended for large-scale use as a storage medium for hydrogen-powered vehicles include low cost and durability.

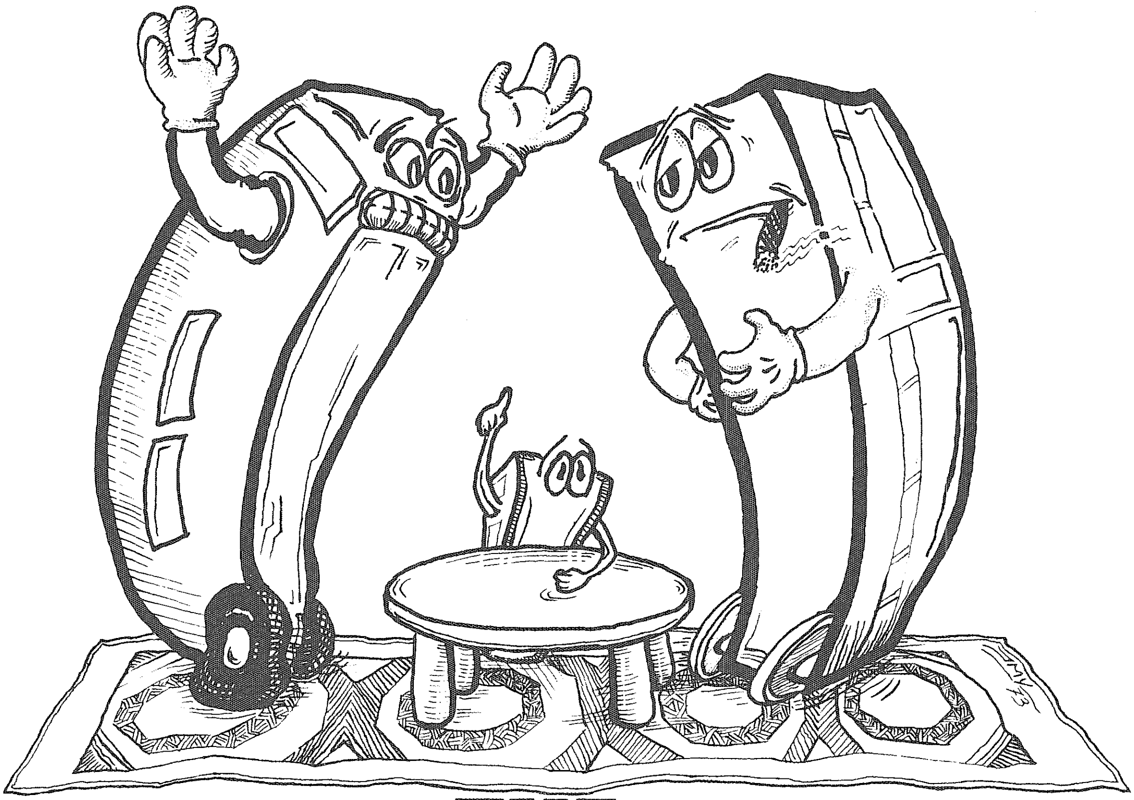
What would a hydrogen-powered car be like? It could use a wide variety of power plants, such as a steam engine, modified Wankel or piston engine, or even a fuel cell driving electric motors. The fuel tank itself would consist of hydride pellets contained within a honeycombed framework of a heat-conducting material. The tank would be surrounded by a coolant network to maintain an even temperature or chill it so that it could be recharged with hydrogen more quickly. A test model of such a system is currently being experimented with at the Brookhaven National Laboratory in New York.

Even if a hydride tank is perfected, Toth doubts that hydrogen powered vehicles would become practical. He pointed out that although a hydride tank would be safer than a gasoline tank in a collision, filling the hydride tank would be a great deal more hazardous than filling a gasoline tank. A higher degree of technical competence and more sophisticated machinery would be required at a "hydrógen station" than at any present-day gas station. Toth says that he wouldn't trust anybody but an experienced technician or engineer to fill a hydrogen tank. No doubt during hard times many an engineer has found employment at a service station, but a chain of "hydrogen stations" is really an unsatisfactory solution to employment problems of engineers.

Toth feels, however, that hydride tanks would be an ideal method for electric utility companies to store the excess power generated during times of low demand while their generators are running at peak output to remain efficient. The excess power could be used to generate hydrogen from water; the hydrogen could then be used as fuel in the generating plant or elsewhere.

Although Garry sees the same difficulties with hydrogen powered vehicles, he is more optimistic about their becoming practical. He also points out that one side benefit of switching to a hydrogen economy is that while minor changes are being made in the transition from fossil fuels to hydrogen power, out-of-date industrial facilities could be modernized, enabling some industries to better meet the challenge of foreign manufacturers.

Admittedly there are a great many technological and political problems that need solutions before the United States can convert to a hydrogen economy. But maybe when we see that our coal and oil supplies are not going to be good to the last drop, hydrogen will appear to be a very attractive, attainable alternative.



# THE POLITICS OF MASS TRANSIT

by James M. Young

Late this fall a Subcommittee of the Minnesota Legislature will make a decision that will change the lives of everyone in the Twin Cities area. The committee will hear three different transit proposals for Minneapolis-St. Paul. In late December (or January 1974) the Mass Transit Subcommittee will author a bill that will go before both houses of the Legislature for final approval and funding. In this manner the Subcommittee will tacitly decide which system the Legislature will support.

The decision will mark the end of a struggle that began in 1967.

For in 1967 the Minnesota State Legislature created two decision-making bodies to guide the growth of the Twin Cities. The Metropolitan Council (MC) was set up to plan and coordinate the development of the entire metropolitan area, and the Metropolitan Transit Commission (MTC) was charged with planning a mass rapid transit system and operating the buses of the Twin Cities. (In 1969 the MTC purchased Twin City Lines, the private owner of the buses.)

When the Metro Council was created it was generally understood that its powers would be expanded if it proved to be a useful agency. In 1969, after the MC had submitted its general development plans to the Legislature, some of its powers over land development and highway planning were increased. In 1971, after the Council had further proved itself, its powers over other agencies were also increased by the Legislature. Thus the Council found itself with the power to redirect the Metropolitan Transit Commission.

The gradual expansion of the Council's powers has not been coordinated well with the control of the Transit Commission. When the Metro Council began to disagree with the MTC about the general transit system to be built in the Twin Cities, the Transit Commissioners found themselves in a deadlock. They could not obtain general agreement on their rapid rail transit plan, and they viewed other transit plans proposed by the Council and a private citizens' group as opposing power plays rather than alternate plans. In short, the agency responsible for developing a transit system had evolved a rigid position and could not accept other views for fear of lowering its prestige.

The fact that new technologies have been developed, which were dismissed four years ago by the MTC as "Buck Rogers stuff," further complicates the issue. Private business and municipal groups have been pressing for years for the immediate construction of a mass transit system and the MTC has been very responsive to these groups. So both the advance of technology and political pressure have forced the MTC to take a hard and fast stand on its subway plan.

The MTC examined many different transit systems in the late 1960s, including a rapid rail line, a system of express buses on special lanes of freeway ("busways"), and Personal Rapid Transit (PRT). The Commission's advocacy of rapid rail transit has always been based on the easy availability of the hardware — the vehicles, tracks and construction techniques — of the system. This dependence on feasibility as the main criterion of choice is evidence of the MTC's determination to provide some solution to the transit problems of our area.

But as the MTC plan has been examined by public agencies and private groups, its rail system has been criticized from many angles. The price for a subway system is very high for the amount of service given, say critics, and there are other systems available.

In the summer of 1970 a Personal Rapid Transit system (see PRT summary on page 22) was advocated by the Citizens' League, under the auspices of Drs. J. Edward Anderson and Jarold A. Kieffer. At first this group attempted to work with the MTC. This proved to be impossible because the MTC had already set up its plan and did not see the need for further criticizing its rail system, let alone developing a totally different system. The Citizens' Transit Council, formed by Dr. Anderson to advocate PRT, ceased its attempt to work with the Transit Commission and began to publicize its own plan.

So in 1970 the MTC no longer wished to consider other types of transit. Under the laws of the State of Minnesota at that time, the Transit Commission believed it had the unchallengeable authority to proceed with the development of its plan.

In 1971, however, when the laws were changed to expand the powers of the Metropolitan Council, the MTC plan had to be reviewed and approved by the Council. To a Transit Commission that believed it had developed the only viable transit plan, such enhancement of the Council's power represented a challenge. Some of the security of the MTC's position was eroded by this challenge, and many of the Transit Commissioners were forced to harden their position further.

In May 1972 the Metropolitan Council distributed its "busway" plan. The plan originally sought to provide some rapid transit service before the "fast link" (or MTC rail system) service was installed and in operation. After the first stage of the subway system planned by the MTC went into operation, this express bus service with restricted freeway lanes would be expanded to transport people to the subway as the subway routes themselves were expanded.

This then was the plan agreed upon by the two public agencies active in the matter. But during the course of 1972, private organizations and individuals became more and more involved in the discussion of the transit system decision. To the secure Metro Council, such public involvement posed no threat. To a now-insecure Metropolitan Transit Commission, such involvement posed at first a nuisance and later, perhaps, a menace.


When its role is in question, any public agency will react to and regard public commentary as a threat. As the people working in the agency come to feel that their jobs and goals are in jeopardy, they begin to react as though their agency is the only agency that can accomplish its goals. This means that the agency begins to dismiss suggestions that at other times it would willingly — if not gladly — accept. Examples of this sort of reaction can be found in any government where agencies and bureaucracies have existed, from the Egyptians to the Nixon administration.

During the course of 1972, a well-planned and detailed PRT system was distributed as a "reaction" to the MTC's plan. The Citizen's Transit Council, associated with the University, had been promoting their plan for two years at this time. When, in October the Citizens' Transit Council released their statement expressing deep concern about the MTC, the Transit Commissioners must have felt at the very least apprehensive. "Too much of the work" of the MTC, said the citizens' group, "has concentrated on developing justifications for conclusions previously reached, instead of developing in a direct and open way the costs and benefits of various alternatives so that from widespread understanding of these costs and benefits the best system for the Twin Cities area could be chosen."

A month later, on 9 November 1972, the Minnesota Public Interest Research Group (MPIRG) in a report to the Metropolitan Council questioned the whole MTC plan. The MPIRG report stated that the MTC plans could be dismissed on the basis of information included in the Transit Commission's own reports. Furthermore, the MTC had shown an "obsession" with rail transit, in the words of MPIRG research director Karim Ahmed. The MPIRG report finally asked the Metro Council to "*emphatically* and *unequivocally*" reject the MTC rail transit plan. (Italics in the original.)

During November and December 1972, the Metro Council formulated a new busway plan. It called for the use of buses as the primary rapid transit vehicle in the Twin Cities mass transit system. The MC called for the construction of special bus lanes on freeways (which could be done at a very small price), and in some areas the construction of elevated bus lanes. The Metro Council plan left the possibility of adding new types of public transit — like PRT — to the busways in the future. The Metropolitan Council report emphasized that busways had proved themselves successful in other cities, and that the equipment and technology for such a system already existed. The busways could be built soon and with little risk.

In January 1973 the positions of the Metro Council and the Metropolitan Transit Commission

# THE THREE CURRENT TRANSIT PROPOSALS

## MTC

The Metropolitan Transit Commission (MTC) wishes to utilize rail transit as the backbone of its mass transit plan. The current MTC proposal contains a rail "backbone" system of 42 stations on 63 miles of two-way track. Auxiliary service would be provided by buses. The rail vehicle selected for use is a 40 passenger model which is 22 feet long, eight feet wide and weighs 37,000 lbs. Reaching a top speed of 60 mph, as many as 10 cars can run on one train.

The MTC feels that rail transit will reduce automobile travel and thus lessen congestion, noise, air pollution and traffic fatalities. One of the factors necessary for a successful rail transit system is a number of densely populated or large activity areas. The MTC believes that a rail system will help to promote these major activity centers while also curtailing the need for additional freeway construction.

Vital factors in evaluating any transit system are the minimum headway and the capacity. Minimum headway is the minimum time necessary to keep succeeding vehicles from colliding. A 90 second minimum headway is typical of rail transit.

The capacity of a transit line is the total number of people that the system can move per hour. An easy formula for this would be Capacity= Occupancy/Headway.

MTC planners predict that for the year 2000, 2.5 percent of the 70 million daily trips made by Twin Cities residents would be by rail. With the auxiliary bus service, that figure would be increased to 7 percent of the total trips made.

Every urban area has a number of captive riders — those who for various reasons are unable to travel by automobile. Apparently the MTC has settled for serving these captive riders while attracting only a minimal percentage of the trips made by auto.

## MC

The Metropolitan Council, after reacting unfavorably to proposals by the MTC, formulated its own transit plan. The Council is planning for contingency mass transit through the increased use of local and express bus service until newer, more advanced technology becomes available.

The Council does not wish to build any transit system which may become obsolete soon after its completion. Since busing is a flexible mode of transportation, it can serve both the high population urban areas, the low population suburbs and the sparsely populated rural areas. It can function equally well on major arterial streets, county roads, side streets and freeways.

Special lanes, called busways, and green-light timing can be employed to help move buses quickly during peak ridership periods. Reserved freeway lanes and bus-only entrances to freeways could speed suburban trips.

The capacity and minimum headway of the proposed busways system is roughly equivalent to those of the MTC's rail transit system.

The Council's plan calls for extending bus service throughout the Twin Cities region by 1975. The Council can foresee an ultimate busways hook-up of up to 100 miles.

The cost of establishing a busing system is extremely low in comparison to other plans with the added factor that busing is immediately available.

Buses presently have a poor image to contend with. However private industry and the United States Department of Transportation are working to change that image. A new bus, developed by a Department of Transportation program, is hoped to be ready for commercial use by 1975.

## PRT

Personal Rapid Transit (PRT) is a fresh approach to transit. It is based on automated small cars, holding up to six people, running on a fixed guideway.

University of Minnesota transit researchers have proposed a PRT network of fixed guideways which would eventually span 442 miles with 506 stations. These guideways are one-way and would be located mostly above ground on major arterial streets and railroad rights-of-way.

The PRT cabs are computer directed. Upon entering the station a patron presses a series of buttons for his destination, enters a waiting vehicle, and the cab automatically takes him there using the optimum route selected by the computer. Service would be on-demand and available 24 hours a day.

The minimum headway between vehicles on a PRT line is believed, by firms developing PRT systems, to be as low as a fraction of a second. One of the reasons for this is due to the fact that unlike a subway train, when a PRT cab pulls into a station it is shuttled onto a siding, out of the path of the following vehicles. PRT cabs need less time to start and stop than larger, heavier vehicles. Being computer directed, the smaller cabs could also respond more directly to a signal to stop suddenly.

Although PRT cabs are smaller, the system as a whole can have a capacity equal to, or probably greater than, that of mass transit systems equipped with larger vehicles.

All but one of the proposed PRT systems are propelled by linear-induction motors. The sole exception is one which is based on an air-cushion system.

stiffened until there was no longer any possibility that the Metro Council could accept the MTC's plan. In fact, the Council had separated with the MTC in November 1972 when it began to draw up its busway proposal.

During January 1973, the chairmen of the two agencies, Douglas Kelm for the MTC and Al Hofstede of the Council, carried on a correspondence which clearly illustrated the breakdown in cooperation between the two bodies they served. Kelm found it hard to believe that the busways could be conceived of as acting as a basis for mass transit. On 22 February 1973, the Metropolitan Council (after some further private and legal correspondence) officially declined to accept the MTC plan.

During the spring and summer of this year preparations have been made for the final transit decision to be made by a Subcommittee of the State Legislature. The Transit Subcommittee agreed to review three plans: those of the MTC and Metro Council, and the PRT plan sponsored by Professor J. Edward Anderson of the University. This review process has been and will be largely based upon the systems themselves; that is, the eight people on the Subcommittee will assess the mass transit technologies themselves.

The members of the Subcommittee began hearings on 18 September. Six more hearings will be held — two each in October, November and December. On 13 and 15 December, the committee will make its decision. The committee will pay special attention to ridership estimates, capital and operating costs, and financing proposals for both these costs in the three systems. In the last hearing before the week of decision, the committee will compare the environmental impacts, the levels of service in, and the reliability of estimates for the three plans.

During 28 October-2 November the committee will be making an investigation of PRT systems and companies on the West Coast. This is a significant move. Since Minnesota politicians have always been willing to move after a precedent is established, and since the Denver area has backed a large-scale PRT system like that of Dr. Anderson's plan, the Subcommittee's tour is an indicator of how seriously it is considering a PRT system. Denver is the first stop on the tour (which also includes San Diego, Los Angeles and San Francisco, California, and Seattle, Washington).

In mid-December the decision will be reached which will change the nature of the Twin Cities as much as did the decision to build freeways here. The advent of a mass rapid transit system, especially of such an innovative type as the PRT, would mean that the Twin Cities metropolitan area would have acquired another means to insure its survival into the 21st century. Without mass transit, as all the administrators, planners and politicians are agreed, serious difficulties lie ahead. The arguing, the ill will generated by the politicking and debating over a transit system will be forgotten after the system is installed. For if the system does not at first appear successful, it can always be changed and remodeled. It is always going to be possible to evolve a new transit system from the old one. But

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without any transit system, there is only an old and obsolescent vehicle left — the automobile.

When even Henry Ford II calls the car "outmoded", it is time to plan new means of transportation. Such planning, whether it is in Minneapolis-St. Paul, New York or San Francisco, is never easy. In the words of Stephen Zwerling, who has written a Doctoral dissertation on the decision to build the Bay Area Rapid Transit (BART) system in the San Francisco vicinity, the decision to construct a transit system is an attempt to "'legislate' the future." That is, construction of a certain type of transit system is going to produce certain results in the city which the system serves. A subway system, as Zwerling comments, will cause the development of a new Manhattan in the vicinity of the transit line. Such development has been clearly stated as one of the purposes of the MTC plan. This is surely a tribute to the openess of Minnesota politics, for as Zwerling points out, the planners of BART planned and sold the system to the public in order to develop San Francisco further — but without stating that urban development was their major reason for supporting BART. If this reason had been brought out in the open, it would likely have encountered opposition from many northern California citizens who wished to see the preservation of their High Victorian city on the bay.

There is real drama in the decision about to be made here in Minnesota. For the backers of each plan believe that for one reason or another they have the only good plan. The Metropolitan Council and the State Legislature have shown their genuine fairness and willingness to consider all three transit plans, for at any time in the past one system could have been arbitrarily chosen. It appears that the choice will be made on the basis of technology, instead of personal desire. And in the final analysis, this is the only reasonable and just basis on which to make such a decision.

## AUTHOR'S NOTE

*This short essay does not do justice to the complex and knotty history of the transit problem here. Someday books will no doubt be written about the subject. But in the dearth of coverage of the question in the Twin Cities media, this article is an attempt to present for the first time the whole story in one place. The author wishes to express his indebtedness to Dr. J. Edward Anderson and Mr. Roger A. Peterson for providing research materials on all areas of the problem where they were otherwise unavailable.*

# I.T. Opinion

# AFTER TIN-LIZZIE

The automobile as we know it is doomed.

As this century draws to a close, the contraption that has been the major means of transport in the United States and around the world will pass away. United States government regulations have already pointed the way to dusty death for the flivver. Not only is there legislation on the books demanding the end of the internal combustion engine, but there is also legislation which calls for the demise of private, individually piloted cars in the largest metropolitan areas of the United States. In order to cope with this legislation, the needs, the expectations and the behavior of people must change. This change will end the era of the car as surely as it will bring in new means of transportation.

One General Motors official has said that "the death of the internal combustion engine is at hand." But when, at the end of this decade, it becomes impossible to buy a new car with a petroleum powered internal combustion motor, there will still be automobiles. The simple change of an engine does not mean the end of the car. Indeed, many other engines are off the drawing boards and inside experimental autos today. In short order Detroit will be producing cars with new engines; nothing much will change in the process.

But more devastating to the automobile than any new engine design are Federal government regulations designed to reduce particulate and gaseous air pollution. These regulations were first set up as guidelines for the largest metropolitan areas by President Nixon's Environmental Quality Council in 1970. Earlier this year the Minneapolis Planning Commission announced that it intended to comply fully with the guidelines set up for the late 1970s. (The local guidelines call in part for a halt to parking-ramp construction in the central business district and the creation of a ring of parking ramps around the downtown area.) Minneapolis-St. Paul and Seattle apparently are the first two areas to prepare for the guidelines.

But in highly automobile-dependent areas — like Los Angeles — the guidelines will not be met so easily. In Los Angeles it is virtually impossible to go anywhere, or to do anything, without an automobile. Since the guidelines call for the elimination of the car as a mass-transit vehicle in the Los Angeles area, the people there are going to object to being deprived of their status symbol and personal rapid transit vehicle. Moreover, automobile and gasoline distributors will doubtless be quite unhappy about the loss of one of their major markets.

Taking the car away from Los

Angeles would change the whole southern California area. Once more the San Gabriel and Santa Anna mountains would be visible on a regular basis, and the vast freeway systems quiet. But such a change cannot, unfortunately, be legislated; the car is so secure in Los Angeles that it seems as though it would take some vast crisis — like the complete depletion of the world's petroleum reserves, — to kill the automobile there. Since a great deal of work is currently being done to find some cheap, safe alternatives to petroleum, it seems quite likely that an alternative will be available soon. So not even the end of petroleum would mean the end of the car in L.A.

Can mass transit as advocated in the Federal guidelines change the needs of people sufficiently to compete with the automobile? Some systems, like the Personal Rapid Transit (PRT) system, apparently will be able to provide the same sort of personalized service as the car. But will such systems be salable to the politicians and local governments of the United States? In a country where tax money drains slowly but surely like molasses from local coffers towards Washington, D.C., local governments are extremely hesitant to support even the cheapest and most worthwhile of mass transit systems.

Eventually a PRT system could be devised that would be compatible with a standard-sized automobile frame. This would allow specially designed cars to act both as private vehicles, and PRT cabs upon entering the PRT guideway. The guideway would become an automated, computer controlled freeway. Computer regulation of cars, coupled with many safeguards against computer breakdown, would drastically reduce the number of accidents in transit. Public vehicles — the type proposed in current, first-stage PRT plans — would also be available in this system, providing for those who cannot afford to own a car.

But even so magnificent a system as this is geared towards the transportation needs of the present. In the future, the transportation needs of the world — and especially those of the United States — will change. As computer guidance systems are developed for automobiles and mass transit systems, there will be no need for someone to pilot a car. This will change the expectations of those who ride: a businessman would no longer need to worry about traffic on his way to work. He could rest, or eat breakfast, or start his job on the way. A long vacation trip on a nation-wide guideway would allow new divertiments — and new unpleasantries — to be developed throughout the country.

If people expect new things from transit vehicles, they will find themselves with new transportation needs. Thus if you plan to have a day free of any responsibility on your trip to California, you may discover that you need new types of clothing for travel, that you need some knowledge of computer programming to plan your route, or that you need something which has just been marketed for just such a long-distance journey — some item which hasn't been dreamt of yet.

New transit needs in industrial societies doom the automobile we know and love. In the near future, in fact, the need for business trips will decrease as communication systems become better and better. Telephones with special recording equipment will begin to compete with all forms of business-related travel soon.

All these factors will eradicate the piloted, petroleum powered automobile. In the industrial nations, like the United States, the demise of the car will change the whole country. Henry Ford once said that "the only thing we learn from history is that we never learn anything from history." If that is so, then no one can say what the automobileless America will be like. Mr. Ford, after all, was unable to guess what his invention would do to the odd courting customs of the human male and female. He was quite shocked to find out — so shocked in fact that he is said to have toyed with inventing the compact car.

There will be no Tin-Lizzie tomorrow. But its successor, whatever it may be, will be as significant a part of the 21st century as the automobile was of the 20th.

# CHECK OUR SPECS BEFORE YOU BUY THEIR 4 CHANNEL RECEIVER.

| | Sylvania | Pioneer | Sansui | Fisher | Harman-Kardon | Marantz |
|---|---|---|---|---|---|---|
| **Model** | RQ 3748 | | | | | |
| **Continuous (RMS) Power[1]** <br> **4 channels** <br> **Stereo Bridge** | 50W x 4 <br> 125W x 2 | | | | | |
| **THD at rated output** | <0.5% | | | | | |
| **IM Distortion at rated output** | <0.5% | | | | | |
| **FM IHF Sensitivity** | 1.9$\mu$v | | | | | |
| **50 db signal to noise ratio** | 2.8$\mu$v | | | | | |
| **Capture Ratio** | 1.5db | | | | | |
| **Price** | $549.95[2] | | | | | |

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

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

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

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

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

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

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

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

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

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

GTE SYLVANIA

Sylvania Entertainment Products Group, Batavia, N.Y.

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

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

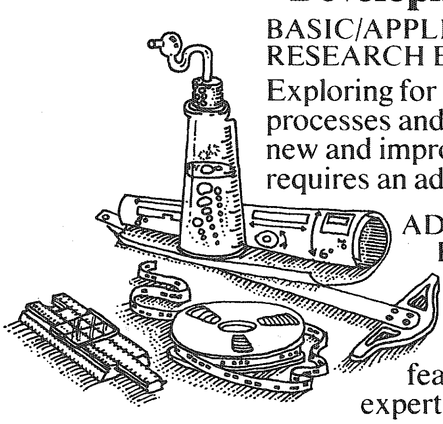
One minute you're studying a general area like mechanical or electrical engineering. The next you're faced with a maze of job functions you don't fully understand. And that often are called different names by different companies.

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

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

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

## Development and Design



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

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

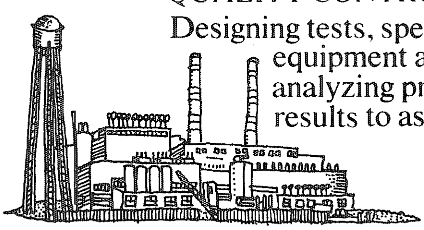
PRODUCT DESIGN ENGINEERING
Transforming the product idea into a design that meets given specs and can be manufactured. Following through to production.

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

## Manufacturing

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

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



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

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

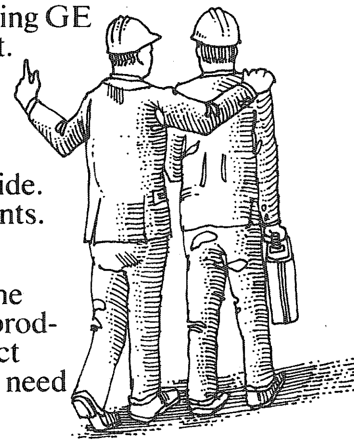
## Sales and Service

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

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

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

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



GENERAL ELECTRIC

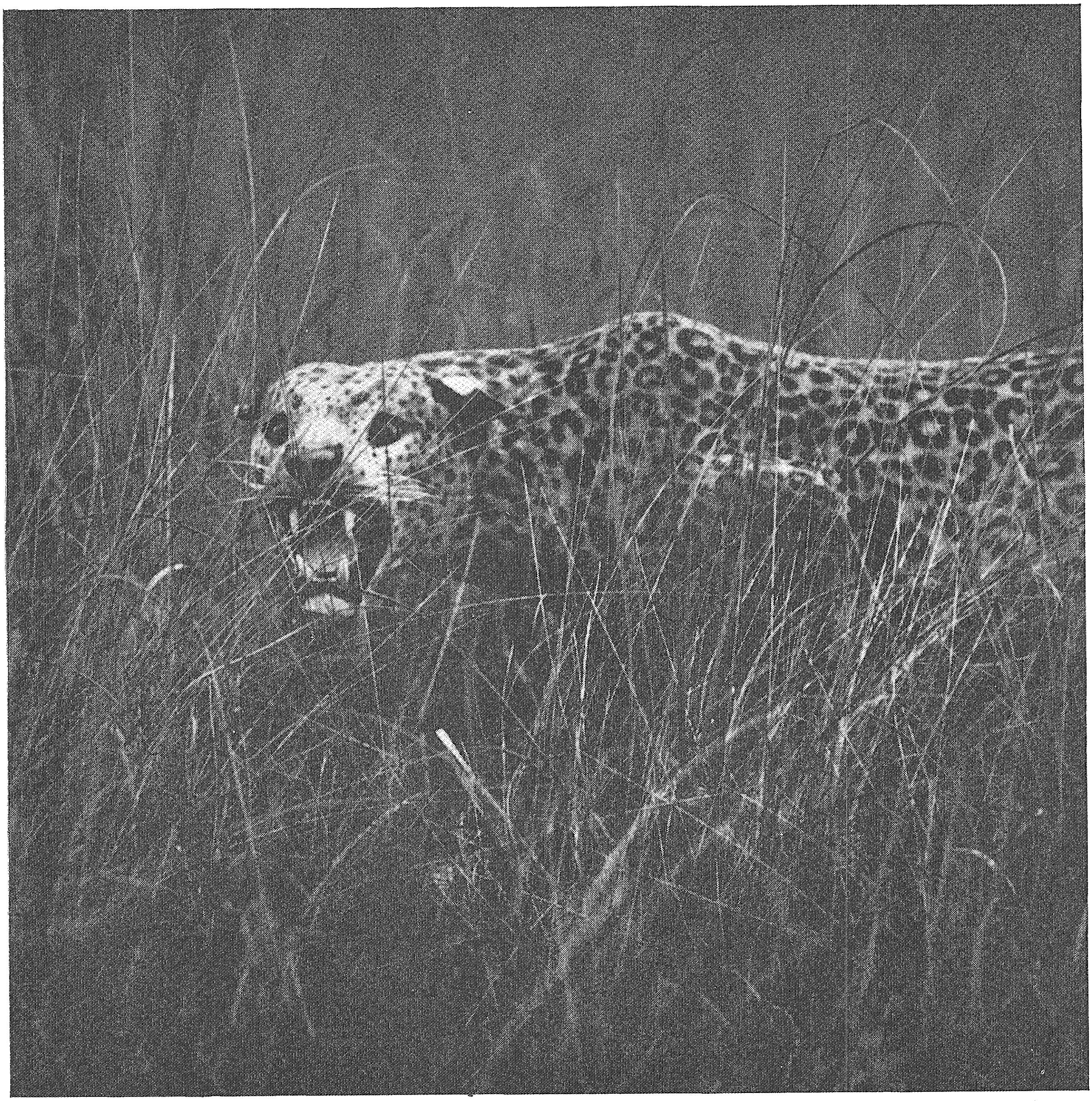
An Equal Opportunity Employer

minnesota **Technolog** november 1973

# LIFE OR DEATH FOR LAKE SUPERIOR?
# LIFE ON OTHER WORLDS
## Alternatives To Our Registration System



# Come closer. It's only a modacrylic.



The leopard was made by a taxidermist. Its coat is a modacrylic textile fiber made by Union Carbide from several basic chemicals. It's called Dynel.

Of course, man-made fibers aren't new. But for versatility, Dynel probably has no equal. We can make it as soft and warm as fur for your coat. Or so tough it approaches the strength of steel.

You'll find it in blankets, work clothes, automobile upholstery, toys, jewelry. In carpets, towels, drapes, paint rollers.

And since Dynel is chemical-resistant, durable and virtually nonflammable, it's used in many more ways. On laminated decks of boats. For tents. As overlays for storage tanks and air ducts.

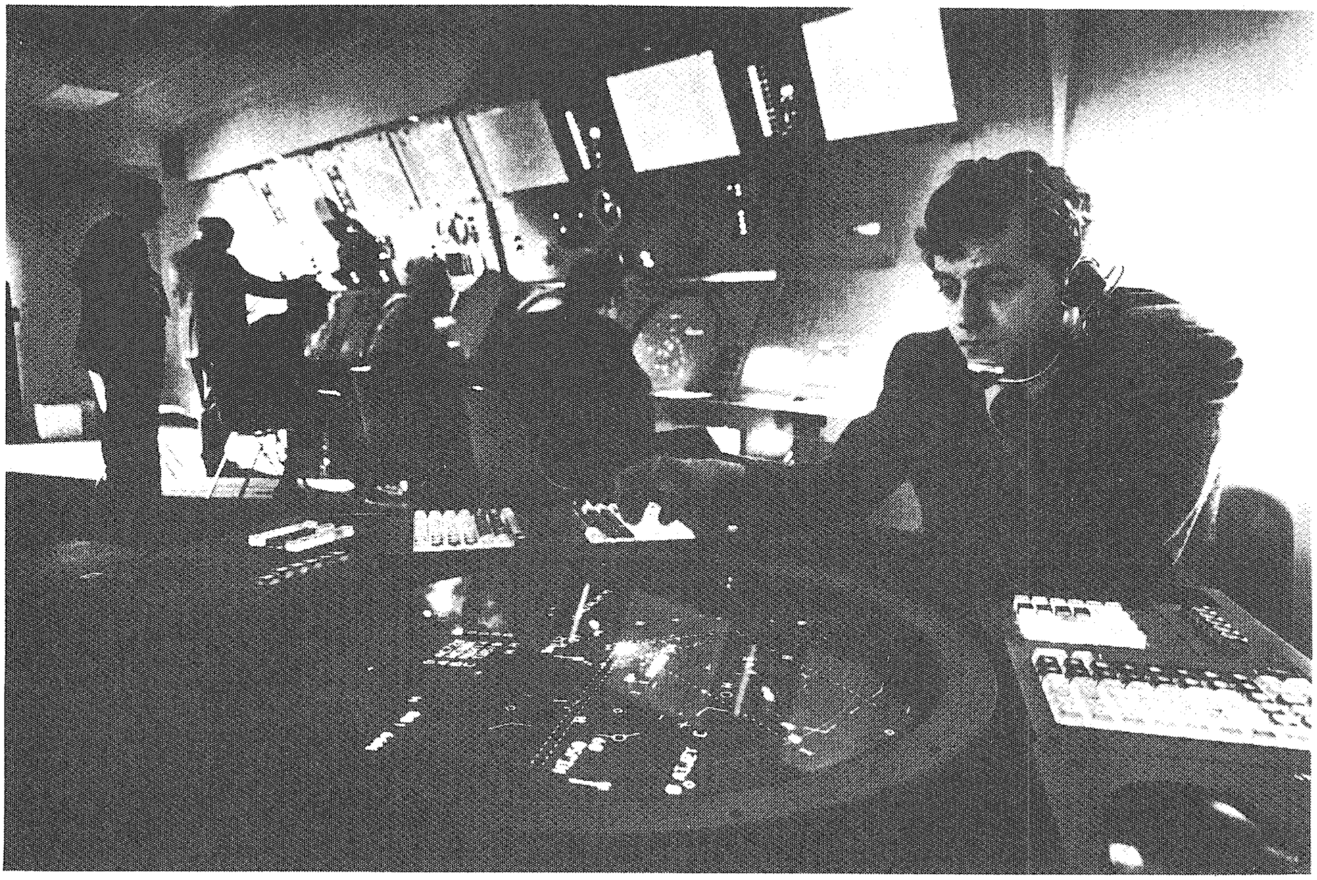
But regardless of all its practical uses, Dynel is most famous for something else. It's great for making wigs. For blondes and brunettes and redheads.

Remarkable fiber? We think so. But haven't you found that a lot of remarkable things come from Union Carbide?

UNION CARBIDE

THE DISCOVERY COMPANY
270 Park Ave., New York, N.Y. 10017

An equal opportunity employer.



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**COVER: ARTWORK BY RANDY SCHOLES, PHOTOGRAPHY BY KEVIN STRANDBERG**

# Technolog editorial pages

## Coal In Our Christmas Stocking . . .

This winter the University of Minnesota will be shoveling it. Coal that is.

Because of the fuel oil shortage, the University has had to sign a "contract." It calls for the use of coal as an alternate source of energy when supplies of fuel oil run low this winter. If the Arabs make good on their threatened embargo of oil shipments to the United States, that winter shortage should begin sometime around Thanksgiving.

### . . . Blue On Blue . . .

Schools in general will be hard put to keep things smoking this winter. According to the mandatory Emergency Fuel Allocation Plan, schools are placed quite low on the priorities list for oil supplies. In terms of importance, the federal government placed schools just ahead of mortuaries and just below the Goodyear Blimp.

According to WCCO-TV, as of 25 October only 88 out of 437 schools in the Twin Cities area have firm fuel oil contracts. The other schools will just have to hustle for fuel on a last-come-some-served basis or get along by adopting emergency measures.

We offer some suggestions to alleviate this condition later on in this piece, but first we have to make certain that there is something worth panicking about.

### . . . Talk To The Animals . . .

Are we getting alarmed over nothing? Is there really a fuel shortage and will it be sufficiently cold this winter to warrant such drastic steps as enforced fuel allocation?

In answer to the first question, yes. Whether real or contrived by the big oil companies, the truth appears to be that there is simply not enough fuel oil available for use this winter. In answer to the second question, let us see.

There are many ways to forecast how cold it will be this winter. According to the Old Farmers Almanac, which is revered throughout New England for its accuracy in weather predicting and worshipped in Troy, New York as a general purpose deity, there is nothing to worry about. They say "winter temperatures will be 2° to 3° above normal." So the average temperature from 1 November 1973 to 31 March 1974 will be a balmy 23°-24° instead of the usual 21° average.

If you want a second opinion, there are other ways to forecast how cold the winter will be. As the story goes, if the stripes on a wooly bear catepillar are thick, then the winter will be cold. If the stripes are thin, then the winter will be mild. So rush to the nearest leaf-bearing tree and if you are tough enough to beat back the savage woodpeckers, catch a wooly-bear and learn the truth. And if you do this, you may discover the truth in more ways than one.

There are other forecast methods, such as plotting the thickness of hair on a horse, how long into October the crickets will sing, seeing if the blackbirds fly south for the winter, or weighing how much hay the ducks are eating.

There is a quaint but effective Canadian forecasting custom, which began in Northern Ontario many years ago. Being a Canadian native, I am familiar with the procedure. Come September, the natives could tell just how cold the winter would be by using a pick-axe to try and smash through the ice that had formed on their rivers. If they made it through the ice, then it would be a mild winter. If not, they wasted a lot of time. But enough of prose, back to the central issue.

### . . . It Looks Black, Folks . . .

The central issue, of course, is what about us at the University? Apparently the use of coal will bail us out of a crisis situation as the hardy Plant Services personnel will be shoveling their little unionized hearts out for us lukewarm students. There is no economic problem with coal. It is actually cheaper than oil although it produces particulate wastes, gaseous outbursts and is less convenient. Much the same can be said for our shortsighted elected representatives who were too busy being politicians to foresee a relatively obvious situation and provide alternatives for it. They are the ones who should be keeping us warm this winter. It seems they are the professionals when it comes to shoveling it.

At least for this winter we will have to swallow the increased pollution caused by burning coal in order to comfortably conform to the rigors of intellectual discipline. But what about next year? And what about the schools who are not so lucky as to be provided with coal? What alternatives can be offered them? Here are a few.

### . . . Expanding Alternatives

The most obvious suggestion is not to let just anyone offer suggestions. If that happened, there is no telling what desperation would drive some people to do. The foresters would probably start trying to burn

Duluth drinking water. Cleveland residents can do that for they have the Cuyahoga River*, but we in Minnesota are not so lucky.

The first alternative for Minnesota schools would be for them to burn their books. They probably need replacing anyway and when education officials get around to replacing them (years after the burning) simply float a school bond issue. Minnesota residents never fail to vote funds for public education, do they?**

Other alternatives include the hugging of closed-circuit television sets in the classrooms, initiating or extending modern dance classes to run simultaneously with science lectures, imposing mandatory jogging, and seasonal conversions to an activist religion.

One idea which proved unfeasible was the suggestion to place a constantly lecturing Freshman English professor in each classroom to increase the room temperature. This sounded fine until the boys in the Heat Transfer Lab pointed out that if the individual in question lectured for over an hour, there was danger of the air becoming hot enough for the building to start expanding. The air would eventually become so rarified that a partial vacuum would form and the windows would implode.

Next month we will tackle the problem of hunger in New Ulm, the giant in Le Seuer, and praying mantises in T.N.C.E. 30.

Editors Note

*The Cuyahoga River, running through Cleveland, Ohio, due to the excessive oil and kerosene wastes dumped into it, has been declared a fire hazard as early as 1968.

**Rockford, Minnesota has voted down a 3.4 million dollar school bond issue four times in a row. The present high school facilities in the town feature a bus garage, a trailer, and a World War II surplus army bunker.

U. S. POSTAL SERVICE

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(Signed) Robert Pirro, Editor

# Sidelight On Exobiology

The Soviet astrophysicist N. S. Kardashev has suggested that there are three types of civilizations possible in the Universe, ranked according to the amount of technological power the civilization can control. (See Carl Sagan, "On the Detectivity of Advanced Galactic Civilization," *Icarus,* July 1973; and elsewhere in this issue of this magazine.)

Kardashev has stated that Type I civilizations have about the power-output capacity of the Earth today — that is, the power output capacity of a single planet. Type II civilizations have the power output capacity of a solar system — they can control their own sun. A Type III society would be able to control the energy output of an entire galaxy. According to the model Kardashev used to determine the probabilities for the existence of these civilizations, Type I cultures would be common, Type II cultures less common, and Type III societies would be rare indeed. (Changing one basic assumption in Kardashev's model — reducing the trend for civilizations to destroy themselves — would make the long-lived Type II and Type III societies much more probable.)

We suggest that Kardashev should follow his contention to its logical conclusion. He should, in other words, include a Type IV society in his list. Such a civilization would be capable of controlling the energy output of an entire cosmos.

It might be possible to find some indication of the existence of Type IV beings by finding some anomaly in the Universe which could only be explained by their existence. If we should find that quasars — to sight an absurd possiblity — did not fit into the laws of the physical Universe no matter how hard we tried to bend those laws, then we might be forced to think about such beings. Astrophysicists have recently found evidence which seems to show that the Universe did not begin with a big bang (see *Science News,* 18 and 25 August 1973). In order to explain the cosmos, we might have to postulate that though it originally began with a bang, large amounts of matter were used by Type IV beings to prevent the Universe from turning into an entropic system. This verges close to theology, and Kardashev could not express such a quasi-religious idea — even in jest — in a Soviet publication. If he did, he might find himself in serious trouble with his government. The Soviet Union has always reacted strangely to just such scientific speculations.

But even if we succeed in detecting such a civilization, it would undoubtedly be fruitless to attempt to communicate with them. According to Carl Sagan's article in *Icarus,* a Type II or III being would have about as much interest in communicating with us as we have in talking with bacteria or paramecia. A Type IV entity would probably be even less interested in us – unless, of course, his name were Jehovah or something similar.

Robert Pirro & James M. Young


# The Environmental Protection Agency vs. Reserve Mining

by Laurence Yarosh

The plant stands on the north shore of Lake Superior, at Silver Bay, Minnesota. It is part of an operation that has created two towns, employs almost three thousand people and accounts for one seventh of the iron ore produced in the United States. But it is most famous for its waste product — finely ground taconite rock, stripped of its iron-rich components and dumped into the lake at the rate of 20 million tons per year.

Reserve Mining Company, owner of the Silver Bay plant and its taconite mine at Babbitt, Minnesota, is being sued by the U.S. Environmental Protection Agency (EPA) to have the taconite waste dumped on land, claiming that disposal in the lake creates pollution.

The suit follows over four years of hearings, conferences and litigation by environmental groups with the state and federal governments. The issue is significant in that it will be decided almost entirely by scientists and engineers. Congress has passed antipollution laws and judges can interpret them, but both must depend on technical experts to answer the crucial question: Does the dumping of vast amounts of tailings into Lake Superior pollute its water or endanger human health?

The batteries of experts testifying for each side come not only from Reserve and EPA research labs, but from colleges and consulting firms from Oregon to Florida. Accusing each other of using invalid experiments and insufficient data, they conflict on almost every point, from the health of the bottom-dwelling crustaceans in the lake to the actual amount of the plant's discharge, making a long and complex trial inevitable.

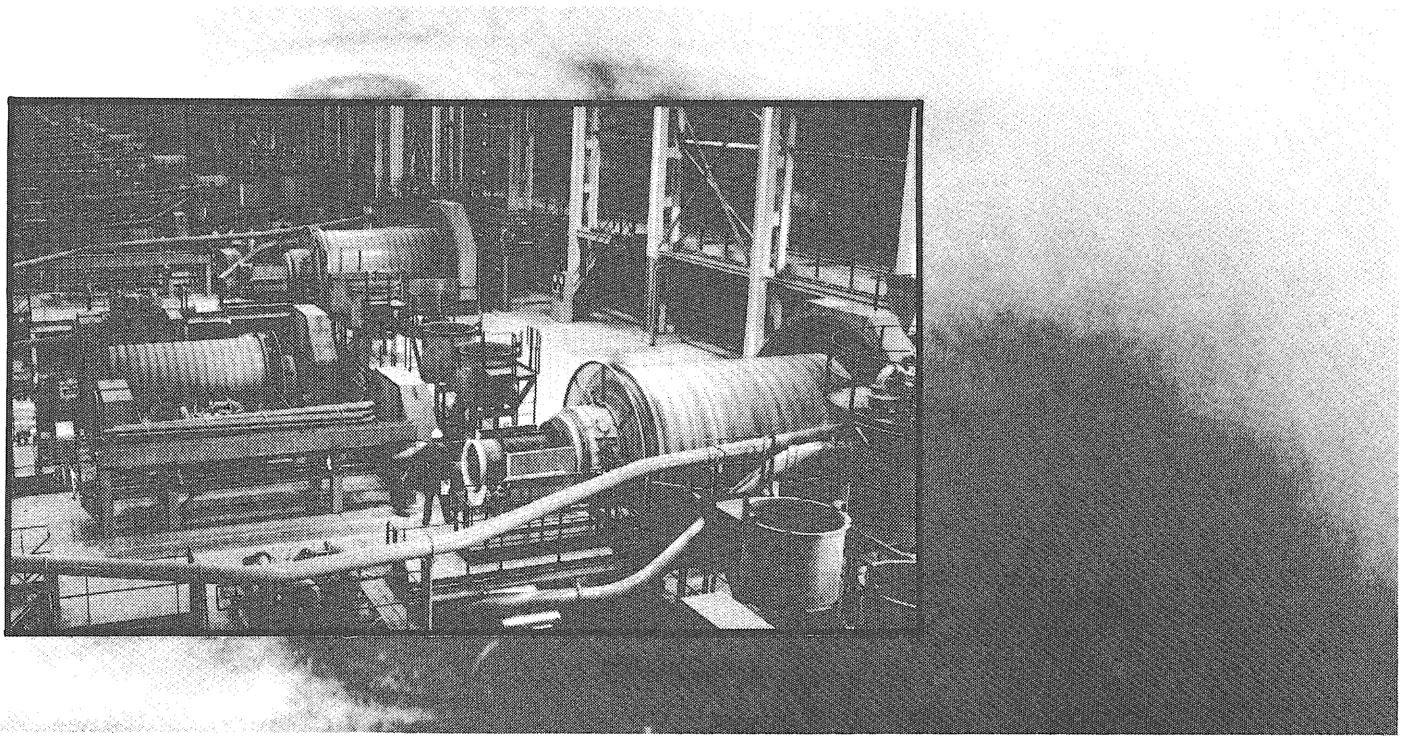
Taconite, the hard, gray rock produced at the Babbitt mine, contains tiny particles of magnetite, an iron-bearing mineral. The ore is crushed and shipped by rail to the processing plant at Silver Bay, where the crushed taconite is ground up and the magnetite particles are extracted by giant electromagnets. The remaining rock, suspended in water, is pumped into the lake. Production of one ton of iron concentrate requires three tons of taconite and 55 tons of water, leaving two tons of tailings.

The waste rock is 41 percent cummingtonite, a silicate significant for its similarity to the asbestos used for fire-proof insulation and automobile brake linings. Passing through three stages of grinding in the plant, some of it is finer in consistency than face powder, and many particles are less than one-half micron in diameter. Mixed in with the vast amounts of water used for grinding and sizing the rock, only 3.5 percent of the discharge is actually solid.

The slurry mixture of tailings and water is pumped to the lakeshore, where it flows across a delta built up from tailings deposited in previous years. The heaviest particles, about 45 percent of the total, settle out on this delta, leaving a slurry of 1.4 percent solids to flow into the lake.

Reserve contends that their operation has no more effect on the environment than dumping sand into a swimming pool. Company president Edward Furness has referred to the tailings as "pure sand . . . inert, inorganic, insoluble in Lake Superior, and biologically inactive." Yet the tailings are quite unlike ordinary sand. First, they are finely ground. Particles less than one micron in diameter can barely be seen with the largest optical microscopes. They may remain suspended in the water for over a year before settling out, and are chemically active because their surface area, in relation to their weight, is quite large.

In addition, Taconite is foreign to Lake Superior. The Babbitt mine is located outside the Lake Superior basin and has been exposed by removing tons of glacial till and topsoil. The cummington-



ite which forms such a large part of the rock is found at only one other point in the lake basin. If the discharge were to add minerals not now found in the lake, it could alter the biology of the area.

Finally, the tailings are dumped in tremendous amounts. The daily discharge of 67,000 tons of tailings is from two to six times the sediment carried naturally by rivers into the lake, according to the EPA. A process involving a few percent of this amount could have significant effects on the lake, effects that would be especially pronounced because Superior is among the clearest lakes in the United States. The tailings will eventually cover large areas of the lake bottom, forcing bottom-dwelling animals to adapt or perish.

The EPA, represented by Justice Department attorney John P. Hills, filed suit against Reserve over a year ago, charging that pollution from the plant violates the Federal Water Pollution Control Act as well as constituting a "nuisance" under common law. They claim that the tailings, besides posing a health hazard from asbestos particles, cloud the water, dissolve chemicals into it, and disrupt the biology of the lake. The charges are flatly denied by Reserve, which claims that in 16 years of operation, the plant has produced no harmful effects in Lake Superior.

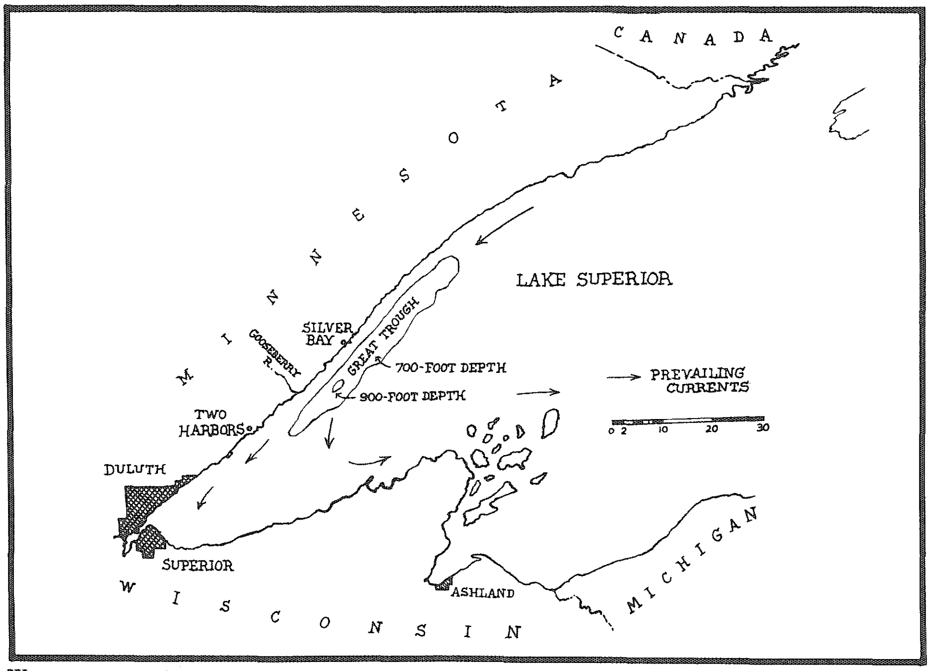
The slurry pumped into Lake Superior is heavier than the pure lake water and tends to sink when it enters the lake. Reserve contends that it forms a "heavy density current" and carries almost all of the tailings to the bottom of a 900-foot deep trough located conveniently a few miles offshore. (see drawing) The area is large enough so that in 40 years, when the Babbitt mine is worked out, the bottom will be raised by an average of only 30 inches.

EPA scientists agree that most of the tailings reach the bottom through the heavy density current, but argue that the smallest three percent remain in suspension and are carried throughout the lake by prevailing currents. Dr. Donald Baumgartner, of the EPA's Pacific Northwest Laboratory in Corvallis, Oregon, has referred to the discharge as "an unstable density flow which spreads out and becomes diluted as it flows down the face of the delta, shedding clouds of finely divided particulate matter . . . ultimately leveling off near, or at the bottom."

In attempting to trace the movement of the tiny particles throughout Lake Superior, the government has relied on the controversial method of cummingtonite analysis. This mineral, while constituting 41 percent of the tailings, is almost nonexistent in natural streams. Detectable in small concentrations through its telltale x-ray diffraction pattern, its presence in a water sample indicates the presence of tailing particles. Relying on this method, the Government claims that the tailings are scattered as far as the Wisconsin and Michigan shores of the lake and make up 30 percent of the suspended solids in the Duluth water supply.

Reserve's attorneys, headed by Edward T. Fride, a Duluth corporate lawyer, claim that the heavy density current effectively carries all the tailings to the bottom and point to a "tailings inventory" survey carried out by Reserve in 1972. It shows that 99.6 percent of the tailings discharged since the plant was opened can be found on the lake bottom near Silver Bay. The missing .4 percent, however, is over a million tons.

Most importantly, the attorneys object to the use of cummingtonite tests to identify suspended tailings, claiming that there are other sources of the mineral. Though the EPA found only one stream out of 60 Lake Superior tributaries with even a trace of cumming-




Western arm of Lake Superior showing the Great Trough where most of Reserve's tailings settle out. The government contends that the remainder are carried by lake currents towards Duluth and the Wisconsin and Michigan shores.

tonite, Reserve scientists, through repeated samplings, claim to have positively identified the mineral in 50 of 67 streams in their own survey. In addition, tailings have been used for years to sand Minnesota Highway 61 in the wintertime, and may have washed into the lake. Although these sources are much smaller than the plant's vast discharge, they enter the water without a heavy density current and, mixing freely with the surface waters, their cummingtonite is more likely to turn up in the EPA's sample bottles.

Government and Reserve scientists have disagreed over the interpretation of x-ray diffraction patterns — Reserve interpreting a given pattern to show cummingtonite, and Government scientists drawing an opposite conclusion. Yet other measurements by the government may prove decisive. In one series of bottom samples from the lake, the EPA measured not only cummingtonite, but various clay minerals, which are present in stream sediments but absent from Reserve's discharge. While cloudy water caused by natural runoff in Wisconsin had a trace of cummingtonite and an abundance of clay minerals, solids in surface water near the Reserve plant were as much as 30 percent cummingtonite, with few clay minerals.

Crucial to all other issues in the trial is the question of whether tailing particles spread throughout the lake. If the tailings sink completely into the deep parts of the lake, then their potential for disturbing the lake is limited and other sources must be responsible for the changes that have been observed.

The most easily observable effect of the tiny suspended particles is a change in color of parts of the lake. Sunlight reflected and diffracted by particles smaller than the light waves themselves gives the water a green appearance, in contrast to the normal blue of the lake. The earliest complaints against the plant came from lakeshore residents claiming that the color makes the lake unsightly and that fishing is impossible in the green areas.

Although green water has been observed in the lake for 100 years, the Government agrees that the discoloration is more frequent and severe in areas affected by tailings. Armond E. Lemke, an aquatic biologist at the EPA's National Water Quality Laboratory in Duluth described an occurrence of green water on the lake's north shore. On the morning of October 17, 1972, patches of green water were seen near the point where the tailings are discharged. A continuous band of green water one-half mile wide began at Pellet Island (at the edge of Reserve's boat harbor) and extended to Split Rock Lighthouse. From there it fanned into the lake and was seven miles wide at the mouth of the Gooseberry River. It broke into patches again near Encampment Island. The green area was over 15 miles long.

Visibility in the green water was from four to six feet, when it may be 40 feet in clear water. The concentration of tailings in the green water, as measured by cummingtonite detection, was 2 to 5 ppm. In clear water it was .2 ppm.

Reserve notes that green water occurs naturally in the lake and argues that it has no effect on the environment. Observing that the green appearance is an optical effect rather than an actual discoloration, Edward Schmid, assistant to Reserve's president, told a Federal conference in 1969, "The water which looks green in the lake is not green in a sampler. A glassful appears clear and colorless . . . While some people may say the 'green water' is aesthetically objectionable, many do not."

The elements which make up the taconite tailings can dissolve when the particles are immersed in water. Extremely small particles have a large surface area in relation to their weight, and the leaching is quite rapid. EPA scientists speculate that the smallest particles dissolve completely before they can settle to the bottom.

Gary E. Glass, a chemist at the Duluth EPA laboratory, has testified that although less than .01 percent of the tailings dissolve, a day's discharge adds a sampler. A pounds of dissolved minerals to the lake, and another 100,000 pounds are leached into the water as the tailings move towards the bottom. The dissolved chemicals include ammonia, nitrogen compounds, silica, sulfates, magnesium, manganese and potassium. As a result, water near tailings deposits on the lake bottom has a high concentration of dissolved solids.

Reserve's answer to these charges is that the dissolved solids, measured in pounds rather than tons, do not have a measurable effect on a body of water as large as Lake Superior, with over 10,000 cubic miles of water. A mathematical model developed by Reserve in 1970 predicts that even after 100 years of plant operation there would not be a detectable increase in dissolved solids in the lake.

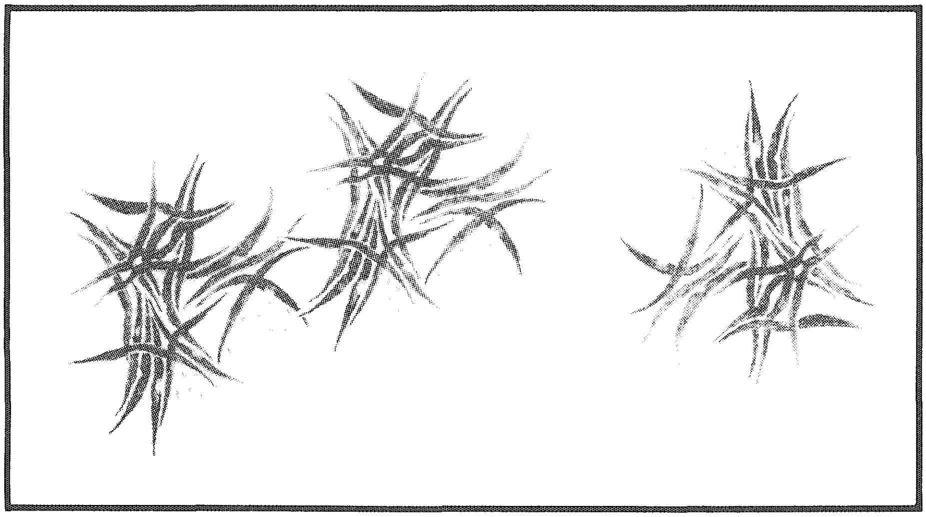
In addition, a Reserve study of water samples from 16 permanent testing stations along the lake's north shore show that the concentration of dissolved solids near the discharge point is not higher than concentrations in other parts of the lake. Samples were also taken near tailings resting on the bottom and showed no unusual levels of dissolved solids, directly contradicting EPA studies.

One of the most serious pollution-associated problems in the other Great Lakes has been excessive growth of algae. The lake algae, single celled green plants, are extremely sensitive to the presence of their nutrient elements in the water. While vast numbers of the organisms have formed green scum in some parts of Lake Michigan and other lakes, the problem does not exist in Lake Superior. The Government suggests that if Reserve and other firms are allowed to continue adding dissolved nutrients to the lake, the green "algal blooms" will appear in Superior as well.

In any normal, clear body of water, the growth of algae is impossible because the nutrients they require, chiefly phosphorus and manganese, are not present. Both of these elements are present in taconite tailings. The manganese is more important, because large amounts of phosphorus already pour into the lake from fertilizer runoff and sewage discharges.

Joseph Shapiro, associate director of the Limnological Research Center at the University of Minnesota, testified that tailings stimulate the growth of algae when present in concentrations as low as .041 ppm or 41 parts per billion. Addition of phosphorus in concentrations of 5 parts per billion greatly enhances the effect. Tailings are present in such concentrations in large areas of the lake.

In addition to these laboratory studies, observations of green water have revealed large numbers of algae, while little growth was taking place outside the green area.



WINNER: *Cymbella ventricosa.* This and other algae are multiplying in Lake Superior partly because of nutrients released from taconite tailings. Algae in Lake Michigan have become a nuisance, forming green scum on the water in some places.

In opposing these claims, Reserve points to a study by Edward Callender of the University of Michigan showing that the levels of manganese, phosphorus and ammonia are no higher in the vicinity of Silver Bay than anywhere else along the North Shore of the lake. He contends that the chief source of manganese is the St. Louis River, entering the lake at Duluth.

A further study done by Jackson L. Fox, a scientific consultant from Gainesville, Florida, concluded that there were no differences in algae growth between areas affected by the discharge and other areas of the North Shore. Other studies showed that the greatest numbers of algae were in the Duluth-Superior area and the South shore of the lake.

In one experiment, slabs of taconite and granite were placed in the lake and growth of attached algae on the two minerals was compared. Reserve could find no differences in algae growth on the two slabs, indicating that no algal nutrients were being leached from the taconite that were not also coming from the granite.

In measuring the effects of tailings on the algae in the lake, the EPA cautions that the absence of specific evidence of algae growth is no source of comfort. Measurement of trace elements and algae populations is difficult in such a large lake, and population changes would have to approach 50 percent before they could be detected. Once the water reaches a state where it could support excessive numbers of algae, it would not be cleared until hundreds of years after pollution was halted.

While the tailings may enhance the growth of algae, they threaten the complex food chain which supports fish life in Lake Superior. Although commercial fishing has not been measurably affected, the Government contends that the lake fish are potential victims of the discharge.

Turbidity or clouding caused by suspended particles reduces the sunlight available to grow plankton, the basis of any lake's food chain. According to a 1968 Interior Department report, "light must penetrate to great depths to produce enough plankton to support the fish. An increase of a few parts per million of suspended solids could affect the production of plankton. Fish food is affected for one mile into the lake, and less desirable forms of bottom life are evident."

Also affected are freshwater shrimp living on the lake bottom, again an important food for some species of fish. Turbulence caused by the heavy density current, as well as a bottom covered by fine tailings devoid of organic matter combine to reduce the population of these animals. One fish species, the Sculpin, has begun eating the

Judge Lord's courtroom is a scene of complex scientific arguments, but there is also a battle of words as the opposing lawyers try to present their cases in the most favorable terms. Some examples:

# THE WORD GAME

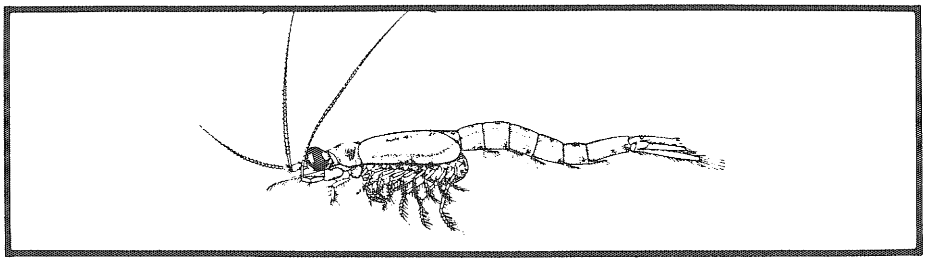
**The Discharge.** Everyone agrees that something is dumped into Lake Superior, but they don't have the same name for it. The government calls it "tailings," a "discharge" or an "effluent." Reserve calls it "waste rock" or "sand."

**Green water.** EPA scientists show their contempt for the water around Reserve's plant by describing it as "murky green." One scientist said it was "milky green." Reserve sees it as "emerald green" and claims that 19th century explorer Louis Agassiz recorded it that way in his diary.

**Heavy density current.** Reserve claims that their tailings are safely carried to the lake bottom by a "heavy density current" and that this is a familiar hydrological phenomenon. If the EPA is familiar with it, they don't remember the name. They call it an "unstable density flow" or a "bottom flow turbidity current."

**Asbestos.** The EPA has found something in the Duluth drinking water that they can say with certainty is "asbestiform minerals" or "amphiboles." A University of Wisconsin scientist says that it is identical to Amosite asbestos, but Reserve isn't likely to believe that.

**Volume of discharge.** To add to their other conflicts, the government and Reserve do not agree on how much of whatever-it-is is being dumped into the lake. The Government's figure, based on reports made to the Minnesota Pollution Control Agency over the past few years, is 67,000 short tons per day. Reserve claims that they discharge 46,000 long tons per day, which comes out to be 51,500 short tons. The discrepancy led an exasperated Judge Lord to comment, "If we can't even agree on how much goes through that plant every day we're sunk."



LOSER: *Mysis relicta,* a species of Lake Superior shrimp. The government claims that *Pontoporeia,* another species, has been reduced in number up to 40 miles from the discharge and that *Mysis* may be more severely affected.
shrimp

eggs of other fish because of the shortage of shrimp.

Reserve has denied that its tailings cause any significant turbidity that could reduce plankton populations. With respect to bottom-dwelling shrimp, David W. Anderson of Reserve's research and development division claims that his tests have shown that the animals can live on a tailings covered bottom just as well as a natural lake bottom. In-lake sampling conducted by Reserve indicates that their numbers are not influenced by the presence or absence of tailings.

The company has attacked the Government's data, claiming that shrimp populations vary drastically with natural changes in the lake bottom, and that the Government's control samples were taken in an unusually favorable area for pontoporeia, the predominant species of shrimp. A 1970 Reserve report states: "had they chosen to use a different 'no tailings' area (southwest of the plant) in their comparison, they would have found 38 percent **more** pontoporeia in the tailings sediment than in the 'no tailings' area."

This argument has been countered by Donald I. Mount, director of the EPA's Duluth laboratory, citing 1) failure of an early state survey to demonstrate differences on either side of the plant before it began discharging, 2) consistent differences by several studies (including Reserve studies) since operation began, and 3) good correlation between the amount of tailings deposition on the bottom and the abundance of shrimp.

The most widely publicized issue at the trial is the Government's ominous suggestion that asbestos-like mineral fibers discharged into the air and water by Reserve's plant may threaten lakeshore residents with lung and abdominal cancer. Although the Government filed its lawsuit in February 1972, the asbestos issue was not raised until last summer when submicroscopic mineral fibers were discovered in both air and water discharges from the plant.

Amosite asbestos, a mineral characterized by long, heat resistant fibers, is used commercially in products ranging from fireproof clothing to automobile brake linings. Workers exposed to asbestos dust for twenty years or more risk developing lung cancer as well as mesothelioma, cancer of the lining of the chest and abdominal cavities.

The mechanism by which the fibers cause cancer is not known, but researchers suspect that they may physically puncture the enclosing membranes of delicate lung cells, or that they may combine with chemicals needed for proper functioning of the body.

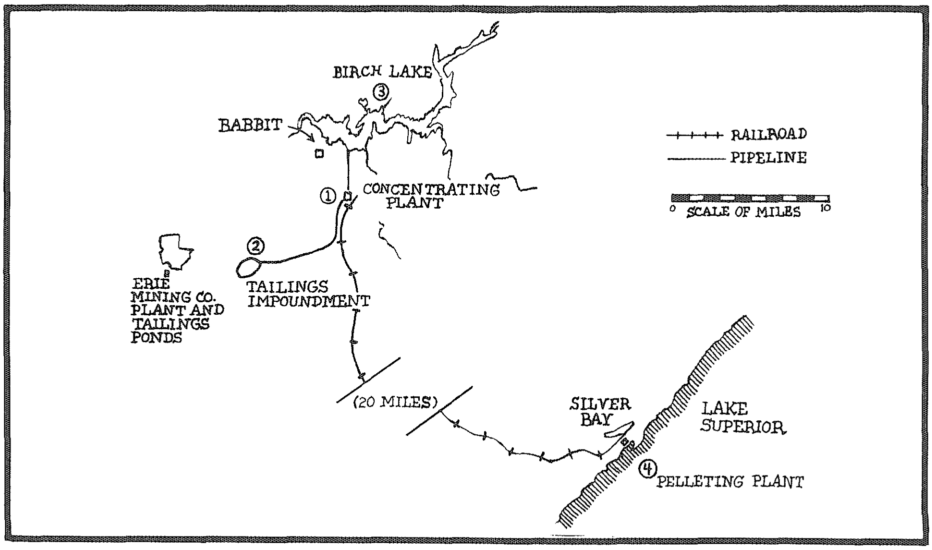
The court must deal with two critical issues. First, it has not been established that the fibers from the plant have the same properties as commercial asbestos. Second, although airborne asbestos is known to be harmful, there is no data available on waterborne asbestos that may be swallowed in drinking water.

Asbestos is a term applied to any fibrous mineral. Amosite, along with cummingtonite (the mineral found in Reserve's discharge) is a member of the group of silicates known as amphiboles. The two minerals have identical chemical formulae, containing iron and magnesium at significant points. They differ only in molecular structure. James R. Kramer, from McMaster University in Ontario, testified for the Government that the morphology (gross structure) of the two types of fiber is identical, and that they react identically to certain chemical tests. Stephen D. Burrell of the University of Wisconsin at River Falls stated flatly, "The material in the (Babbitt) mine is identical to that which is termed amosite." Tests are being conducted at laboratories across the country to determine if swallowing the fibers can endanger human health. There are not yet any conclusive results.

Reserve, which has been defending itself from the other charges since its plant first opened, was caught by surprise when the asbestos issue was raised. At first the company sought to have the issue excluded from the trial. Their request was denied, and their rebuttal to the Government's case will be presented in the near future. They can be expected to argue that the waterborne asbestos comes from natural sources, with their own discharge sinking into the great trough on the lake bottom.

Once Judge Miles Lord has decided whether taconite tailings actually pollute Lake Superior, he must decide on a solution to the problem, ranging from closing the plant completely to a modified in-lake disposal plan. The government has proposed a detailed plan for on-land disposal of the tailings, drawn up by the International Engineering Company (IECO) of San Francisco, California.

Under the plan, the present operation will be divided into two parts. The furnaces that turn iron concentrate into hard pellets for shipment across the Great Lakes will remain at Silver Bay. The grinders and electromagnets that produce the concentrate and tailings will either be junked or moved to a site near the mine at Babbitt.




IECO's proposed on-land disposal system: Taconite from mine is separated and crushed at concentrating plant (1). Concentrated tailings are forced through a 10-mile pipeline to impoundment area (2). Needed water is piped from Birch Lake (3) and iron concentrate is shipped to Silver Bay (4) where it is formed into pellets and shipped to blast furnaces in Chicago and Cleveland.

An ultramodern plant will be built at Babbitt, designed to produce higher quality concentrate (with higher iron content) than the present operation. The tailings in the discharge will be concentrated by mechanical hydroseparators and flocculants (chemicals to make the smallest particles clump together) and pumped through a ten-mile pipeline to a disposal pond hemmed in by a system of dams. Once the tailings have settled in the ponds, the water will be recovered and re-used. Additional water will be pumped from nearby Birch Lake.

The concentrate produced by the new plant will be shipped on the existing railroad to Silver Bay to be made into pellets. Because the concentrate, which contains about 10 percent water, may freeze in winter, an unusual system of insulated, electrically heated railroad cars will be used.

The tailings ponds will be built within a few miles of a similar facility owned by Erie Mining Company of Hoyt Lakes, Minnesota. Their "tailings basins" cover 2,000 acres and contain 235 million tons of tailings. The estimated cost for the proposed system is $187 million plus $25 million per year in operating costs.

Reserve has presented a long list of objections to the proposal, contending that it will destroy recreational areas, pollute the area with blowing dust, threaten nearby residents with flooding from broken dams and allow tailings to seep into the ground water. Further, they estimate that it will cost $530 million, almost three times the Government's estimate, and that it will require five times the water that could be drawn from Birch Lake. The ponds will lie entirely within the Superior National Forest, and their construction may violate Federal conservation laws.

A significant part of the trial will involve details of the cost estimates, along with testimony from accountants as to whether Reserve, along with its owners, Armco Steel and Republic Steel, can afford to finance the plan.

All of the Government's arguments relate to a basic contention that the discharge is promoting the eutrophication of Lake Superior. The natural history of any lake involves a change from the Oligotrophic state, characterized by clear water, absence of algae, varied bottom life and abundant fish, to a Eutrophic state, with cloudy waters, large numbers of algae, few bottom-dwelling creatures and few and undesirable fish. The change is brought about mainly by streams which carry nutrients and silt into the water.

Reserve's discharge, when considered as a stream, can thus produce the contradictory effects of stimulating algae and killing freshwater shrimp.

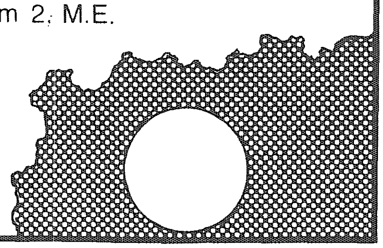
Reserve is fighting a losing streak, after the conclusion by the 1970 Federal Enforcement Conference in Duluth that its discharge constituted interstate pollution and a State Court order the same year that the discharge be modified to assure that no suspended particles escaped from the heavy density current.

A significant part of the trial will be made up of attempts by each side to attack the validity of unfavorable scientific studies. The 1970 Enforcement Conference resounded with charges of invalid laboratory procedures, biased methods of data analysis and suppression of unfavorable results. Environmental groups have openly accused Reserve scientists of manipulating studies to support the company's position.

After the trial and possible appeals have ended, a decision will have been made either to embark on a project that could cost half a billion dollars and cripple Reserve as a competitive enterprise, or to allow continued dumping in one of the continent's purest lakes. The court's decision will be based on the testimony of a series of experienced scientists, both employees of the opposing parties and consultants from the universities and private consulting firms.

If the court's decision is to allow dumping, the results will be manifest in about 20 years. If Reserve Mining's predictions are correct, Lake Superior will be clear and beautiful, its lakeshore population prosperous and healthy. If these predictions are wrong, the lake will be clogged with algae, its fish will be disappearing and the nearby population will be stricken with cancer. The result will be momentous for those who ask whether technology will serve man or dominate him — whether we can enjoy a high standard of living without destroying our planet in the process.





# STACKING THE DECK

## The Future of the Registration System

by Don Blyly

**Some University officials fear there will be no computer system at all during this decade.**

If you want your degree from the University of Minnesota, you have to confront the bureaucracy. Bureaucracy in its simplest form involves registering for classes. Amid cries of "there must be a better way" the management consultants of Cresap, McCormack and Paget, Inc. submitted a 65 page report to the University of Minnesota which outlined the things they found wrong with the registration system and recommended ways to solve these problems. Their final recommendation called for the creation of a computer registration system by Fall 1974. Now, University officials admit there is no chance for a computer system until Fall 1975, and some officials fear there will not be a computer system at all during this decade.

What is wrong with the present system? Many things, according to the consultants' report. In 1971 the consultants stated that a primary problem with the present arrangement was its lack of a focal point of responsibility in the registration system. This meant that each sub-unit — like the Admissions and Records, Data Processing Center, and Room Scheduling offices, plus the various colleges — could make changes on its own without considering what effect its actions would have on the efficiency of other sub-units. In fact, some offices went so far as to make changes without even notifying other sub-units. The report strongly recommended that a Registrar be appointed, having the responsibility and power to coordinate the operation of the current system as well as planning a smooth transition to the new system. Although the position was created, the sub-units still seem free to do as they please.

All Room Scheduling functions are performed manually, requiring a long lead time for departments to develop their course offerings. Departments prepare their course offerings late in Winter quarter and then forward this information to the Room Scheduling office. Fall quarter classes are expected to be completely planned by this time. Minor changes may be made by the departments in their Winter and Spring offerings, but the departments are already committed to the specific courses and numbers of sections they will be allowed to offer.

A computer system would tremendously increase the flexibility of departments to prepare future courses. At the University of Illinois at Champaign-Urbana, where a computer registration system is used, new courses can be added three days before the first day of classes (although it is preferred if three weeks' notice is given).

Here in Minnesota, because much of the registration process is done by hand, huge amounts of time are wasted for both students and University employees. For example, fees are collected in a very time-consuming and inefficient way. Class card decks are split between the colleges so that a student in I.T. might not be able to get into a class that other I.T. students have beaten him to, although cards for that same course might still be available in other college registration areas. Neither is the distribution of registration information to colleges and advisors very good. Departments often lack good information concerning the number of students who are likely to take any course in a given quarter. Even when the information is available in somebody else's files it would be too time-consuming to get the information to the people who need it. A computer system could store, sort and retrieve all this information in its own "files."

There is no priority system for insuring that the people who need a course most have the chance to get into it. Instead, a student with an early registration date can fill his schedule with prime courses at prime times; a student with late registration may be blocked from taking needed courses if they are filled before he registers. I.T. has several programs to make sure that a senior is not kept from graduating due to a closed course, but other students are not so lucky. A computer system with preregistration would solve this problem.

How do the I.T. registration administrators feel about these complaints? They admit that the present system does not allow much flexibility in setting up new sections and that occasionally other problems will arise with individual cases. But all in all they feel that the present system is far better than any previous system. For example: At one time registration was run on a first-come, first-served basis. This resulted in people bringing their sleeping-bags to campus and sleeping outside overnight in order to get a good chance at first choice of the classes. This was particularly hard for students when registering for Spring quarter classes in mid-February. Later a lottery system was established which required students to go to their department office to draw a number to determine when they could register.

Everyone seems to prefer the present alphabetical system.

Surprisingly, there seems to be a tremendous feeling that a computer system would take a lot of flexibility out of the system, even though the consultants' report repeatedly stated that the computer system would tremendously increase the system's flexibility. The experiences of numerous colleges and universities which have been using computer systems for many years strongly support the view that the computer increases flexibility in scheduling class changes, meeting individual student needs, and predicting class demands.

**There is no guarantee that a student who needs a particular course can get into it.**

The administrators also feel that the students really don't have many objections to the present system — at least none that the administrators have heard about.

How do the students feel about the present registration system? They seem to support the administration's view that there are few student complaints. A common feeling seems to be that the system could be better, but that it is not too bad now. Most people manage to get most of what they want most of the time. It seems they would just as soon continue with a system they are used to rather than cope with a new system.

One former student expressed the view that the problems in the system make it more valuable than a system without problems. He felt that learning to cope with the problems of the University regulation system prepared him to cope with the bureaucratic problems he encountered in his later employment. Thus, the University would be doing students a disservice by instituting a more efficient system; the "real" world is composed of inefficient systems and therefore the University should use inefficient systems when dealing with students. On the other hand, if the University encouraged students to work towards more efficient systems, there might eventually be a decrease in efficiency in the "real" world.

Here is a summary of the changes suggested by the consultants report: Tentative course offerings would be prepared, published and distributed to students. The assignment of rooms for classes would be automated. Around the middle of Fall quarter, students would make their Winter quarter course selections in consultation with their advisers. These selections would be fed into the computer. The computer would analyze this information and supply each department with data on how many students wished to take each section of each course. The departments would make any necessary changes and finalize their course offerings. The computer would make final room assignments for the finalized courses.

According to some priority system, the computer would then start assigning students to courses. The priority system at the University of Illinois, for example, gives top priority to disabled students, followed by James Scholars (people who maintain a grade point average of 4.25 or above out of a possible 5.00), followed in order by the remaining graduate students, seniors, juniors, sophomores and freshmen. Among the possible priority systems suggested by the report for the University are the following:

1) The random, rotating alphabetical system presently used by C.L.A. and I.T.,

2) Ordering students by number of credits completed to date,

3) Randomized order within each class, with graduate students first, seniors second, etc. or,

4) Cumulative order on the basis of the student's grade point average.

Whatever priority system would be used, the computer would in each individual case try to give the student the schedule he requested. Whenever the computer discovered that a requested section was full, it would try to switch the student to another section of the same course which did not conflict with the student's other courses — making sure to allow the student a lunch break. If this were not possible, the computer would then check to see if any section of a given course were open. If it were open, but in conflict with a section of another course the student was taking, the computer would see if there were a different section of the second course which did not conflict with anything. This would continue either until the computer managed to arrange a schedule that gave the student all the courses he requested, or until the computer had to admit defeat and give the student a schedule short one course.

These computer-prepared schedules would then be distributed to the students along with a computer-prepared tuition statement. If the student were willing to accept this schedule, he would confirm it by dropping a check in the mail to cover his tuition deposit. On the other hand, if he wanted to change his schedule he would go to his department office and make the changes using a cathode ray tube (CRT) computer terminal. This terminal would instantly be able to tell him what course sections were still open, and when he found a course section still open, he would enroll in it using the CRT. Then, to finish registration he would mail in a check for his tuition deposit. By having the CRTs permanently installed in each department office, they could be used by the departments for getting other information from the computer all year long; thus computer costs and use would not be limited to registration.

The student would still be able to add or drop courses after the beginning of classes. This could also be handled by CRT.

The computer would print class rosters for instructors before the first day of class, rather than waiting for the third week of class as is presently done. It would probably also print revised class rosters at the end of cancel-add periods.

The consultants' report contained a very detailed timetable for converting to the computer system. The timetable called for the new system to be in operation beginning with Fall 1974. The position of Registrar was created on schedule. An advisory committee (with representatives of Admissions and Records, the Data Processing Center, the coordinate campuses, the graduate school and students) was established on schedule and has been meeting for two hours per week for over two years. But nothing else is on schedule.

One of the main reasons is money. According to various estimates it would cost somewhere between $300,000 and $1,000,000 to convert to the new system. The Legislature in the past few years has not given the University enough money to maintain its existing programs, and certainly would not dream of giving the University an extra million dollars just to switch from a registration system which works to a new system based on new-fangled technology — despite the fact that numerous major universities around the country and a consulting firm hired by the University say a computer system is more efficient and less costly in the long run. Apparently, since few people support the plan at the University, the Legislature will be slow to fund the proposed registration system.

What has the advisory committee — designed to create an official University position on the registration system — accomplished in two years of weekly meetings? They have decided that they are not sure they want a pre-registration system. They have decided that they are unsure whether the CRTs should be distributed to the department offices for year-round use, or placed in one central location and used just for registration. (The committee seems to prefer having them all in one central location.) They have not decided on anything definite except that the final plan they approve will be quite different from the consultants' plan. And they all go around muttering about a computer system destroying the flexibility of the registration system.

Even if the committee could decide anything, the computer registration system would probably not be put into operation soon. According to Assisstant Dean Paul A. Cartwright, regardless of what anybody at the University does, it seems unlikely that there will be a computer system in operation during this decade unless there is a drastic change in the state Legislature's attitude towards higher education.

When a computer system is finally installed, I.T. will probably see it first. Dean Cartwright got computerized transcripts for I.T. students a year before any of the other colleges got them, and he has been trying to convince people to try an experimental computer registration system in I.T. In fact, three years ago juniors in electrical engineering used CRTs for registration, and the experiment worked quite well. But there is no indication that the state Legislature will release money for any more experimentation for quite some time.

Until then we can just be thankful that students at this University are willing to put up with the present system.

# OF WORLDS BEYOND

## EXOBIOLOGY: A NEW SCIENCE IN THE MAKING

by James M. Young

"Five or six had already hatched and the grotesque caricatures which sat blinking in the sunlight were enough to cause me to doubt my sanity. They seemed mostly head, with little scrawny bodies, long arms, with an intermediary pair of limbs which could be used at will either as arms or legs . . . As I stood watching the hideous little monsters break from their shells I failed to note the approach of a score of full-grown Martians from behind me. . . . " *

So Edgar Rice Burroughs, creator of Tarzan, described life on Mars in his first novel written in 1911. Burroughs had taken the ideas of astronomer Percival Lowell and turned them into a novel about a dying planet whose seas had dried up and whose semi-barbarous societies fought with swords and atomic explosives. At the time Burroughs wrote, it seemed quite probable that Mars was a dying world that might, in Lowell's famous words, be "an abode of life."

Half a century after Burroughs wrote *A Princess of Mars* it was obvious that the red planet could not hold the dying seas and civilizations Tarzan's creator dreamed about before World War I. Observations by the Mariner satellites (and by Soviet spacecraft) had shown by the mid-Sixties that Mars is a barren planet pocked with craters, blanketed by a very thin carbon dioxide atmosphere and ill-suited to life as we know it.

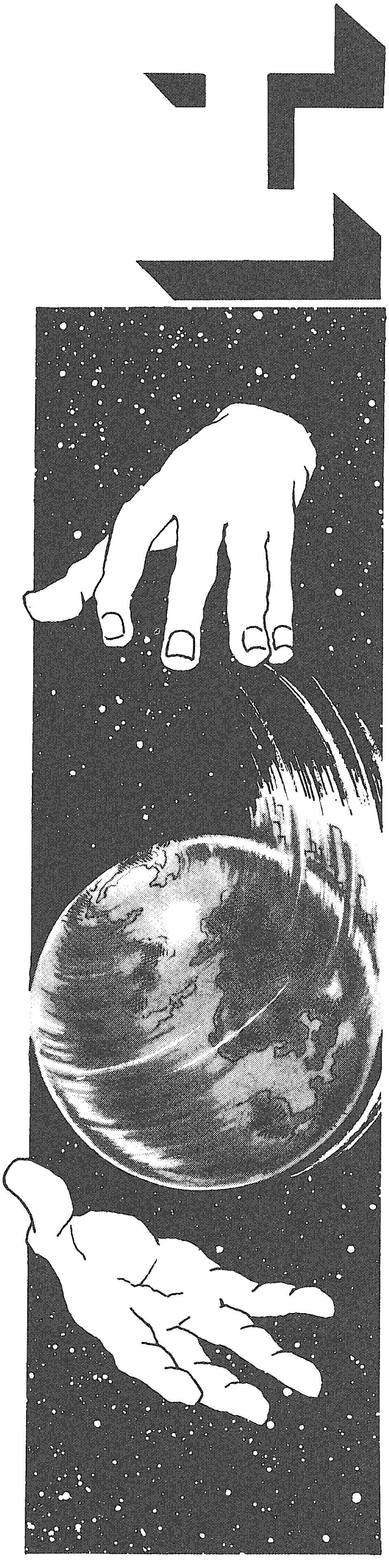
Rather than being the aging planet Percival Lowell thought he saw through his telescope, Mars is apparently a juvenile world. Mars lost its primary atmosphere of hydrogen and helium more than three billion years ago when the Sun's radiation excited the original atmosphere of light gasses beyond the Martian escape velocity. The Sun's radiation was so powerful that it "blasted away" the primary atmospheres of Venus and Earth at about the same time. But Venus and Earth soon coalesced into worlds with distinctive cores, mantles and crustal layers. This structure promoted volcanic activity on a massive scale, and the current atmospheres were outgassed by volcanic activity (though the Earth's atmosphere has since been changed by biological activity). Mars, which is much less massive than either Venus or the Earth, has apparently not yet finished coalescing into a mature planet. Its thin $CO_2$ atmosphere has been produced by outgassing, but it would evidently take several billion years more for the planet to coalesce, develop a hot core and begin to outgas an atmosphere as its inner neighbors did billions of years ago. Mars has barely started its evolution, compared to our world or Venus.

When geophysicists, astronomers and biochemists began to compare notes on Mars, they began to develop a new science. It is called exobiology — the study of life on other worlds. Exobiology has drawn on the theoretical and empirical knowledge of several sciences to create a unified concept of the formation of planetary systems and the development of life on other planets.

Comparison of the Earth with Mars and Venus has led to a theory of planetary evolution based on the model developed by the German physicist C. F. Weiszaecker in 1943. Weiszaecker took the 18th century hypothesis (first put forward by the French nobleman, Laplace) that dust clouds condense into planets, and turned it into a mathematical model based on observed occurrences. According to Weiszaecker, as a star coalesces from a dust cloud, the remaining dust surrounding the star begins to develop vortical currents. These tornadoes of dust cause the planets to form. As the entire dust cloud flattens into a disc, the dust which has not become part of some planet is pushed away from the central star by the star's radiation. According to Weiszaecker, planets form around a star as naturally as cats have kittens. Until 1972 there was one great problem that stood in the way of the complete acceptance of this theory.

If the planets had formed from such a dust cloud, then the Sun should be rotating on its axis much faster than it is — unless some mechanism acted to brake its rotation. If the Sun acted as the hub of such a swirling dust cloud, then it should have rotated increasingly faster as long as it remained in direct contact with the dust, since the angular-momentum of the entire cloud would be transferred to the cloud's center. Once the planets had begun to form and the cloud began to disperse (either into the atmospheres of the planets or out of the solar system entirely), the

*From Edgar Rice Burroughs, *A Princess of Mars* (Chicago, 1917 and many subsequent editions), Chapter IV. Copyright renewed 1939 by Edgar Rice Burroughs, Inc.



Sun should have continued to speed up its rotation until it reached a peak rotational speed several times faster than its current speed.

But in 1972 the American astronomer S. S. Huang reported that the Sun's magnetic field could have reacted with the pre-planetary dust cloud in order to break the solar rotational speed. This would have flattened the dust cloud into a disc and promoted planetary formation. Such a model also explains why stars younger than type F5 on the main sequence of stellar evolution (younger than our Sun) rotate rapidly, whereas stars of type F5 or later (including our Sun, a type G0 star) generally have a blurred spectrum and slower rotational speeds than younger stars. Our Sun's spectrum isn't blurred by a pre-planetary disc of course, but it may appear blurred by the planets when seen from other suns. The blurring of spectrums is very probably caused in part by dust clouds and pre-planetary discs.

How many stars have planetary systems? In the Earth's immediate vicinity — in our sparsely populated corner of our galaxy's spiral arm — about 90 percent of all stars are on the main sequence of the Hertzsprung-Russell diagram. Of these, about 90 percent are of Type F2 or later and therefore are probably accompanied by planets. If the entire galaxy were consistently populated like the spiral arm we occupy, then 81 percent of its $10^{11}$ stars would in all probability have planetary systems; there would be about 8.1 x $10^{10}$ solar systems in our galaxy.

However, there is some evidence to show that the galaxy may not be uniformly populated like our spiral arm. In the core of the galaxy, for example, the conditions for star formation may be quite different. From Earth we can not see the core of our galaxy because the cosmic dust becomes so dense towards the nucleus that we are essentially blinded in that direction. So astronomers are not certain what conditions are like at our galaxy's nucleus, though they have begun to examine the nuclei of nearby galaxies to learn what it should be like. Even if conditions in the rest of the galaxy were so different that the number of stars expected to have planetary systems were reduced by several magnitudes, there would still be thousands of planetary systems within our "island universe." This knowledge must come as a blow to some provincial human beings who think Earth is unique among the stars. (Consider too that there are probably more than $10^9$ galaxies in the universe.)

Stephen Dole, a researcher for the RAND Corporation, developed a computer generated model for planetary formation based on the Weiszaecker hypothesis. His research, reported in *Icarus: International Journal of Solar System Studies* in 1970, suggested that every planetary system will have terrestrial and gas-giant (or jovian) planets. The terrestrial planets will always orbit nearer the central sun than will the gas-giants. If Dole's model solar systems are accurate representations of what the universe is like, then every solar system must have an Earth-like planet about as far from its sun as the Earth is from Sol. This implies that life as we know it may be as common as planetary systems.

For wherever there is an Earth-like planet, it seems that life-forms based on the carbon atom are likely to arise. Given a planet with an atmosphere made up largely of $CO_2$, $NH_4$ and $CH_4$, and given that the planet is within the proper temperature range for water to exist as a liquid, the basic macromolecules on which life is based form rapidly. Experiments in the 1950s showed that amino acids could form in a laboratory model of the Earth's early oceans and atmosphere when electrical current — simulating a lightning bolt — was passed continuously through the model. During the 1960s it was shown that aminos and adenosine triphosphate (ATP) can be formed by irradiating such a model with ultraviolet light and hard radiation. Even simple agitation of water in a reducing atmosphere creates ATP.

All life on Earth uses ATP to store energy. Since the molecule was very common in the Earth's ancient seas, the conditions were ripe for the formation of living

organisms.

It apparently took about a billion years for cellular life to develop on Earth. The ancient seas were full of organic molecules during this time — a "thick soup" of potential life. At some point, after a chemical reaction which may have lasted $10^8$ years, long chains of molecules developed in the oceans. Sections of cells (like the mitochondrion) may have developed first, and were later somehow incorporated into a larger cell and maintained as part of the larger organism. (The mitochondrion and chloroplasts have been shown to have their own DNA, somewhat different from that of the cell nuclei of the cells in which they appear. This implies that they developed independently from the cell.)

It took between two and one-half to four billion years for an oxidizing atmosphere to develop on Earth. Large multicellular life has only dominated the planet during the last half billion years or so, and man has only existed for a few million years. It has, in short, taken about $4.5 \times 10^9$ years for a technological civilization to develop on Earth.

Since both planets and life seem to form very easily — so easily, it seems, that amino acids can be found in the atmospheres of such inhospitable planets as Venus and Jupiter — the probability is obviously very high that the inhabitants of Earth are not the only form of life occupying a planet. According to Dole's computer-generated model solar systems, there ought to be life on one planet in each planetary system.

What are the chances that there are other intelligent races, other technological civilizations in our galaxy? First of all, consider the time it takes for an average technological civilization like ours to develop — four and one-half billion years. If our galaxy is about 13 billion years old (as has been most recently estimated), then a technological society could have developed before the Earth began to form. Since it would have taken about two billion years after the galaxy's formation for main sequence stars with planetary systems develop, then Earthlike worlds probably existed 11 billion years ago. Given 4.5 billion years for life to develop and evolve (and for a technological civilization to arise), societies like our own could have developed 6.5 billion years ago — 1.5 to 2 billion years before Earth formed. Considering the vast number of solar systems that exist in our galaxy, the number of technological civilizations like our own that could have existed in the distant past is staggeringly large.

Bear in mind that any civilization as advanced as we are — if we are indeed advanced at all — has the capacity to destroy itself. If our civilization (or one like it) could avoid self-destruction, it could develop a technology capable of controlling stars, solar systems and perhaps whole galaxies. A Soviet astrophysicist, N. S. Kardashev, hypothesizes that there should be three basic types of civilization in the universe, based on the amount of energy the civilizations' technologies allow them to control. Type I societies would be like our own — capable of controlling the energy output of one planet; Type II civilizations would be able to control stars and solar systems; and Type III could control an entire galaxy. In an essay "On the Detectivity of Advanced Galactic Civilizations" in the July 1973 *Icarus*, Carl Sagan has brilliantly estimated the probable number of such societies in our galaxy.

Sagan supposes that the number of civilizations in our galaxy can be estimated in relationship to the rate of the emergence of civilizations (based on the rate of solar system formation) and the mean lifetimes of such civilizations. The principles for this estimation are outlined in a book Sagan wrote in collaboration with the Russian I. S. Shklovskii, *Intelligent Life in the Universe.* The American astronomer Frank D. Drake framed the first postulates for this research in the early 1960s. Drake said that

$$N = R\,L, \qquad (1)$$

where N is the total number of civilizations, R is the rate of the emergence of technological societies (which is a function of the rate of stellar formation, planetary formation, the number of planets where life occurs, and the

fraction of that number where civilizations do emerge), and L is the mean lifetime of these societies. L is set with the assumption that large numbers of civilizations can survive to ages measured in terms of hundreds of millions or billions of years.

Sagan has computed the total number of civilizations with the further assumption that any civilization that reached the Type II technology level will have passed the stage where it will destroy itself. Sagan then divides L into two values, $L_d$ (the time in which a Type I civilization has the potential to destroy itself) and $L_g$ (a large number representing a long lifetime for a society, roughly equivalent to the lifetime of a small star). Setting $f_g$ as that fraction of civilizations which survive for $L_g$, Sagan says that

$$L \sim (1-f_g)\, L_d + f_g\, L_g. \qquad (2)$$

Therefore the total number of civilizations in our galaxy will be about

$$N \sim R\, [(1-f_g)\, L_d + f_g\, L_g]. \qquad (3)$$

He then applies some probably figures to these values. He sets $L_g$ at about $10^9$ years, $f_g$ at about $10^{-2}$, and R at about $10^{-1}$ stars per year$^{-1}$. (R was set at a different value in *Intelligent Life in the Universe* and revised to this value in the article.) As long as $L_d \ll L_g$, L should be equal to about $10^7$ years (by equation 2). Therefore N should be equal to about $10^6$ civilizations.

Sagan realizes full well that some of his assigned values may have to be altered as astronomical knowledge increases. Still, the idea that there are one million civilizations in our own galaxy — most of them Type I societies — is surely well supported by this argument. Changing the value of $L_d$ would alter the value for N of course, and Sagan's value for $L_d$ is indeed very small; he does not think much more than one thou-

## RECOMMENDED READING

There is a great deal of material about the possibilities of extraterrestrial life in any library, most of it drivel. But it should be remembered that 90 percent of everything is crud. The ten percent remaining makes very interesting reading indeed.

Probably the best all around discussion of the subject is in Carl Sagan and I.S. Shklovskii's *Intelligent Life in the Universe* (San Francisco, 1966). The book is excellently illustrated and extremely readable. It provides wide-ranging background material for further reading.

Another book well worth reading — and the book that triggered most present work on exobiology — is the anthology *Biology and the Exploration of Mars,* edited by J. P. T. Pearman, Colin S. Pittendrigh and Wolf Vishniac (Washington, D.C., 1966). This book contains a chapter on exotic biochemistry that is really fascinating. "What is Life?" — the first chapter written by Daniel Mazia — is also quite good.

Another anthology of essays by many people, edited by Eric A. Ottesen and Elie A. Shneour, is *Extraterrestrial Life: An Anthology and Bibliography* (Washington, D.C., 1966). It contains many interesting articles on such topics as "The Nonprevalence of Humanoids." Many of the authors here are quite self-conscious about the fact that they are writing speculative material that could be classified as science fiction.

*Exobiology,* edited by Cyril Ponnamperuma (Amsterdam, London and New York, 1972) is a very scholarly book on the subject. Some of the chapters are interesting, but this is not an exciting book. A concluding chapter by Carl Sagan describes Stephen Dole's model solar systems.

Sagan, an ubiquitous individual, edits a journal called *Icarus: International Journal of Solar System Studies.* Despite attempts to look like a staid scientific publication, *Icarus* is actually a science fiction magazine — with the emphasis on science to the almost total exclusion of the fiction. The July 1973 issue has three excellent articles on the topic: Sagan's "On the Detectivity of Advanced Galactic Civilizations;" John A. Ball's "The Zoo Hypothesis;" and F. H. C. Crick and L. E. Orgel's "Directed Panspermia." An essay on "Extrasolar Planetary Systems" by Su-Shu Huang in the March 1973 issue is also quite interesting.

All these works have been consulted during the preparation of this article. They may all be obtained in the Physics Library.

sand years would be spent in the balance between self-destruction and movement into a Type II culture. Dependent on how pessimistic one feels, 1,000 years may or may not be a very fair — or a very long — duration for a cold-war period in the history of a technological society.

Sagan concludes his article by recommending that we look for evidence of Type III civilizations because the manipulation of whole galaxies ought to be easily visible. Since there are apparently some odd stellar motions in the core of the spiral galaxy M31 in Andromeda (see Vera C. Rubin, "The Dynamics of the Andromeda Nebula," *Scientific American*, June 1973), we may already have found evidence of such a society. Since M31 is about $2.2 \times 10^6$ light years away, the manipulation of stars in its nucleus took place — if it was indeed manipulation and not some as yet inexplicable natural phenomenon — more than two million years ago. Without realizing it, and without any of the flying saucer fanatics ballyhooing it, astronomers may already have uncovered evidence of a very advanced extraterrestrial civilization which flourished in another galaxy before men had begun to build cities on Earth.

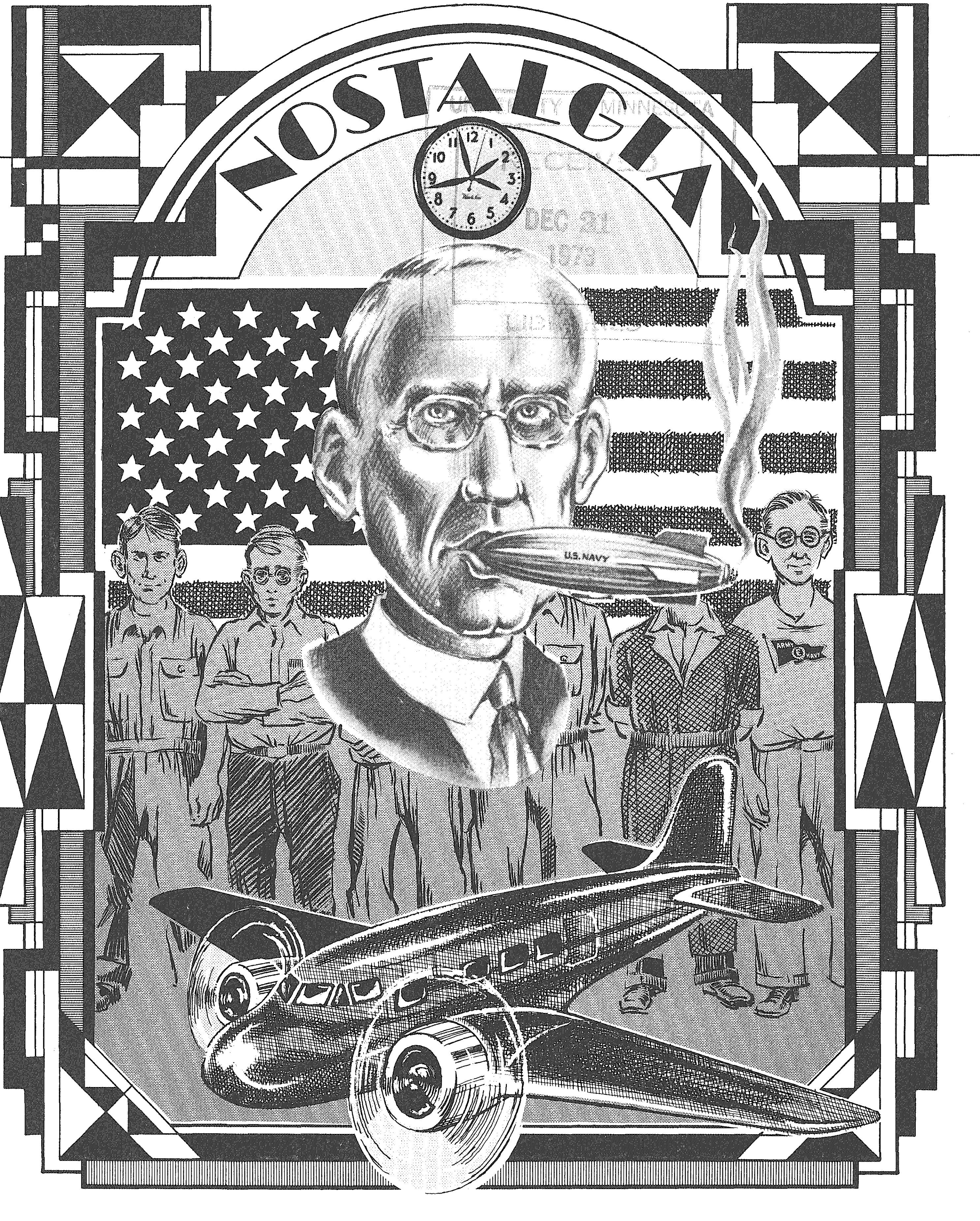
Exobiology is a science still feeling its birthpangs. Any new science draws heavily on the techniques and knowledge of other sciences, and most exobiological study has concentrated on learning how life evolved on this planet and how it might evolve on other worlds. Eventually, as mankind increases its knowledge of the cosmos, exobiology will develop into a comparative science.

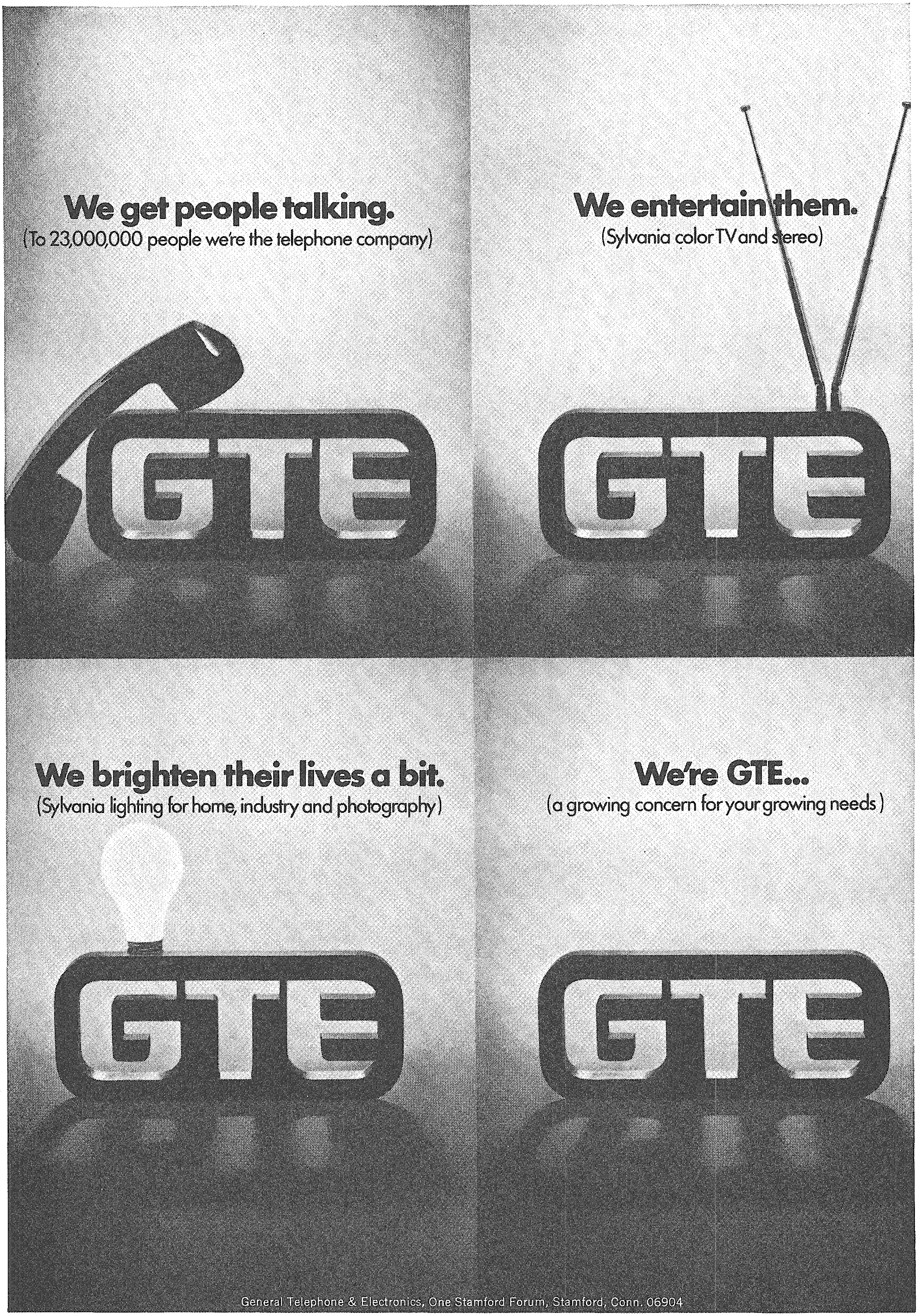
Researchers in a new field often feel self-conscious about their endeavours into a "radical" field. Especially since exobiology is so closely related to science fiction, many scientists intrinsically distrust it. For this reason there has been little theoretical work done on the nature of "life as we don't know it" — that is, exotic biochemistry based on silicon, nitrogen or sulphur atoms rather than carbon. Mars might be an appropriately cool place for life to evolve using silicon as the basis for a genetic macromolecule, for example; but United States Mars landers will be designed only to look for carbon-based life. In other words, researchers are so self-conscious about exobiology that they are not prepared to investigate other worlds completely and intelligently. (Appeals have recently been made, however, to add devices to American Mars probes which can search for evidence of exotic biochemistries on the red planet.)

In order to advance human knowledge, human beings must be willing to speculate. No matter where an idea originates, whether in science fiction or in a joke, if it is a well thought out idea it is always worth exploring. It may well be worth considerable expenditure of money to develop exotic biochemistries in the laboratory. New medical treatments and further knowledge of how carbon-based life developed are two of the many possible spin-offs of such investigation.

When astronauts land on Mars they will not find the exotic ruins and dying world of Edgar Rice Burroughs. But they will discover new facts about the most exotic thing men have yet found in the Universe — life itself.

minnesota **Technolog** december 1973

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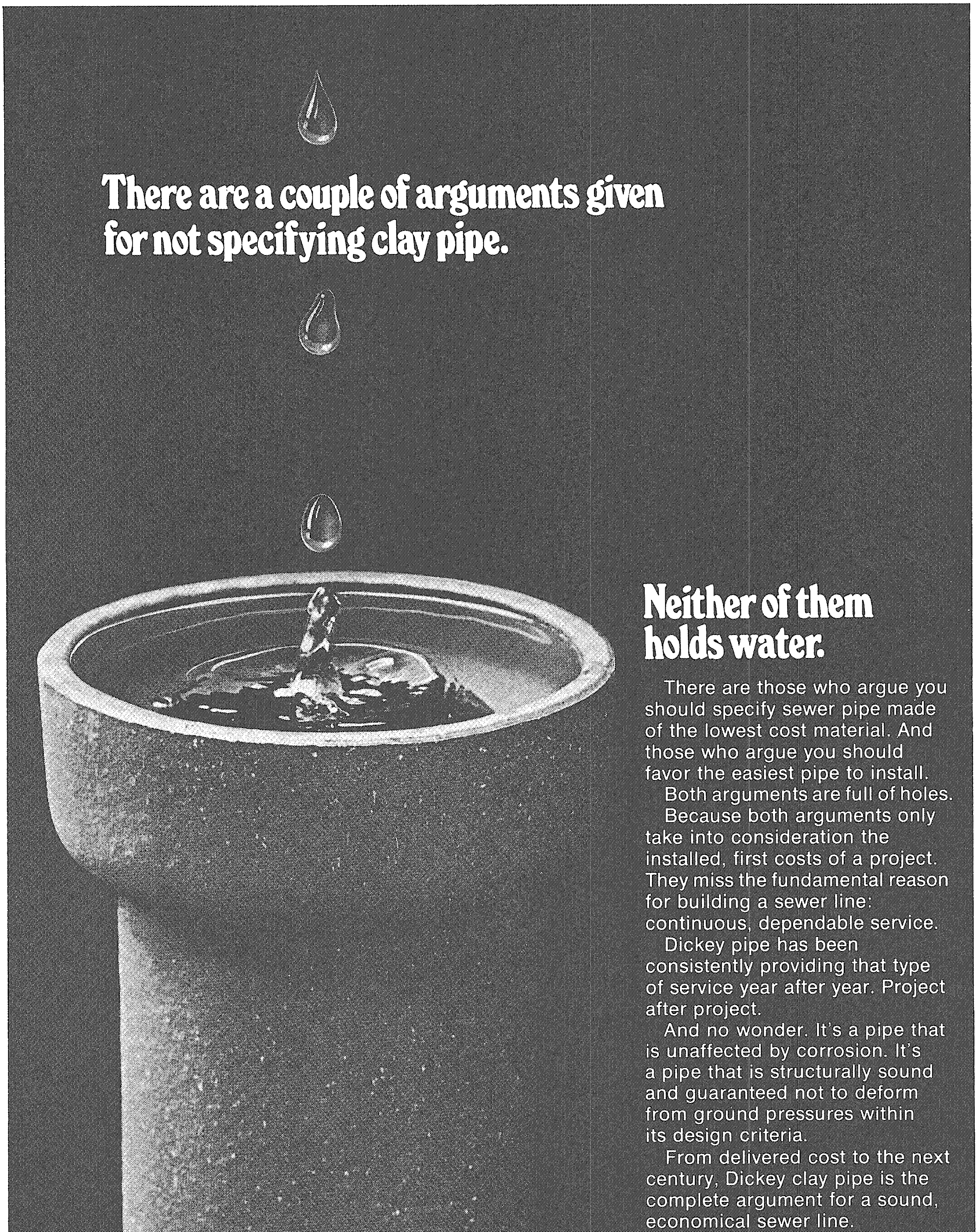
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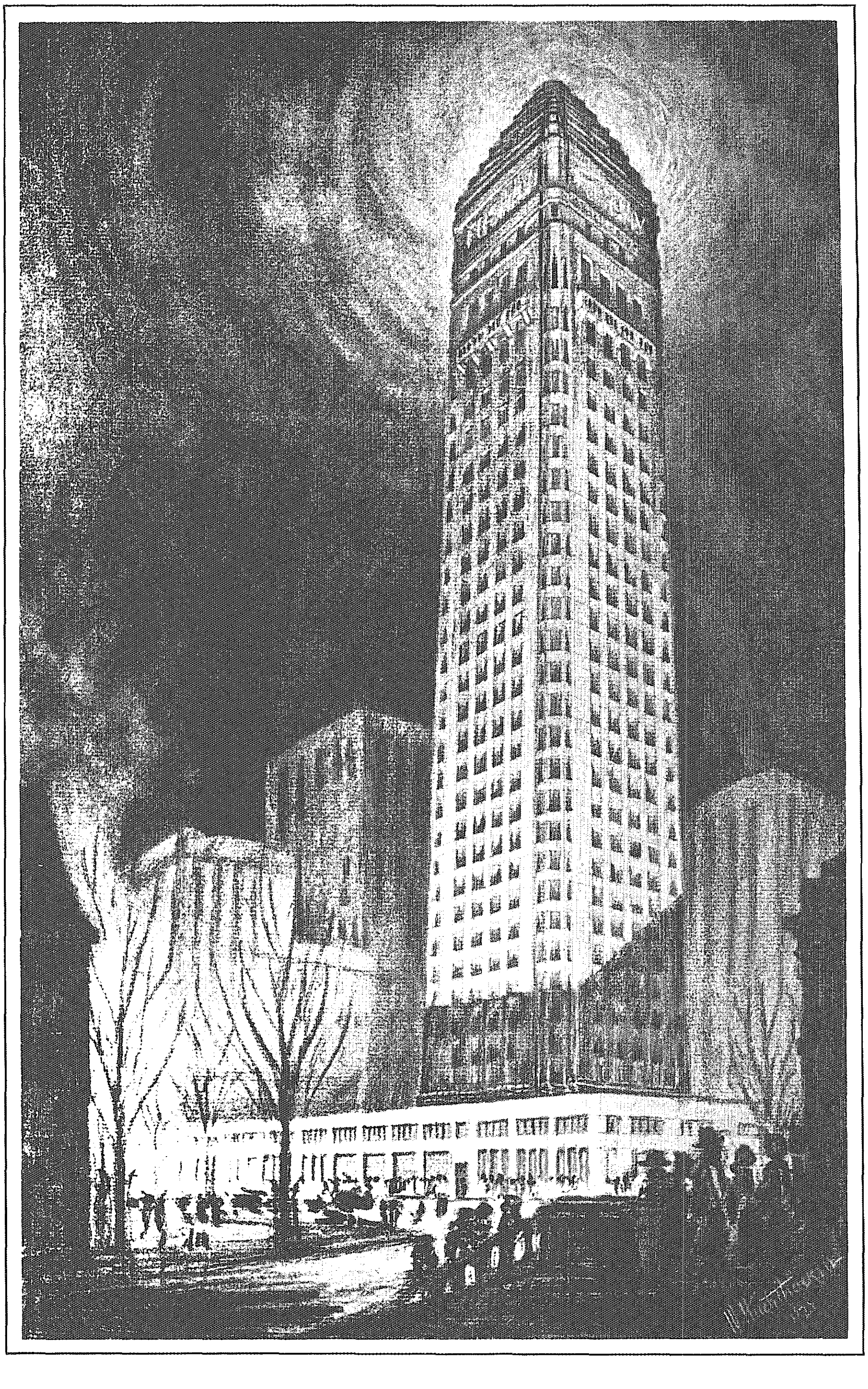


*The Foshay Tower*

The MINNESOTA TECHNO-LOG

University of Minnesota

Volume VIII JANUARY 1928 Number 4

# Details of the Foshay Tower

*This structure, now under construction in Minneapolis, is patterned after the Washington Monument. It is to be taller than any building in the Northwest*

*By* ALBERT W. MORSE, E. '29

ARCHITECTURAL features embodied in the design of The Foshay Tower, now under construction in Minneapolis, make this building of particular interest to the engineer.

Its unusual height of 30 stories, greater than that of any other Minneapolis building, or of any as yet announced, has a certain public appeal, and it is probable that The Foshay Tower heralds a period of construction to be characterized by a group of buildings which will materially alter the Minneapolis sky line.

In overcoming the problems which would arise from the design of a building of this type, the University of Minnesota has played an important part, since the men intimately identified with the work received their training here. G. R. Magney and W. H. Tusler of the firm of Magney & Tusler, Inc., the architects, are Minnesota men. Mr. Magney completed a special course in architecture and engineering in 1905, and Mr. Tusler graduated from the College of Science, Literature and the Arts. Leon E. Arnal, the designer of the building, is a professor of architecture at Minnesota. In addition to these men, there are about a dozen identified with the firm who are former students of the College of Engineering and Architecture.

The Foshay Tower is patterned after the Washington monument, and the tapering outside walls of the tower converge at the rate of about 4 inches to each floor, extending from the second floor to the roof. The architects considered that this was too great a taper to permit the running of the wall columns vertically, with an off set at splices, so they are built at an angle to conform with the outside walls. At the base of the tower the dimensions are 81 ft. x 87 ft., and the walls converge to a floor area of 59 ft. x 65 ft. at the base of the pyramidal roof.

To insure stability for so slender a structure, the footings were run to a depth of 62 ft. below street level, extending 12 ft. into rock, the last 8 ft. being below standing-water level. Borings were made at the center of each caisson excavation, so as to determine the structure of the rock ledge, and this in turn governed the construction of the caissons.

A coffer-dam was used in the excavation, and to accommodate the earth pressure which later is to be carried by the building, in addition to the wind pressure, provision had to be made against rather large shearing forces at the foundation. A horizontal system of trusses in the basement floor is intended to transfer these forces to the walls, and from there they will be taken to the foundation by means of vertical bracing.

Sub-basement excavation extends 50 feet below street level.

Provision for wind stress, occasioned by a rather large bending moment of the steel columns, was one of the chief considerations in the design of the tower, and after this had been provided for it was found that an additional provision for the dead and live loads was unnecessary. Columns and girders with especially designed wind-bracing features, including brackets at the ends of the girders to maintain rigidity, are intended to care for this wind stress, with the reinforced concrete floors acting as stiff diaphragms in resisting the tensional action caused by the wind.

Thirty pounds for each square foot of exposed surface is the wind requirement of the Minneapolis Building Inspector's office, and this is the equivalent of a 97 mile-per-hour wind. It is believed that the maximum wind velocity recorded by the federal weather bureau for this district is 76 miles per hour, the equivalent of about 15.5 pounds per square foot. Minneapolis is not in what is known as the tornado belt, which is liable to receive wind velocities up to 137 miles per hour, or about 60 pounds per square foot. A hurricane recorded for August 20, 1904, was the most recent one in this vicinity, and in these wind disturbances of a velocity of 100 miles per hour are rarely exceeded. It is believed that with the general requirements as specified by the office of the Minneapolis building inspector, any building so designed could safely withstand any storm which might occur in this district.

With the allowable unit stresses one-fourth of the amounts which would be necessary to cause failure of the building, it becomes apparent that 120 pounds per square foot wind pressure would be necessary to cause destruction.

A further requirement of the Minneapolis Building Inspector's office is that overturning moment created by wind cannot be greater than 75 per cent of the stability moment of dead weight, and in the Foshay Tower this is 14 per cent.

LOADS varying between three and four million pounds are carried by the inside columns, which in turn are sustained by steel grillages built with steel slabs in the caissons. It is believed that the dead load carried by a column by far exceeds what uplift may be caused by wind, making unnecessary any anchorage to allow for this uplift after erection of the steel has been completed.

Specifications call for a reinforced concrete chimney, five feet in diameter, with the top at the point of the pyramidal roof, to be invisible from the street. This chimney, together with the elevators, stairway, toilets, janitors' closets and pipe space is to be carried up through the center of the building, thus insuring the maximum of light and air, with all office space on the outside.

It is planned to provide storage tanks in the basement, on the seventeenth floor and in the roof space for fire protection, with hose connections on each story. The tanks on the upper floors are to be supplied with city water by pumping,

*(Continued on page 124)*

# A NEW ELECTRICAL BUILDING

## Plans Are Nearly Completed For The Next Unit In Ten Year Building Program

By Albert W. Morse

WITH plans ready for the contractor, the Electrical Engineering department is practically assured of having a new building by a year from this fall. This will provide adequate housing for department offices and classes, and will place on the campus one of the most attractive buildings included in the University expansion program.

In securing these new quarters, Prof. G. D. Shepardson, head of the department, will reach a goal toward which he has been striving since he came to the college in 1891. Unforseen difficulties have been encountered in the course of the years of planning, but at last a building has been assured which will be worth the effort.

The location is between the main engineering building and the Northern Pacific tracks, as finally decided upon. The front of the new unit is to be on line with the front of the main building, with the laboratory extending back in the direction of the experimental building. It is anticipated that eventually the front of the new building will be the same length as that of the main engineering building, with the addition built on to the north. The mechanical department will probably occupy this part, having a laboratory extending back parallel to the electrical laboratory. Provision is made for a hallway to pass through the entire front of the completed structure.

The front section will equal the main building in depth and height, and be of corresponding architecture. A connecting link with a hip roof will then extend back to the laboratory, which will differ slightly in architecture from the front portion. The entire structure could not be designed similarly to the main engineering building and kept within the $300,000 appropriation, so the architect conceived the idea of having a narrow, connecting link to introduce the change.

Department offices will be located on the main floor to the right of the entrance, with a seminar room on the extreme right and two laboratory and sevice rooms across the branch corridor. Space on the left is allocated to a class room, an office, a photometer room, and a stairway. Proceeding out through the connecting link, three laboratory rooms will be on the right, and on the left hand there will be in turn a janitor's closet, faculty toilet, and three offices.

Standing in the doorway of the main, two-story laboratory, a person will be able to get the finest vista on the campus, a distinction now conceded to the engineering library. Every detail is planned symmetrically, and the confusion so apparent in the present building will be entirely lacking.

According to C. H. Johnston, state architect, who designed the building, this 150x55-foot laboratory will be one of the finest located in collegiate institutions throughout the world. Its system of communicating trenches and shafts for wiring makes it exceedingly elastic. Seven vertical wire shafts built into the walls enable connections to be made freely with the different floors. Two of these are located at the front of the building, two at the junction of the front section with the connecting link, two more at the entrance of the laboratory, and one beside the elevator at the north side of the laboratory. These shafts connect with a wall trench extending around the building, which in turn branches off into lateral trenches in the floor at intervals of twenty feet. Thus a student will be able to operate machinery at any point in the building without exposing a network of wires.

An interesting feature of the laboratory will be the system of bringing in new equipment. Vans will unload onto a cement coping at the rear of the building, and the main crane will be brought into play through some double doors, eliminating the injuries to a building caused by bringing in equipment through regular entrances.

Prof. F. W. Springer is responsible in no small degree for the completeness and admirable arrangement of the laboratory. He has maintained an active interest in this work ever since his entrance into the department, which is amply testified to by his constant interest in the laboratory of the old building. A piece of apparatus developed and constructed by Professor Springer, which has been in use several years, is the portable alternating current switchboard. This was finished in March, 1912, and is still giving satisfactory service.

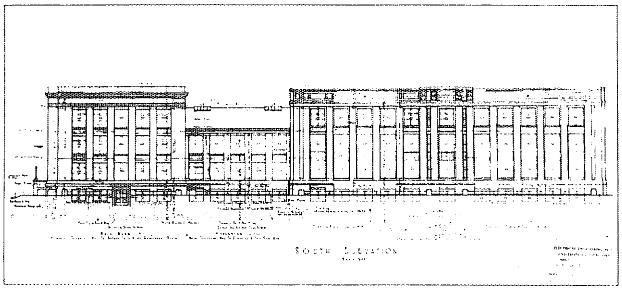
On the second floor, the front section will contain three unusually large rooms, devoted to classes, study, and illumination laboratory work. Here the various systems of lighting will be demonstrated, including straight direct, straight indirect, and semi-indirect. Then there will be a dark room for radio work, and the stairway. The entire right side of the connecting link will be taken up by a design room, with lateral trenches in the floor to facilitate wiring. On the left there are to be a janitor's closet, a women's toilet, and three private laboratories. The entire second floor of the main laboratory will be devoted to a gallery extending out about ten feet from the front and sides, with a narrow passage across the back.

Most of the front section on the third floor will be converted into a lecture hall. Here the student branch of the American Institute of Electrical Engineers will finally come into its own. In the past, institute members have been buffeted by the winds of fortune between the engineering auditorium and numerous rooms in the Minnesota Union. Arrangements will be made for stereopticon and moving picture facilities, and the room will be available for various lectures of interest to department members. A classroom, a photometer room, and an apparatus room are also to be located here.

Storage space will be found on the right of the connecting link, and the left side will be divided into two smaller storage rooms, a janitor's closet, and a faculty toilet.

The third floor of the laboratory will be probably one of the most complete communication-develop-






*South Elevation of the New Electrical Building*

ment units in the country. Research and practice rooms, grouped about the radio station, will afford students exceptionally complete and unified facilities. The station itself, with its ante-room, studio, and station, will occupy the forward part of the left side. Behind this, there will be a research room, a branch corridor leading to the stairway and elevator, a telephone research room, quarters for high frequency testing, and finally a large radio laboratory. Located on the other side of the building, there will be a telephone and telegraph laboratory, corresponding in size to that for radio, and between the two and at the end of the main corridor will be an apparatus room. Forward on the right side, there are to be two offices opening off from an assistance room. Then the remainder of the space will be allotted to signal corps work, with subdivisions devoted to an apparatus room, a practice room, an office, and two research rooms.

Two seventy-five-foot towers, placed at the extreme ends of the roof, will support the radio aerial. And, in order to prevent useless speculation on the subject, it may be stated here that precautions will be taken to prevent the accessibility of the towers during class scraps.

A sub-basement will provide a large amount of general space, with only a small portion taken up by a machine room.

It is planned to devote the front section of the basement to mechanical equipment, electro-thermal practice, a classroom, two dark rooms, and a corridor running laterally the entire width, with entrance at the ends. In the connecting link, the right side will be divided into a students' toilet and a room for dielectric tests. On the left will be a janitor's closet, a laboratory, and two offices.

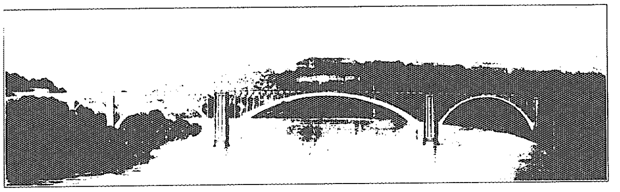
Sophomores have been kept in the basement for so many years that when the plans were laid out it was only natural to set aside a portion of this part in the new building for their laboratory. Professor Shepardson, however, intends to let the sophomores use part of the main laboratory. Rooms for measurements, meters, and spare parts take up the remainder of the right side. On the left will be a large storage battery room, a machine room, a shop, and three stock rooms.

Since its organization in 1889, the new building will be the first satisfactory solution of the department's housing problem. It at first occupied the east half of what is now the Men's union, which it vacated in 1899. Then it was scattered in seevral buildings, with the offices and library in the armory, the laboratory in which is now the forge shop, and classes wherever possible. In 1901, the present electrical building was erected at a cost of $19,766.50, exclusive of the chimney and basement, which were added later. The original plan was to put a front across at the east ends of the electrical and mechanical buildings, and in 1907 the legislature appropriated $250,000 for this purpose. During the same session, however, $450,000 was voted for extending the campus over the Great Northern tracks, and it was decided to wait and erect a building on the new ground. Accordingly, the $250,000 was used in the erection of the main engineering building, and the electrical department waited.

Agitation for the new building started again in earnest when on Dec. 12, 1910, the engineering faculty voted in favor of requesting its erection. After "almost" getting the bill through the legislature three times, it was included in the general University expansion plan, for which the legislature made a ten-year provision in 1919. In the spring of 1921, the regents made an allotment for visiting other electrical laboratories, and in December of the same year they voted $300,000 for the building itself.

Various considerations made it desirable to place the structure between the main engineering and chemistry buildings, but it was found that the cost on that site would amount to approximately $450,000, with only $300,000 available. The architects made their report to the board of regents in December, 1922, offering the alternatives of either a larger allotment or the use of a smaller site. Action by the Greater University Corporation released the space directly north of the main engineering building, and it was decided to place the electrical building here.





# CAPPELEN MEMORIAL BRIDGE

By O. H. Hosmer, '23

## THE NEW FRANKLIN AVENUE BRIDGE

The four hundred foot concrete arch constituting the main portion of the Franklin Avenue bridge will be the longest concrete arch bridge in the world. This span surpasses the Risorgimento Arch across the Tiber river at Rome by sixty-two feet. The record span of the Franklin Avenue bridge and its engineering achievement make it a noteworthy structure.

The main arch will consist of two separate ribs of 400 feet between the faces of the piers with a rise of 88 feet above the springing line. The two arches on each end, already completed, have a span of 199 feet and 55 feet 5 inches respectively, making a total length of 1011 feet 6½ inches between the shore abutments. The 400-foot span is necessary to give a channel clearance of 50 feet by 300 feet above the springing line elevation as required by the War Department for navigation purposes.

The geological conditions of the river bed at Franklin Avenue are typical of this section of the Mississippi river. Overlying the bed rock are huge boulders and a conglomerate of glacial deposit and limestone debris varying in depth from a few inches to a few feet. As the foundations for the new bridge are only 50 to 75 feet from the foundations for the old steel bridge, new shot-drill core borings were unnecessary. Sufficient holes were drilled at the time of laying the foundation for the steel bridge to determine the condition of the various strata, to make certain that the sandstone strata lay in its natural bed, and that there were no breaks or caverns beneath the top layer. The piers for the approaches are founded on solid limestone, and in a few instances on hard compact clay.

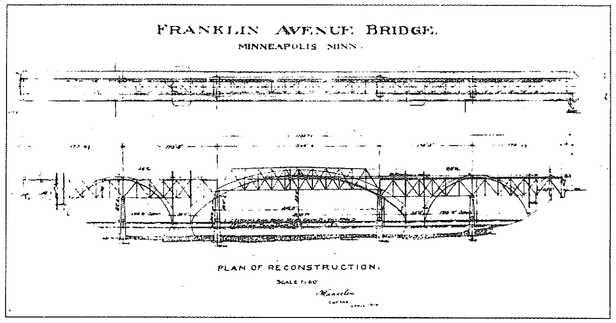
In July, 1919, the building of the cofferdam frames was begun about a half mile up the river from the bridge site, and when completed were floated into position. These frames were 80 feet up and down stream, and 64 feet wide, and divided into two compartments, 40 by 64 feet to facilitate handling. The 14-inch steel sheetpiling which surrounded the frames was driven through the conglomerate of gravel and the limestone debris into the underlaying sand rock. The boulders were removed from the foundation site before the cofferdam frames were in position, and to further expedite the work, excavation of the debris with a clamshell bucket was begun before the driving of the piling was completed. The forms for the piers, which measured 35 feet by 73 feet at the springing line and 64 feet by 80 feet at the base, were set in place after the cofferdam had been unwatered by three motor-driven centrifugal pumps. Although it was late in December before the forms were in place, the work of pouring the concrete was carried on regardless of the weather. This was accomplished by heating the water and the aggregate with steam coils, and the concrete in place by coke fires in salamanders. The temperature of the concrete mortar when poured into the forms was about 60 degrees fahrenheit.

Each rib of the main arch will be 12 feet wide with a radial thickness of 8 feet at the crown and 16 feet at the springing line, and will carry spandrel walls 14 feet 4¼ inches apart with concrete cross girders to support the concrete deck. The rib reinforcement frames for the main arch, five for each rib, will consist of 6x6x½ structural steel angles. Smaller angles were used for the arches already completed. Cantilever sidewalk beams overhanging 5 feet 3 inches cast with the spandrel walls, support the sidewalk. These beams typical in design to those of bridges of this type give a solid support and a most graceful effect. The floor slabs over the main arch will be continuous over four spandrel walls at the crown and over two spandrel walls at the abutments.

The floor slabs and girders under the trolley







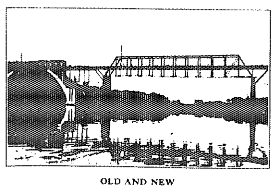

tracks are designed for 50-ton cars with 25 per cent. impact, and under the remainder of the roadway for 150 pounds per square foot, or an axle load of 40,000 pounds, with 25 per cent. impact.

For slab and girder design the permissible stresses in the concrete are 650 pounds per square inch for compression, and 16,000 pounds per square inch tension in the steel; for arches, 600 pounds per square inch for compression in the concrete which includes temperature stresses for a total range of 75 degrees fahrenheit. The sidewalks are designed for a load of 125 pounds per square foot.

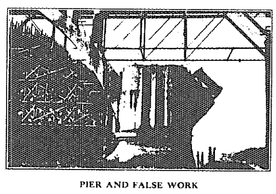
Each rib of the center span when complete will contain approximately 2,000 cubic yards of concrete, and each rib of the approach spans contain 1,450 cubic yards and 95 cubic yards respectfully. The 199-foot span was poured in three operations, each requiring about 10 to 12 hours. Each rib was divided into five sections. The crown section of the span was poured first, the haunches next, and last the key section completing the span.

The old steel bridge in place is being used for traffic as well as construction purposes. Its roadway is 18 feet wide, so that by removal of the sidewalks the concrete ribs which are 25 feet apart, clear the steel work, which will be removed when the main arch is completed. The floor for the 25-foot space will be cast in slabs and will be placed in position by a traveling crane from the completed floor over the arch ribs.

The concrete mixing plant is located along the C. M. & St. P. R. R. tracks about 2,000 feet from the east end of the bridge. Dump holes under the track allow all aggregate which is delivered in bottom-dump cars to flow into a hopper bin. Belt conveyors elevate it to the top of the storage bins, and dump onto a reversible carriage-mounted belt conveyor. This carriage can be moved to allow dumping into any bin. Just to the north of the storage bins, and at a height about the industrial railway system so the concrete can be dumped directly into bucket cars are located two one-yard motor-driven concrete mixers. The batch hoppers for these mixers are served by a belt conveyor



OLD AND NEW



PIER AND FALSE WORK

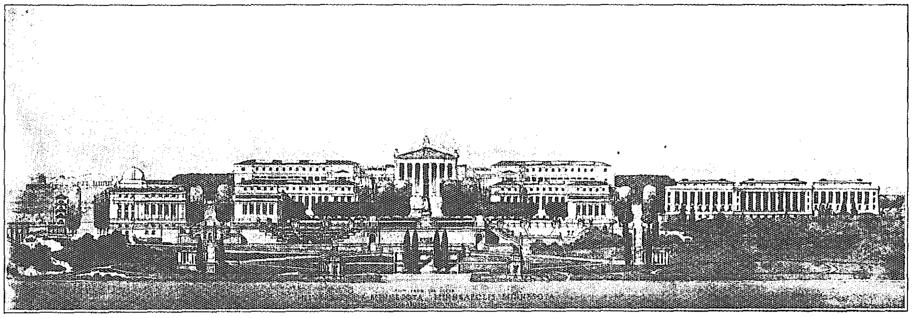
*These days nostalgia seems to be an over-used gimmick. However, after 54 years of continuous publication, the time seems appropriate for the* ***Minnesota Technolog*** *to pause and take a glance back at what has happened to I.T., the University and the Twin Cities over the years.*

*While most University based publishing ventures have not met with consistent success, such as the* ***Gopher, Ski-U-Mah, Random, Ivory Tower, Minnesota Loon,*** *and* ***One,*** *the* ***Technolog*** *and it's predecessors have been consistently well-accepted and supported by the I.T. community.*

*The first I.T. publication was the annual* ***Engineers Yearbook.*** *It ran from 1893 to 1908 when it was replaced by the* ***Minnesota Engineer.*** *A quarterly magazine, it published through 1915. After World War I the* ***Technolog*** *appeared with the first issue coming out in November, 1920. The* ***Technolog*** *has published continuously since that date with eight (sometimes nine) issues per year. The only other University publishing mainstay, the* ***Minnesota Daily,*** *has had to cease publication several times, due to financial problems and censorship battles, since it first appeared in 1900. In terms of continuity, this makes the* ***Technolog*** *the oldest publication in the University of Minnesota.*

*The nostalgia section, broken down into five categories, consists of reprints of past* ***Technologs.*** *While no means complete in itself, the nostalgia issue will be complimented by a display of other past* ***Technolog*** *articles. This display will be located outside the* ***Technolog*** *office, Room 2 Mechanical Engineering Building.*





ELEVATION FROM THE SOUTH

# OUR FUTURE MINNESOTA

**By Samuel Sutherland, '23**

Interest in higher education has so rapidly grown within the past half century that our great universities are finding it more and more difficult to cope with the situation and provide themselves with adequate buildings for the use of the students now on their rolls and the many more yet to come. Technical education, in particular, is being more earnestly sought after and has created a crying need for laboratories, drafting rooms, shops, and the like.

In the beginning, a few buildings, nondescript architecturally, and flung without rhyme or reason on the campus, was considered all that was necessary. But the conviction began to grow that this sort of thing would not do at all, and an absolute maze of buildings would result if an orderly plan was not adopted.

This was true of all universities save one—the University of Virginia. At its very start it had a plan for its future development drawn by the statesman-architect, Thomas Jefferson, in 1810. This plan was so broad and so well conceived that the fundamental scheme is still being followed to this day, being only slightly changed, due to new conditions, by the firm of McKim, Mead and White.

The rest of the great universities were not so fortunate. Yale, Harvard, and Columbia have all met, in common with all others, a great difficulty in providing physical plants for their students. The trustees, however, of nearly every college in the country have adopted a comprehensive scheme for their future enlargement. Columbia University now has one, so has New York University.

In a like manner, the Board of Regents of our own University, after falling into the same pitfall as the others, decided in 1909 to secure a plan for its development. No longer were the different schools and colleges to be placed helter-skelter about the knoll, but a broad, well defined scheme was to be adopted.

They therefore adopted a general program, and invited some of America's greatest architects to enter a competition which was to provide the University with a plan for the development of the forty-acre new campus, secured the year before. The winning plan was that suggested by Cass Gilbert, and, after the judgment, he was commissioned to work out the plan in detail.

The plan suggested by Mr. Gilbert took in the advantages afforded by the irregularities of the site and were as follows:

A formal grouping of semi-classical style buildings of brick and stone about a large mall. The mall consisting of two open courts, one north of Washington Ave., 275 feet wide and 1,300 feet long; the other south of Washington Ave., and about 500 feet square, and at a lower elevation. The larger was to be known as the North Court and the smaller as the South Court. In the old stone quarries in the bluffs along the river were to be placed a Greek theater and a Botanical Garden.

To the east and the west of this central mall were to be grouped smaller buildings on courts parallel to the main mall. At the head of the mall were to be placed an Academic hall, a Library, and a Museum. Rectangular buildings were to face on the North Court and L-shaped ones on the South Court. The Engineering group was allotted the east side of the larger court and also a smaller minor court east of Church Street. To the south of the Engineers were to be placed the Medical group with the Biological group, the Chemistry group, Astronomy and Geology west of Pleasant Ave.

In accordance with the scheme, Main Engineering, Experimental Engineering, Anatomy, Millard Hall and Elliott Memorial Hospital were built. Biology, which is one-half of one of the L-shaped buildings on the South Court, was built latest. Two of the

(Continued on Page 14)

## FUTURE MINNESOTA

(Continued from Page 9)

smaller laboratories on the west of the North Court were combined into the Chemistry Building, and the School of Mines was set on a minor axis north of Chemistry. These small changes did not radically change the original scheme.

Due to the unparalleled growth of the University since the adoption of the plan thirteen years ago, it has been found advisable, by Prof. Forsythe and his colleagues, to revise the scheme in order to utilize the ground area more efficiently and also to use the ground provided by the removal of the Northern Pacific tracks.

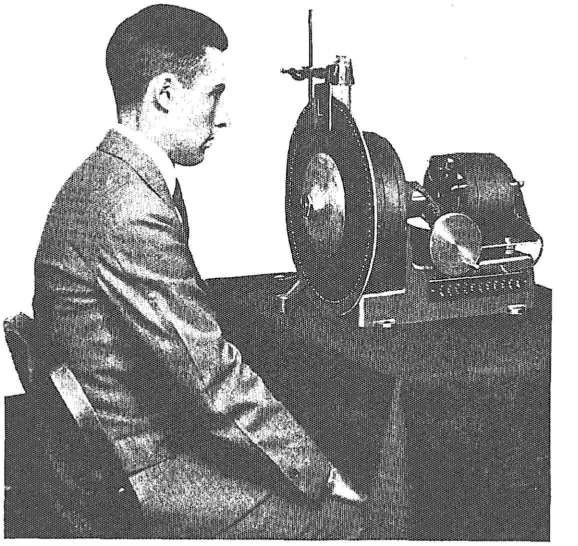
The plan as it now stands is to have at the head of the mall an Auditorium seating 7,000 people. The funds for this building are to be raised by private subscription or endowment. The library is to be just to the north of Chemistry and of equal size. Two buildings of this same size are to be set across the mall. These are as yet unassigned but one will probably be the Technology Building and the other Physics.

Four smaller buildings, two parallel to Washington Ave. (one of which will probably be the School of Architecture), and two flanking the Auditorium are yet to be built. At the extreme southern end of the mall will be placed the campinile, designed by Mr. Jefferson Hamilton, a University alumnae practising in Minneapolis, the sketch of which appears on the cover.

About the Engineering Court are to be erected two or three buildings to complete the rectangle. One of these will be the electrical building.

In order that the landscape effects will not be spoiled, the car tracks on Washington Ave. will be depressed.

Other changes in the plan will undoubtedly be found necessary, but the original conception of the University's needs was in such a broad and comprehensive spirit that eventually Minnesota will have a dignified and efficient campus.



ILLUSTRATIVE RECEIVING APPARATUS
FIGURE 5: A neon lamp illuminates a series of small apertures; as they pass the field of view the observer sees an image in the frame.

# Television

## *A description of methods and apparatus used by communication engineers in finally realizing dreams of "seeing at a distance"*

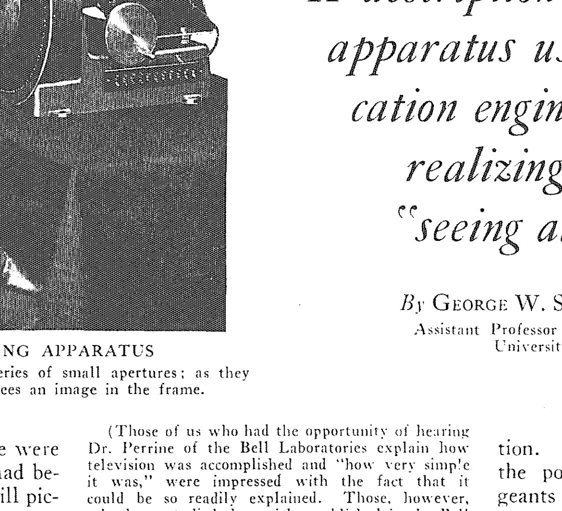
*By* GEORGE W. SWENSON, E '17, EE' 21
Assistant Professor of Electrical Engineering, University of Minnesota.

SOME five or six years ago we were startled by the news that it had become possible to transmit a still picture from New York to Chicago in a few minutes. To further substantiate the news item, the papers printed copies of such pictures on their front pages. They were not perfect photographs, by any means, but it was possible to distinguish the subject matter. Since then we have heard little about this new invention of picture transmission, but there has been slow and sure improvement in this art until now pictures sent in this way cannot be distinguished from an original print, except with a high power microscope. We are informed that this service is now available between New York and eight large cities in the United States and that it is sufficiently patronized by the public to make it self-supporting.

About a year ago we learned that it was now possible to sit in one's own home and in a few minutes converse with anyone in the British Isles who had a telephone; thus spanning the great Atlantic ocean and possibly thousands of miles of land. This new service is still in the experimental stage and certainly is not yet on a paying basis, but there is little doubt that it will be a commercially profitable venture before long.

Late in the spring of 1927, we were again startled by the announcement that apparatus had been developed and perfected to the point where it was possible for two persons, at Washington, D. C., and New York respectively, to hold conversation over a long line and at the same time see each other and observe each other's facial expressions. In the same demonstration television was also accomplished by radio from Whippany, New Jersey, to New York.

(Those of us who had the opportunity of hearing Dr. Perrine of the Bell Laboratories explain how television was accomplished and "how very simple it was," were impressed with the fact that it could be so readily explained. Those, however, who have studied the articles published in the Bell Journal on this subject appreciate how much money, energy, and perseverance were expended in solving the innumerable problems which presented themselves on every hand. Pictures are published through the courtesy of the American Telephone and Telegraph company.—AUTHOR.)

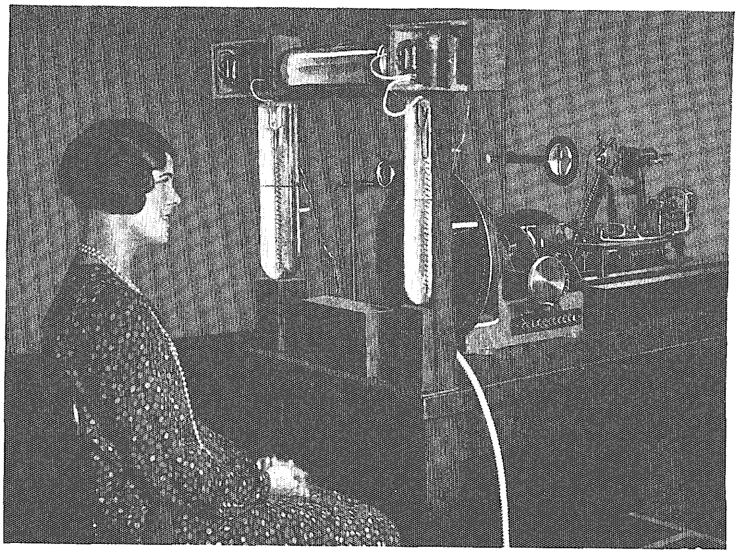


SCHEMATIC DRAWING OF TRANSMITTER
FIGURE 2: Light from a single source is projected as a moving spot on the subjects.

While research and development work toward the refinement and perfection of television will go on for years, enough has already been accomplished to show that it will, very probably, have a place in the field of distance communication. Just what the ultimate uses for television will be can only be left to the imagination. Whether it can ever advance to the point where athletic contests, pageants and other spectacles can be seen at great distances can only be suggested as possibilities until more is known and discovered about the various elements of television.

THE general principles underlying television are in no sense new. In other words, it has been known for a long time how television could be accomplished, but it was quite another thing to realize it practically. Some of the elements essential to success could not be developed before general science was further understood. We are, therefore, indebted to the Bell Laboratories for making such new discoveries as were necessary and for so coordinating the various phases of the problem as to make television so soon a reality. In his conversation with the President of the American Telephone and Telegraph company on the occasion of the first demonstration of the invention, Mr. Hoover said "We have long been familiar with the transmission of sound. Today we have, in a sense, the transmission of sight for the first time in the world's history. I am glad to welcome television as the latest product of scientific discovery. It promises that where the voice has led the way over the telephone wires, the eye will ultimately follow. Washington and New York are today not only within earshot of each other, but within sight as well."

An analogy may be drawn between television and telephony by which we may all better understand the principles. In a telephone conversation the sounds of the voice are made to actuate a diaphragm on the transmitter, which, when it vibrates, compresses and releases the pressure on the carbon particles in the carbon cup. This changes the current in the primary of an induction coil from a steady current to a pulsating one in accordance with the nature of the sound. The variation in air pressure or vibrations which we interpret as sound are then converted into variations of current which can be transmitted over a wire line or by radio. It is essential that the current variations follow faithfully the sound vibrations and that these current variations be transmitted over the line intact and that nothing be added to or subtracted from them in the transmission. In television, we wish to transmit variations in light, which can be done if we have some device that will change light intensity variations into current variations. In order to do this faithfully and without too much lag in action, the potassium hydride cell was chosen because it gives comparatively large current changes with changes in light intensity and returns quickly to its initial state when the agitation is removed. For greatest sensitivity with this cell, it was found necessary to make it large and to present a large area of photo-sensitive surface to receive the reflected light from the object. Fig. 1 shows the construction of one of the three cells which were used in the transmitting device. The ruler below shows that it is fourteen inches long and presents a sensitive area of forty square inches. These are the largest photo-electric cells that have ever been built.



ILLUSTRATIVE TRANSMITTING APPARATUS

FIGURE 3: Light from the arc is condensed on the disk which carries a spiral of pin holes. The light is then projected as a moving spot on the subject.

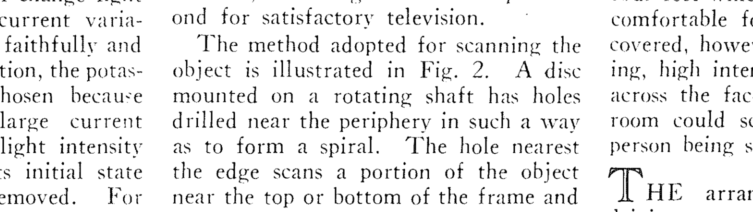
TO secure sufficient picture detail at the receiving end, it was decided to consider the picture as divided into 2,500 small areas or spots, each of which might have a different shade, or reflection coefficient. If the picture or subject were in a square frame, there would be fifty rows of fifty elements each. It was further found, that if a picture were repeated or interrupted at least 16 times per second on a screen, that the flicker was not objectionable and because of physiological and psychological effects, the observer was not conscious of the series of changes and repetitions, but simply saw the picture as a whole. We find from the above, therefore, that transmission systems must be capable of transmitting faithfully from 0 to 40,000 changes in current per second for satisfactory television.

The method adopted for scanning the object is illustrated in Fig. 2. A disc mounted on a rotating shaft has holes drilled near the periphery in such a way as to form a spiral. The hole nearest the edge scans a portion of the object near the top or bottom of the frame and the last hole, the opposite side of the object. The intervening holes cover the space between the two extremes. Since the view is divided into 50 such lines, there must be fifty holes in the disc. A very strong light is placed on one side of the disc and is focused through an optical system on the object at some point which represents one of the 2,500 parts into which the view is divided. What individual spot on the view is illuminated at any particular instant depends on which hole in the disc is in line with the light beam, and its position in the frame. The frame in front of the disc limits the size of the view to be scanned. As the disc makes one revolution, the light beam is thrown on all parts of the view in rapid succession and will give one complete picture. In order to allow for changes in position or facial expression of the object, it must be scanned at least 16 times per second and the disc must rotate at the rate of 16 revolutions per second or 960 r. p. m.

The above method of scanning was chosen because it was found that by placing the photo-electric cells near the object and on the opposite side of the disc from the light source, that sufficient reflection could be obtained from the rapidly moving spot of light to effect the proper change in the photo-electric cells necessary for sufficient current changes. It was found that if the photo-electric cell had been placed at the opposite end of the optical system from the object, that it would be necessary to illuminate the object with a light of 16,000 candlepower at a distance of four feet which would be extremely uncomfortable for a person. It was discovered, however, that the rapidly moving, high intensity spot of light passing across the face in a dark or semi-dark room could scarcely be noticed by the person being scanned.

THE arrangement of the disc and driving motor, the photo-electric cells, the arc lamp, the optical system and the subject being transmitted is shown in Fig. 3. It will be seen that the beam from the arc lamp is condensed to illuminate the area traversed by the moving holes within the frame. The holes, as they pass over the elements of the view in succession, throw this small spot of light on each of the elements. The reflection of light from each element in turn reacts on the photo-electric cells and causes whatever change in current is necessary to represent the relative brightness or shade of that particular spot.

After apparatus is available for changing light variations into current variations, these current variations can be transmitted over a pair of metallic conductors to the receiving station just as in a telephone conversation. The changes in current produced by the photo-electric cells are very feeble, however, and need a great amount of amplification.



LARGE PHOTOELECTRIC CELL

FIGURE 1: The cell presents 40 square inches of photo-sensitive surface to receive light reflected from a subject. There are three of these cells.

*The Miracle Drug*

# PENICILLIN

BY RALPH WHITE
CHEM. E., '47

**Because of the war a deep interest in the new drug penicillin, has been aroused, both among the public and in medical circles. Much is still unknown about this new discovery, and new uses are constantly being found for it that will lead to a more healthful postwar world.**

IN the history of modern medicine, certain events stand out as epoch-making. Pasteur's discovery of the germ, Paul Erlich's synthesis of the potent arsenicals used against social diseases, and the discovery and synthesis of the sulfonamides are notable among them. Now it appears that another event is destined to rank as even more important—the discovery of penicillin. There is a real romance behind this magic drug: its unique discovery, its difficult production, its strange properties, its amazing therapeutic values. Its future may prove to be the opening of an entirely new and unexplored realm of "miracle drugs."

Just fifteen years ago in St. Mary's Hospital in London, a hitherto unknown physician observed a phenomenom which foreshadowed a new era in the field of medicine. The man was Dr. Alexander Fleming, and the phenomenom occurred when some of the plates of staphylococcus colonies in his laboratory became contaminated with some mold—the common green type found on moldy bread and cheese. This was not an uncommon occurrence, but apparently Dr. Fleming was the first to notice a peculiar condition: the germ cultures around the spots of mold were obviously undergoing lysis, that is, they were being destroyed. The thought occurred to Dr. Fleming that if this mold, *Penicillium Notatum* by name, could kill staphlococcus germs on a culture plate, it might be effective against other bacteria—disease-causing bacteria. And so he performed a number of tests. He found that it was not the mold itself that affected the germs, but a yellow liquid which the mold produced. He named this potent liquid "penicillin." For his tests, he produced it by growing the mold on a meat-extract broth for six or seven days, and by then filtering it from the broth. The results of his experiments, which Dr. Fleming published in the *British Journal of Experimental Pathology* in 1929, indicated that he had discovered a number of penicillin's basic properties, and was aware of its terrific inhibitory effect on certain organisms.

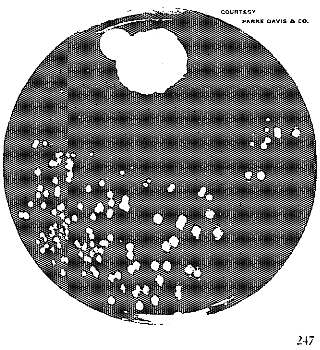
During the following decade, nothing spectacular was done in the way of research on penicillin. But in 1940, Dr. M. E. Florey and his group of "Oxford workers," under pressure of war needs, set about to re-investigate its possibilities. Not only did they succeed in formulating most of its properties, but they established a standard unit of assay, the Florey, or Oxford unit. (The Florey unit is that amount of penicillin which, when dissolved in 50 c.c. of meat-extract broth, just inhibits completely the test strain of staphyloccus aureus.) After testing the new drug on animals, they tried it in hundreds of clinical tests on patients. The results were so amazing that penicillin's reputation for incredible therapeutic power was almost immediately established.

Dr. Florey was greatly impressed by the results and saw the vast possibilities of such a powerful drug. So in the summer of 1941 he visited the United States and aroused such interest that, after a conference with members of the National Research Council and representatives of several pharmaceutical houses, plans were laid for the immediate production and clinical investigation of the drug. Today, studies are being carried out in the United States at the College of Physicians and Surgeons, N. Y., the Mayo Clinic, the University of Minnesota, the National Institute of Health, Evans Memorial Hospital at Boston, and almost all large pharmaceutical houses.

Production today has not been definitely standardized in either England or the United States. However, the present methods of production are all based on the same fundamentals. In order to get a maximum output of penicillin, a high potency strain of *Penicillium Notatum* mold must be selected for the "stock culture." To prevent a spontaneous loss of potency, an aqueous suspension of the mold spores is mixed with sterilized sand, and dried. This "soil-

**THIS IS a photo of the culture-plate on which the anti-bacterial action of penicillin was first noted by Alexander Fleming.**

COURTESY PARKE DAVIS & CO.







# Electric Refrigeration

*Quiet, simple, dependable units, automatic in operation, provide a "cold" degree of temperature at a cost lower than that of ice.*

By CARL M. GLADDEN, Ex '20
Servel Corporation, Minneapolis

PROBABLY one of the earliest methods of food preservation of which most of us have read is described in stories of early American lives wherein the heroine, the picture of domestic charm, is in the spring house. There the milk and eggs are kept cool by running water and the evaporation of moisture from the walls. Methods had to be evolved for the protection of food of the city dweller and merchant and food in transportation.

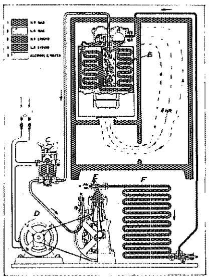
Refrigeration was a luxury limited to the very rich until the early part of the nineteenth century. It was in 1802 that the first delivery of ice was made in the United States, but ice was not available to city users in dependable quantities until 1895. This was brought about by the advent of mechanical refrigeration in a commercial way for ice making.

The most important consideration of refrigeration is the maintenance of temperature for proper food preservation. When this is accomplished food spoilage is eliminated and the health of the family protected from food poisonings. Spoiling and decay comes about by the growth of microbes which are commonly known as molds, yeasts and bacteria. At 50 deg. F. these multiply at a very rapid rate causing the decomposition of the food on which they feed. Electrical refrigerators will maintain temperatures from 40 deg. to 45 deg. F. which will practically stop the growth of these organisms.

A study of house temperatures revealed that not one cellar or room was below 55 deg. F. in the summer months. Likewise it was found that less than 35 per cent of the ice refrigerators in use would maintain temperatures below 50 deg. F. This means that there is a big field for electric refrigeration with its ideal temperature of 40 deg. to 45 deg. F.

The average refrigerator is but poorly insulated as shown by the above figures. The walls and doors should be insulated with 2 in. of solid cork board or its equivalent in heat resisting material. It is only with such insulations that electric equipment can effect efficient operation. A refrigerator designed to insure positive air circulation throughout, insures protection at all points. A recent report before the American Medical Society states that the majority of boxes in use are probably 15 per cent efficient, or 85 out of a 100 lbs. of ice is used to neutralize the heat which percolates through the walls.

Electrical refrigeration is based on the natural law that a liquid in changing into a gas absorbs heat. All liquids require heat to change them into vapor. The boiling point of different liquids varies greatly. Under atmospheric pressure water boils at 212 deg. F., alcohol at 173 deg. F., sulphur dioxide at 14 deg. F. and methyl chloride at —11 deg. F.



REFRIGERATION SYSTEM

This electric refrigerator which is described below, makes use of the heat absorbing quality and low boiling point of methyl chloride. Methyl in a gaseous state or in a liquified form is non-poisonous, non-corrosive, nor does it form injurious compounds with air or water. It was discovered by Dumas and Peligot in 1835 and has been in use as a refrigerant in France since then. Prior to the war the cost to import to this country was about $30 per lb. which made it prohibitive. But the Roessler and Hasslacher company has produced it in the United States from natural gas and chlorine at a nominal cost. About two and one-half pounds are used in a domestic machine.

When a liquid boils it must receive heat from a body of higher temperature. To boil water a source of heat with a temperature greater than 212 deg. F. must exist and a fire is necessary. To boil methyl the source need only be slightly higher than —11 deg. F. Under atmospheric pressure methyl can be liquified under moderate pressure.

In this refrigerator, the liquid methyl under pressure is admitted through the float valve (A) (see diagram of operation) to the expansion coils (B) which is placed in the ice compartment of the refrigerator. The coils in turn are immersed in an alcohol solution. As the liquid methyl changes to a gas inside these coils, heat is absorbed from the alcohol solution surrounding them, lowering its temperature and in turn the box temperature. As the heat is absorbed by the methyl the pressure becomes greater and the boiling point rises. When the pressure reaches a predetermined point, the piston of the pressure control switch (C) is raised, cutting in the switch and starting the ¼ h. p. motor (D) and at the same time allows the gas to pass through the parts in the base of the piston to the compressor (E). As the machine runs it draws this heat-laden gas out of the coils thereby reducing the pressure with a corresponding drop in temperature. When the pressure is reduced to the proper point the piston falls and the machine stops. The average running time is 6 to 7 hours. The gas coming from the refrigerator is condensed and sent on to the condenser coils (F) where the latent heat becomes apparent heat and is removed through the copper condenser coils by means of a fan and the methyl becomes a liquid again. This passes on up to the float chamber where it is admitted to the cooling coils through the needle valve, and the cycle is complete.

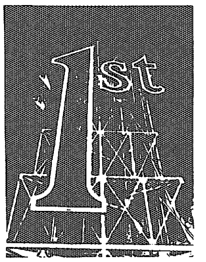
The machine is built to handle all requirements up to 80 cu. ft. of space. A larger water cooled machine operated by a ¾ h. p. motor is rated at 750 lbs. ice melting capacity (from and at 32 deg. F.) in 24 hours.

This and the other sizes will effect large economies over ice, which will cover interest and depreciation on the machine. On the larger machine the following figures show what may be expected.

| *Ice melted in 24 hrs.* | *Ice at 40 cts. cwt.* | *Hrs of machine operation* | *Energy cost at 4c per kwh* | *Saving each month over ice* |
|---|---|---|---|---|
| 250 lbs. | $1.00 | 8 | 0.32 | $20.40 |
| 300 | 1.20 | 9.5 | 0.38 | 24.60 |
| 350 | 1.40 | 11 | 0.44 | 28.80 |
| 400 | 1.60 | 13 | 0.52 | 32.40 |
| 450 | 1.80 | 14.5 | 0.58 | 36.60 |
| 500 | 2.00 | 16 | 0.64 | 40.80 |
| 550 | 2.20 | 17.5 | 0.70 | 45.00 |
| 600 | 2.40 | 19 | 0.76 | 49.20 |

Servicing is an item that should be carefully considered. The larger companies maintain service departments with regular inspection calls. This (*Continued on page 272*)





1st National Bank, St. Paul

## the modern

# Neon Sign

## —how it works

***Laddy Markus, electrical engineering Junior, has made the history, development, theory, and use of the neon sign the subject of a practical discussion. Neon, the ultra-modern in signs, has become the feature of our white-ways and its history is as interesting as the light itself.***

By LADDY MARKUS
EE '32

IT IS just twenty-three years since the first commercial neon sign was erected in America and only five years since the first neon installation was made in the Twin Cities, but today the gayly colored luminous tubes, representing the most advanced form of modern illumination, may be seen in every corner of the globe. The blazing slogans of the business world may be seen everywhere; in the great metropolises, in the tiny villages, and in the far-off corners of the Orient. Even gay Broadway, once known for thousands of twinkling electric lights, has turned to neon for colored signs.

The actual production of light by an electric discharge through a gas dates back to the beginning of the world for lightning is an electric discharge through the mixture of gases which make up the atmosphere. In the early days, however, little was known of the reasons for the flash of light and the accompanying crash of thunder, and many ancient civilizations regarded lightning as a supernatural phenomenon.

The northern lights, too, are a form of luminous discharge as static electricity, formed high above the earth through the influence of sun spots, discharges through the rarified atmosphere producing the twinkling luminous discharge so common in the far North.

It was not until the seventeenth century that man was able to duplicate, even in a small way, the glow discharge of nature. Jean Picard, a French scientist, used the ordinary barometric tube to obtain a luminous discharge. A high vacuum containing only a small quantity of mercury vapor was obtained by inverting a closed glass tube filled with mercury. A blue discharge through the mercury vapor was obtained when static electricity was produced by moving the mercury column up and down.

The invention of the Leyden jar in the eighteenth century made available for the first time the high voltages necessary for an electric discharge through a gas under low pressure. Perhaps Benjamin Franklin showed his friends the pink glow obtained in an evacuated flask when brought near a charged Leyden jar. He had only to rub a piece of sealing wax with cat's fur and touch the wax to the Leyden jar repeatedly to obtain the high voltage needed for the glow discharge.

In the nineteenth century many scientists were working on the problem of producing a more convenient light source than the arc light. In 1850, Heinrich Geissler began making gas-filled discharge tubes. His tubes were no larger than the little spectrum tubes so common in laboratories today and were then of little practical use.

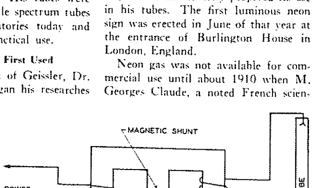
**Carbon Dioxide First Used**

Following the work of Geissler, Dr. McFarlane Moore began his researches with gaseous conductor lamps in 1891 finally developing into a carbon dioxide discharge tube which gave an illumination similar to daylight. This gas was first used in a script sign erected at the office of the New York World in 1904. Many other commercial installations were made in this country and Europe before rare gases were obtainable in commercial quantities.

The Moore tube consisted of a glass tube many feet in length and filled with carbon dioxide at a pressure of one-tenth of a millimeter of mercury. The high voltage necessary to operate the tube was obtained from an induction coil. Since carbon dioxide was not an inert gas, it had a tendency to combine with the electrodes and the tubing gradually decreasing the gas pressure in the tube. Additional apparatus was necessary for automatically admitting more gas into the tube as the pressure decreased. The light given off by the tube was entirely satisfactory while it lasted, but the auxiliary apparatus necessary was so complicated that the use of the light in the home was out of question.

With the isolation of neon gas in 1898 by Sir William Ramsay and M. Travers, Moore immediately proposed its use in his tubes. The first luminous neon sign was erected in June of that year at the entrance of Burlington House in London, England.

Neon gas was not available for commercial use until about 1910 when M. Georges Claude, a noted French scien-




—Courtesy Electrical Engineering.

**Schematic Diagram of Ordinary Neon Tube Installation**





# A Radio Controlled Car

*The radio controlled car which was one of the features of the recent electrical party, was designed and constructed by a group of senior electrical engineers.*

By W. H. GILLE, W. T. DEVOY AND C. A. JACOBSON
Electrical Engineering, '29

THE "car" itself was a bicycle with a "side car." The frame work for the side car was made mostly of ¾" angle iron and such material as could be obtained in the work shop of the Electrical Engineering building, and consisted of an upper and lower shelf. The lower shelf being used for batteries and the upper for the radio set and the relays.

The drive motor was a 12 volt Dodge motor-generator, borrowed, for the occasion, from the Northern Auto Electric company of St. Paul. The series fields were not used, armature connections being direct to the main brushes. The mechanical connection was made by reversing the two drive sprockets of the bicycle. The small sprocket was fastened to a large "V" belt pulley and the two as a unit mounted in the pedal shaft bearings. The motor was belted to this pulley by means of a round belt. The total reduction was about 15-1 which was found to be too high. A ratio of 30-1 would have been more nearly right.

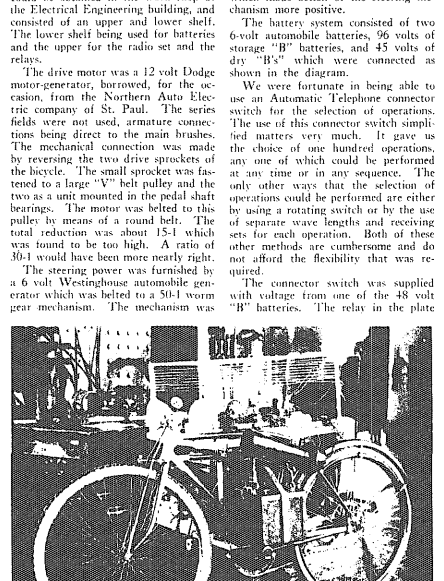
The steering power was furnished by a 6 volt Westinghouse automobile generator which was belted to a 50-1 worm gear mechanism. The mechanism was connected to the front wheels by means of two cranks and a connecting rod. The total reduction ratio was 150-1. This motor was connected to 12 volts which made action of the steering mechanism more positive.

The battery system consisted of two 6-volt automobile batteries, 96 volts of storage "B" batteries, and 45 volts of dry "B's" which were connected as shown in the diagram.

We were fortunate in being able to use an Automatic Telephone connector switch for the selection of operations. The use of this connector switch simplified matters very much. It gave us the choice of one hundred operations, any one of which could be performed at any time or in any sequence. The only other ways that the selection of operations could be performed are either by using a rotating switch or by the use of separate wave lengths and receiving sets for each operation. Both of these other methods are cumbersome and do not afford the flexibility that was required.

The connector switch was supplied with voltage from one of the 48 volt "B" batteries. The relay in the plate circuit of the last tube was connected in place of the regular telephone line and dial. The various operation circuits were completed through the connector switch brush which was connected through a set of points on the "E" relay to ground. The purpose of the "E" relay was to open the brush circuit while the brush was moving so as to prevent interference with any other circuit than the one selected. As the contacts on the switch would not stand more than ½ ampere, secondary relays had to be used in all the circuits. Automobile cut-outs with the current coils removed were used for most of these relays.

The radio connecting link was accomplished by means of a simple Hartly oscillator and a three tube receiving set. A UX 210 was used in the oscillator with 400 volts on the plate. The output was tuned to 180 meters. The impulses were sent out by a telephone dial in the plate supply, which in turn were picked up by a loop antenna and a three tube receiver, detector and two stages of audio amplification. The detector was made to oscillate by capacity feed back through two turns of the loop. The loop was wound horizontally around a frame fastened to the corners of the top shelf of the car. UX 201-A tubes were used in the detector and the first audio and a 112 in the last stage. Change in plate current in the 112 tube to operate the relay, was brought about by placing a grid leak and condenser in the grid circuit. The grid return was brought to the negative filament with no C bias. The value of the grid leak is very critical so a 100,000 ohm variable resistor was used with a .004MF condenser. The value of the condenser is not critical but if this resistance is too low the plate current change is not affected enough and if the resistance is too high, the relays become sluggish in their operation. 120 volts of "B" batteries was used on the detector and the 112, while 147 volts and 4½ volts of "C" were impressed on the first audio. This combination resulted in the dropping of the current through a 5000 ohm relay from ten milliamperes to two milliamperes when the oscillator was tuned to produce a beat note of about 1000 cycles in the detector tube. This change was ample to operate the relay as it was set to close on seven milliamperes and release on five milliamperes. The grid



THE RADIO CONTROLLED CAR

On the table to the left can be seen the oscillator which was used to direct the maneuvers of the car.


## LOOK! *Seat Covers* OF LUSTROUS *Plastic* FOR YOUR CAR!

THE NEWEST STYLE note in motor cars is seat covers of smooth, lustrous plastic—custom made and woven from the remarkable Dow plastic, SARAN. This innovation in car slip covers offers light, attractive pastel shades—or, perhaps, transparency to actually reveal tints of the upholstery—in every way lending new smartness and distinction to the car's interior.

Now, for the first time, seat covers in light colors are practical because SARAN is quickly and easily cleaned with just a damp cloth. There is no danger of the colors running. You can ride on these seat covers in wet bathing suits, if you like. If windows are left open, have no fear of damage from summer showers. For, SARAN is waterproof plastic.

There is plenty of ventilation with SARAN seat covers—they're cool! The smooth surface permits you to slide easily into modern low cars without difficulty or the slightest danger of catching clothes or hose. The value in these new seat covers is exceptional because SARAN will out-wear the life of the car.

While, currently, seat covers of SARAN are custom made only, they are significant of a marked trend. They provide a striking example of the constant efforts of manufacturers to adapt plastics to numerous new products.

DOW

CHEMICALS INDISPENSABLE TO INDUSTRY AND DEFENSE

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York City—St. Louis—Chicago—San Francisco—Los Angeles—Seattle—Houston

*Blouse Back*
SPORT JACKET
$12.95

*All Wool*
SLACKS
$5.95

*Clothiers — Tailors — Furnishers*

# JUSTER BROS

**On Sixth Street . . . Just Off Nicollet**



# NEARLY ½ MILLION HORSEPOWER!

The Northern States Power Company's 23 steam and 26 hydro-electric stations today have a total generating capacity of 442,000 horsepower.

With the recent completion of the giant hydro plant at Chippewa Falls, an additional 29,000 horsepower is now available.

These 49 mighty power sources never cease working, day and night, to supply the electric light and power needs of you and the other million and a half residents of the territory this company serves.




The Outward Sign of Inward Security

## You Don't Mind Reciting When You've Got the "Dope"

WE have that same feeling of security since we have installed the McClintock Burglar Alarm.

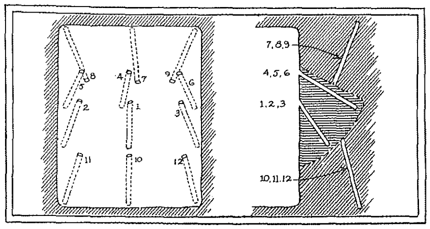
The system operates by the new Sound Wave method, which will defeat, without exception, any attempt to cut cables or wires, or to drill through our vault linings or doors.

Come in and let us show you what we have done to give your valuables 100% protection.

UNIVERSITY STATE BANK
WASHINGTON AVENUE S. E. AND OAK STREET



## Choice of Explosives for Ore Mining




LESSON NUMBER TWELVE

## BLASTERS' HANDBOOK

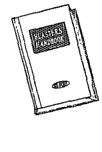
IN ore mining, the selection and use of explosives becomes nothing less than a fine art. Every formation of ore and rock requires a different explosive. Drilling and loading methods must be correctly performed to ensure satisfactory results.

For instance, what explosive would you use where moisture is present in excessive quantities, which explosive to produce the least obnoxious fumes, which dynamite to use below or above ground, which kind for soft or for hard rock? How can you choose explosives to reduce the hazard of igniting gas and dust mixtures?

*Some day you'll need this information*

You may need to know the answer immediately. Textbooks—even the best—do not contain this vitally important data. During the last 125 years du Pont has been making and testing explosives for every type of blasting operations. These tests have been applied to all industries where explosives were essential.

This coupon will bring you a copy of the Blasters' Handbook without any cost. It's a reference book for explosives' users. Some of the largest engineering colleges use the Blasters' Handbook in their engineering classes. You need it today and you'll need it even more when you're out in the field.




*Mail the coupon for your copy NOW*


More aluminum up there, less in new telephones
—for victory!
Many materials used in telephone making are listed as "critical" for war purposes. Bell Telephone Laboratories and Western Electric have redesigned apparatus and changed manufacturing methods to employ available materials.
Take aluminum. The reduction in its use in a year's telephone output is enough to build 294 combat planes. This program has been replacing critical materials at an annual rate of 7,747,000 pounds. Though it grows steadily more difficult to maintain as shortages increase, the program helps to meet the greatest demand in history for military and civilian communication equipment.
"THOSE PLANES WILL HELP DADDY LICK 'EM!"
Western Electric
. . . is back of your Bell Telephone service

# RED SCARE

# No Need to Worry

*Liberty means responsibility; that is why most men dread it.*—**George Bernard Shaw**

Some people may not accept the belief that the **Technolog**, like literature and the arts, reflects the spirit of the times. Perhaps the **Technolog** does qualify as literature but even if it does not, the times are indeed accurately reflected in the pages. The 1920's building boom and the spirit of adventure in invention is present. The gloom of the 1930's is evident both in the overall size of and lack of technical reporting in the magazine. The war years were reflected by such ads as the Western Electric ad which graces page 15. Shown here is the McCarthy period.

These two pages, clipped from the 1950-51 **Technolog**, embody the disease that swept up Americans in an epidemic which dominated the 1948 to 1954 period. This ailment, in the form of a fever, produced symptoms of hysteria with the victim hallucinating that there was a communist under his bed. The repercussions of this "red scare" are still felt to this day.

While the editorial and advertisment may appear ridiculous today, it should be remembered that they were taken very seriously only 20 years ago by many serious and frightened Americans. With that realization in mind, maybe there really is a need to worry.

NO NEED to worry. It'll never reach America. Let the next generation worry about Communism.

That is what most people would like to think. But the danger is far more imminent than that. Did you realize that:

- Communism is infiltrating the entire world, not only the much-publicized areas. Witness the testimony of a missionary from deepest, dark Africa, who states that already the approach of communism is evident, heralded by strikes and riots. His days in that area are numbered—maybe only two years, maybe even less—before the godless communism will certainly take over and drive religion out.
- A columnist visiting behind the iron curtain reports that children, both boys and girls, are serving as "volunteers" in labor four months out of the year—volunteer labor camps that are surrounded by barbed wire and guards armed with machine guns. The service was labeled "voluntary"—if they don't volunteer, they lose their food and clothing privileges. This sounds like an echo from Germany, where the youths were similarly organized and taught they were supermen, and where one youth was proud of the fact that he had turned his father in for some anti-German activities —his father received the death sentence. This same pattern of poisoning the minds of the youths is being followed in Russia.
- The trial of communists by Judge Medina in New York city, harassed at every turn by the communists, follows the instructions set up by the communist workers' manual, which states that workers, upon arrest, should give only their names and nothing else. They should always plead not guilty, demand a "working class" jury, and fill the courtroom with hecklers. In short, they are to do everything possible to hinder the courts in carrying out justice.
- Communist youth work has been going on in our own country for many years. A good example is a young man whose parents came from Greece. A number of years ago he joined a group of other young Greeks in New York city—a group supposedly dedicated to the fight against fascism. A talk with him revealed that he had been thoroughly saturated with communism and was an ardent advocate of it. And there are similar organizations, such as the now-extinct American Youth Congress and the American Youth for Democracy. Many of these organizations seize upon any unrest or conflict—to promote the communist aims under a deceptive guise.

What is to be done? We should make it a point to see that our schools give proper guidance to youth—guidance, not just information. We need to be better informed, not only as to the advantages of each type of economy, but also as to the disadvantages. Anyone who realizes fully just what communism is and will do to his freedom of speech and religion and the other freedoms will certainly want to keep our present system. We all realize our system has certain faults, but we should correct these faults rather than throw the whole system out.

We as college students owe it to ourselves and our country to be well-informed on communism and its perils, particularly since a great number of us will some day be in a position to influence many people. Get the facts. Then follow the advice of the radio program that supplied some of the above facts, and "Americans, Speak Up!"

*R. A. H.*

THE MINNESOTA TECHNOLOG, *October, 1950*

# "That's right.... *church closed*"

"No, this didn't happen in a communist country.

"Happened right here in town. We'd just gotten home from a motor trip and, of course, hadn't heard what happened.

"Been going to that church about fifteen years, so what a shock it was when Officer Povey stopped us at the door. *'That's right,'* he told us, *'I said church closed!'*

*"Then* he explained. There'd been a fire in the church the day before and he was shooing folks over to the Guild Hall for services. Mary and I looked at each other . . . then grinned. We'd *both* had the same crazy idea that the State had taken over the churches.

"That night Bill and Edna Johnson dropped in for TV. We told them what happened at the church. And about the crazy idea we had. But Bill asked, *was* it so crazy? Then he pointed out that it *had* happened in other countries. So we all got talking real serious.

"All week I've had it on my mind . . . *suppose we had no Freedom here?* Suppose the State took over religion, the press and professions like music, medicine and art? Suppose they took over industry and made me work where I didn't want to? Suppose the State took over our house? And suppose, on election day, we had our choice of *one* candidate?

"Maybe I don't run my life perfectly but I sure wouldn't want the State to run it for me! Y'know, every Thanksgiving we give thanks for the good things we have . . . all of which add up to Freedom. *So why shouldn't we all be just as thankful the* other *364 days, too?"*

# REPUBLIC STEEL

**Republic Building, Cleveland 1, Ohio**

***Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free . . .*** an America whose vast Agricultural Industry is unsurpassed. *And through Agriculture, Republic serves America.* Republic produces quality steels for *all* industries and much of it can be found in thousands of agricultural tools and equipment for field, pasture and farmstead. Thus, Republic works with the farmer to help keep America the best fed nation on earth.

* * *

*For a full color reprint of this advertisement, write Republic Steel, Cleveland 1, Ohio*

THE MINNESOTA TECHNOLOG, *April, 1951*


*The distinctive nature of **Technolog** humor was quickly established.*

*In the first issue of the **Technolog**, November 1920, Dean L.D. Coffman wrote "I congratulate the engineering students upon the publication of the **Minnesota Technolog**. It is encouraging to know that the students of a professional school, in association with members of the faculty, are willing to devote themselves to the publication of a dignified, strictly scientific journal." As if in direct response to those noble words, the very next issue of the **Technolog**, December 1920, contained a cartoon that was so racist and in such bad taste that it defies description, let alone publication. From that point on, the '**Log** kept on rolling.*

*The **Technolog** pin-up became an I.T. tradition in the late 1940's. During the early 1950's the **Technolog** staff was continually criticized by the administration for the crude jokes and "leggy" pin-up shots that the magazine published.*

*Here with our pin-up queen is a collection of **Technolog** jokes as they appeared and re-appeared, through the years. Current I.T. people who have long memories will remember similar **Technolog** features, **Logs Log** and **Splinters**, which ran up to two years ago. They are not included here primarily because most of the jokes they used were stolen from older, previously published jokes which were, in turn, stolen from older, previously published jokes which were, in turn, . . . . Anyway, a glance at the humor on these two pages should give the reader the main impression why this type of feature has been excluded from the 1973-74 **Technolog**.*

*A fellow was trying to start a conversation with the young lady who sat next to him at the table. "Do you like Kipling?" he asked.*

*The young lady giggled and then replied, "I don't know. How do you kipple?"*

Leroy Brooks was assigned the job of writing up his senior class play in the high school paper. He came in for his share of literary fame when this write-up was published:

"The auditorium was filled with expectant mothers, eagerly awaiting the appearance of their offspring."

**Engineer: "She's a nicely reared girl, isn't she?"**

**Physicist: "Not bad from the front either."**

**The doctor was questioning the nurse about her patient. "Have you kept a chart on his progress?" he asked.**

**"No," she said blushingly, "but I can show you my diary."**

A lovely co-ed named Loretta
Loved wearing a very tight sweater.
Three reasons she had:
Keeping warm wasn't bad,
But the other two reasons were better.

**Some girls may have to answer a lot of questions when applying for a job, but it is really a matter of form.**

Stalin: Tell me, comrade, what was the first thing you did when you came back home after four years of war.

Ski Trooper: Well, sir, I hadn't seen my wife in four years and . . . you know how it is.

Stalin: Er, yes, but tell me, what was the second thing you did.

Trooper: Took off my skis.

One reason why some girls are called radio flappers is because they are so easy to pick up.

Customer: Waiter, there's a piece of wood in this hot dog.

Waiter: Yes, sir, but I'm sure—

Customer: Sure, nothing! I don't mind eating the dog, but I'll be hanged if I'm going to eat the kennel, too!

She was only a shoemaker's daughter, but she knew all the heels.

*Teacher: David, what does F-E-E-T spell?*

*David: I don't think I know.*

*Teacher: Well, what is it that a cow has four of and I have only two?*

*The class was dismissed.*

## YE SHOE - HORN

By OSCAR QUACKENBUSH FEGAS, B.V.D. '111

# man! dig these crazy jokes

At the funeral of a real "cool" musician, well attended by his friends, the minister said in closing, "Spike is not dead. He only sleeps."

One of his friends cried out, "Sleeps? Man, I'll lay two to one he don't wake up."

Two bopsters looking at the Ford Dam. One says to other: "Man, those crazy beavers!"

Two bopsters are at the fair. One sees a ferris wheel and says to other: "Man, dig that crazy streetcar!"

Davenport Chess—She moves into his arms and then neither moves for several hours.

**The ship was sinking and the captain called all hands aft. "Who among you can pray?" he asked.**
**"I can," replied an ensign.**
**"The rest of you men put on life jackets, then," ordered the captain. "We're one short."**

First Architect: "Jackson fell off his stool with a quart of beer."
Second Architect: "Did he spill any?"
First Architect: 'No, he managed to keep his mouth shut."

"Up and atom," cried the molecule.

*And of course you've heard of the clothing manufacturer who put out a two-way suit for people who don't know whether they're coming or going.*

Pro: "No, use your brassie"
Fair Golfer: "But I don't wear any in this hot weather."

If a girl expects to win a husband, she ought to exhibit a generous nature—or how generous nature has been to her.

She to Bob Giantvalley: Who was that lady I saw you outwit last night?

*Mae: "Don's always been a perfect gentlemen with me."*
*Nena: "He bores me, too."*

*A young woman tourist was spending the night in a Texas hotel. She was asking the clerk for sights to see of unusual interest.*
*"Well," said the clerk, "we have the only helium plant in the world."*
*"How wonderful. Is it in bloom now?"*

Our nomination for the most popular Saturday evening sport is, "Ring around the bathtub."

And then there was the attorney who sat up all night trying to break a widow's will.

A man was suffering from laryngitis and as a result he could hardly speak above a whisper. He wasn't too sick, but not being able to talk was a nuisance, so he went to a druggist and said, in a whisper, "Can you give me something for my laryngitis?"
The druggist, a good one, said, "I don't recommend without a doctor's prescription. There's a new doctor a couple of doors down. Why don't you go see him?"
The man went to the doctor's house and rang the bell. In a minute, the doctor's attractive maid opened the door. The man with laryngitis whispered hoarsely, "Is the doctor home?"
The maid whispered right back, "No, come on in."

**The Tridelt, excited about having been pinned by a fraternity man the night before, dressed hurriedly and was walking towards the cathedral when she came upon a group of male friends bound for State Hall. Stopping in front of them, the girl proudly thrust out her chest and commanded happily, "Look!"**
**But in the excitement, she had forgotten to wear the pin.**

# *Introducing:*

# Dean Spilhaus

**Minnesota engineers greet new dean**

**by SID LEVIN**

Dr. Athelstan F. Spilhaus

THE U. S. Navy made extensive use of the bathythermograph during World War II. This weird-sounding instrument was invented by Dr. Athelstan F. Spilhaus, the new dean of I.T., and was used in connection with sonic detection of submarines.

Now, at 37, Spilhaus has turned his talents from inventions to education, and is one of the youngest men to head a technical school on campus. This short, stocky, thin-haired, very jovial man who speaks with a slight English accent assumed his new duties on Jan. 1.

Born at Rondebosch, near Cape Town, Union of South Africa, he attended Rondebosch Boys' high school and Berkhampstead (a prep school), in England. Spilhaus returned to South Africa in 1924, and entered the University of Cape Town three years later. Between courses in mechanical engineering at the University of Cape Town, he worked as an engineer at sea—first on the Indian-African line between African ports and Indian and Burmese ports. Subsequently he worked as an engineer on the Deutsch Ost Afrika line between African and European ports.

After a year, Spilhaus left Junkers and toured continental Europe by bicycle. He then went to England and finally he came to the U. S. He did graduate work in aeronautics at the Massachusetts Institute of Technology, receiving his Master's degree in aeronautical engineering in 1932. His thesis for this degree led to an appointment as research engineer with the Sperry Gyroscope company, Brooklyn, N. Y.

A scholarship enabled Spilhaus to return to M.I.T. for further advance study in the field of meteorology. Successful to a high degree, Spilhaus' philosophy was, "Be a success first, then talk about it."

Having already done a year's work (1935-1936) in meteorology as a lieutenant in the Union of South Africa Defense forces, Spilhaus began training meteorologists for the U. S. Army Air forces and the Navy. By this time Spilhaus was one of the outstanding men in the field of meteorology, and he served on various civilian committees as meteorological consultant to the Army Air forces. This was during the early days of the war.

Although still a British subject, Spilhaus couldn't stay out of the war. He had been doing a great job as civilian consultant, but in spite of all this in 1943 he entered the U. S. Army as a captain. He was stationed at the Signal Corps laboratories in New Jersey for the purpose of coordinating the research and development of all meteorological equipment for the air forces.

Spilhaus served in Alaska which "stood me in good stead for getting used to the cold Minnesota winter." He also served in Europe where he studied allied and enemy equipment, and North China where he came in daily contact with the Chinese Communist forces. He went off active duty in 1946 with the rank of lieutenant-colonel. That same year he became a U. S. citizen.

Spilhaus was very pleased with his appointment at the University of Minnesota. "One of the factors influencing me to accept the position at Minnesota was the closely-knit educational system here," he says. This ties in very neatly with his idea that "travel and varying interests are of great educational value."

At the present time Dean Spilhaus is living alone at the Continuation center. His wife and five children are still in the East where the children are attending school. They will arrive here at the end of the school year.

Dean Spilhaus has left for New Zealand as one of two representatives of the U. S. to the Seventh Pacific Scientific Congress of the National Research council. This congress ordinarily meets every three years, but this is the first time it has met since 1939 because of the war. The dean says, "Although I have not been in Minnesota very long, I shall miss it. I heartily await my return."





# DR. HENRY T. EDDY

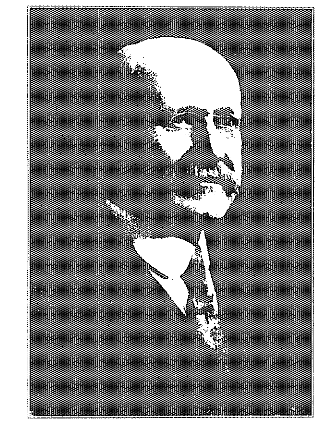
**By President Cyrus Northrup**

It is difficult, in a brief address, to do justice to the character and achievements of our distinguished friend, Dr. Henry T. Eddy. It is impossible to enumerate his various contributions to Science or to analyze minutely the nature and extent of his influence upon the scholarship of the Country. I can only outline in a general way some of the most important characteristics of his life, leaving it for you who have known him well for many years to fill in the picture.

My acquaintance with Henry T. Eddy began in 1863 when we entered the Freshman Class in Yale College. I knew him very well throughout his College Course of four years. He graduated in 1867. Among his classmates were Rev. Dr. David J. Burrall, at one time pastor of Westminster Church in this city; Bishop Boyd Vincent, Episcopal Bishop of Southern Ohio, and two United States Senators, Newland of Nevada and Wetmore of Rhode Island. As a student in College, young Eddy was from the first distinguished as a mathematician and if there were any mathematical prizes to be awarded he was pretty sure to receive them. He won several, including the highest prize of the Senior year. After graduating at Yale, he entered the Sheffield Scientific School and took the course in engineering. After completing his work in New Haven, he was for a time instructor in Latin and Mathematics in the University of Tennessee, then was assistant professor in Mathematics and Civil Engineering in Cornell University; then Adjunct Professor of Mathematics at Princeton; then first professor of Astronomy, Mathematics and Civil Engineering in the new University of Cincinnati, and then he became president of Rose Polytechnic Institute. In the meantime, when granted a leave of absence, he had pursued his studies both in Berlin and in Paris. He was indefatigable in his pursuit of knowledge.

Upon his retiring from the presidency of the Rose Polytechnic Institute, the opportunity came to secure him for Minnesota. I take credit to myself for his coming. It seemed to me that we had the chance to secure a great man for the University and we did secure him. He came to the University in 1894 as professor of Engineering and Mechanics. He was afterwards made Dean of the Graduate School and continued in that position until he reached the age for retirement. His years in the University were filled with original investigations, the preparation of scientific treaties, and instruction of classes in the higher mathematics. His reputation grew as the years passed on, and one Commencement Day in New Haven I had the pleasure to see and hear the President of Yale confer on him the degree of Doctor of Science. He had previously received the degree of Doctor of Laws from Center College.

Dr. Eddy was born in Massachusetts, but of Connecticut ancestry. His father, a member of the Yale Class of 1832, was first a Congregational Clergyman and later a physician and inventor. His mother was a graduate of Mt. Holyoke Seminary and for some years a teacher of Mathematics in that institution. There are some parts of the country where Congregational Churches do not exist, and



DR. HENRY T. EDDY

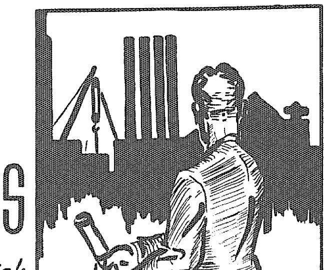
members of Congregational Churches who have taken up their abode in such district usually join a church of some other denomination, as they ought to. Dr. Eddy, though originally a Congregationalist, with a long line of Congregational ancestors, had lived in the Middle West where there was no Congregational Church, and in consequence he had joined the local Presbyterian Church. But in coming to Minnesota he and Mrs. Eddy became members of the First Congregational Church, and from that time till their death they were both active and influential members of the church. They were both deeply interested in Missions, foreign and home. Dr. Eddy was president of the First Congregational Society of St. Anthony and his name is signed to the pending call for the Annual Meeting, December 27th. He had been a deacon of the Church; and the Church's representative on numerous councils and associated charitable and religious conferences. If there was anything which needed to be done, Dr. Eddy could always be relied on to help. He was wise in council and efficient in service.

And when we come closer to him and cease to think of abstruse mathematics and church offices and college degrees, and look at him as a man, we see that he was a learned man, a distinguished man, but above all, a good man—a modest Christian gentleman. Can anything better really be said of any man? Men who die drop everything they **have.** But they do not drop what they **are.**



# JOBS FOR ENGINEERS

## *1941 Placement Hits New High*




BY

PROF. A. S. LEVENS*
DIRECTOR INSTITUTE PLACEMENT SERVICE

PLACEMENT Service of the Institute of Technology experienced its biggest year since 1931, when the Service was first established. One hundred thirty-eight companies sent representatives to interview our students. Last year we had 103 and our previous peak occurred in 1937 when 61 representatives visited our campus. Thirty-three companies visited for the first time.

Practically all of our graduates were placed shortly before graduation. With the exception of a very few, the rest were taken care of during the summer months. In several fields the demand far exceeded the supply. This was particularly true in aeronautical, mechanical, civil, and metallurgical engineering. We experienced a much greater demand for chemists and electricals than we had in the past few years. Our five-year combination group was oversubscribed. Many industries seem to feel that the combination of business administration and some branch of engineering gives our men excellent preparation for technological work.

### Salaries Up

There has been a definite upgrading of salaries this year. We have noted several cases where the companies had made commitments early in the year at rates of pay which were then reasonable and later sent in new schedules at higher rates. Beginning salaries for men with bachelor degrees this year averaged \$145 per month, with a range from \$125 to \$183.50. In many cases our graduates will earn considerably more because of opportunities to work overtime. We know of several instances where our men are adding approximately one-third to their base pay each month as a result of overtime. There was an increased demand for juniors also, and many were placed as a result. A considerable number of them were offered salaries ranging from \$100 to \$135 per month. Several companies were also willing to employ a few of our sophomores.

### Draft No Problem

During the early part of the year we experienced difficulty in placing those men who had low draft numbers or who were in the four-year R.O.T.C. training. However, during the latter months of the school year action was taken by Dean Lind and a University committee to bring the attention of draft boards to the urgent need for technically trained men and the necessity for deferments. In fact, deferments have been obtained for most of the juniors and seniors so that they could return to school this fall. There is little doubt that the demand for technically trained men will continue next year. While it is relatively easy to place our men, may I point out that most of you will experience the keenest type of competition *after* you are on the job. Not many of you realize that when the defense program has been completed there is likely to be a curtailment in the number employed and consequently only those who have made outstanding records will be retained. Frankly, I would urge all of you to do your utmost to make good on your first job. It is not very pleasant to be out of work, and I hope that many of you will not have to experience the trials that a great many of our alumni experienced during the period between 1932 and 1936.

May I point out that it will rest upon engineers and scientists to develop many new products for consumer use in order to maintain a high rate of employment. It will be up to the young engineer to apply his training and ingenuity toward the development of a flow of usable goods which will necessitate the retention of the large number who are employed at this time. I cannot help but feel that a most vital challenge to the engineer presents itself today, a challenge to synchronize the work of the engineer with a better life in America and possibly over the entire world. Let us make an effort to direct our energies toward peace-time activity and let us give thought to these problems today while we are embroiled in activities which demand the use of "all-out" energy.

### A Word of Advice

It is my hope that you will locate good positions upon graduation. Don't forget to order your personnel sheets. And remember the engineering library has pamphlets which describe the work of several hundred industries. Learn as much as you can about the companies in which you are interested long before the representative visits the campus.

At the present time I am enjoying my work at the University of California, Berkeley, California. I will be thinking of you when dear old Minnesota gets down to the —10° to —30° range.

If any of you visit Berkeley, come in and say "Hello." Best wishes to all for a successful year.

*On leave 1941-1942.



# LET'S LOOK AT THE ENGINEER

## *A Technolog Survey*

BY ED KNIGHT, Aero. E., '43, AND DONALD BAER, Ch.E.B., '44

DO you think you work hard? The results of the first of the TECHNOLOG's new series prove it.

Tabulation of 543 questionnaires, representing about one-fourth of the Institute of Technology enrollment, and what we believe covers a typical cross section of the engineering student body, revealed that the average Technology student earns slightly better than 60 per cent of the total cost of his college education through employment during the summer and during the school year.

Over 54 per cent of the future engineers earn over one-half of their college expenses, while 33 per cent earn all of their expenses. Only 12 per cent of the Tech students earn no part of their college costs at all.

Referring to the figure below we see that the freshman earns a higher percentage of his expenses at college than his upperclass brethren, possibly due to the fact that he is able to allot more time to outside employment than upperclassmen. The average number of hours worked each week by students working during the school year is 19 hours.

A job keeps the average engineer busy 19 hours a week.

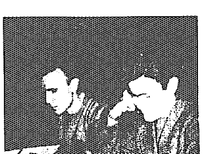
Of the total number of students in the Institute of Technology, 57 per cent are employed during the regular school year in addition to carrying an average of 16 credits of classroom work. Figure 1 below shows that the freshman class has the greatest percentage of its members represented in jobs during the school year, while the upper classes lag a little behind.

Students in the junior class hold the most lucrative positions commanding the highest hourly wage of the working students in the Institute. The sophomores hold the next best paying jobs and the freshmen earn the least per hour of work. Average hourly wage for the whole Institute of Technology is 45 cents an hour.

Figure 1 shows that the sophomore's average weekly wage is somewhat higher than that of his fellow engineers, while the juniors run a close second and the freshmen again bring up the rear. The 543 questionnaires that were returned show that during the regular school term the weekly earnings of the students were more than \$2,400.

Employment during the school year does not seem to affect the scholarly ambitions of the engineering students; there is a difference of only one-half a credit in the scholastic load carried by the working and non-working students. Working students carry an average of 16 credits while students who do not work during the school year carry an academic load of 16.5 credits.

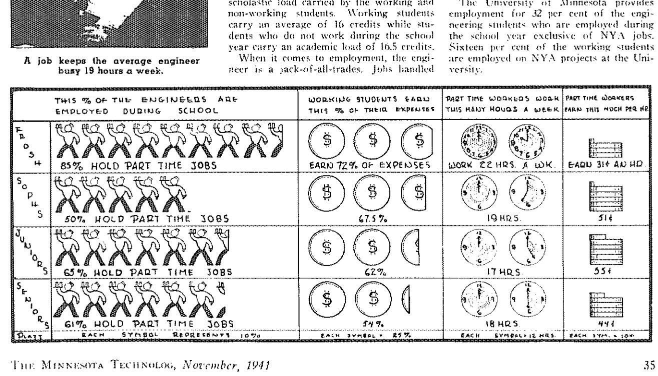
When it comes to employment, the engineer is a jack-of-all-trades. Jobs handled



Average engineer carries 16 credits.

by Tech students during the school year cover a wide range of every conceivable type from bar-tending to teaching piano, including playing in swing bands, mopping floors, and selling those well known brushes. Only 17 per cent of the engineering students who work during the school year are fortunate enough to find employment in jobs having a connection with their field of classroom study. These jobs include assisting in the various laboratories on the campus, inspection work in factories, drafting, and various other technical positions.

The University of Minnesota provides employment for 32 per cent of the engineering students who are employed during the school year exclusive of NYA jobs. Sixteen per cent of the working students are employed on NYA projects at the University.



# FROSH

*What makes an engineer? Who the hell knows.*

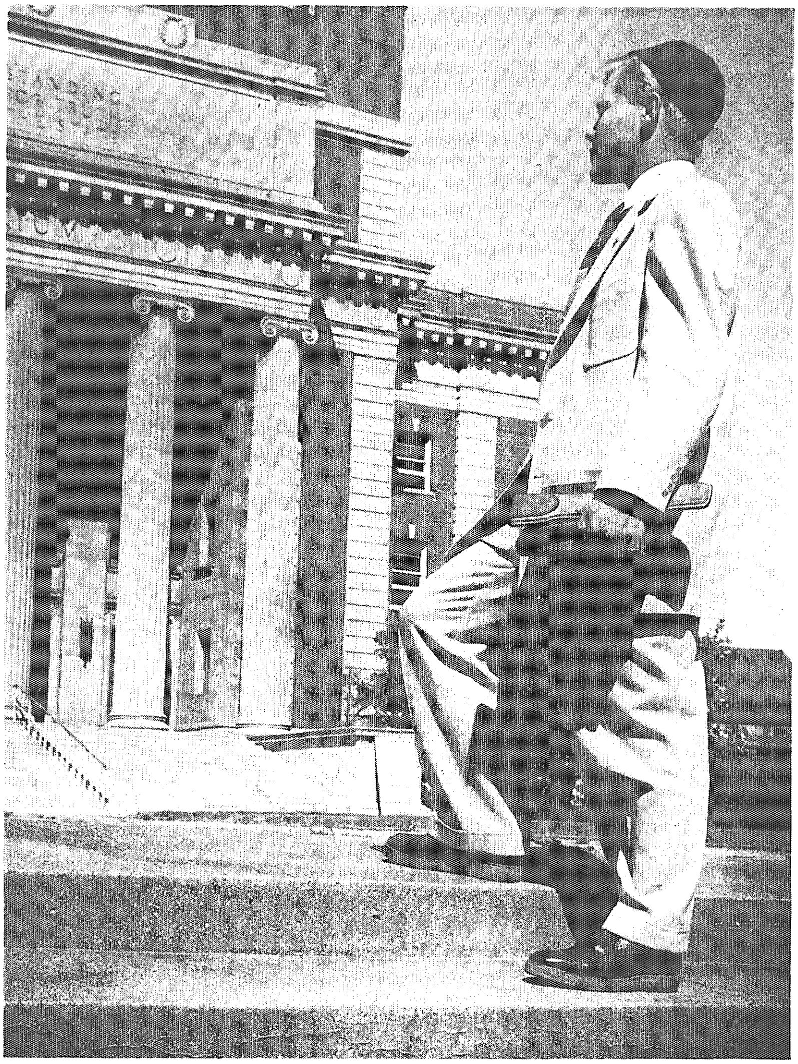
*Over the years the engineer has undergone a lot of changes. In 1923 the Engineers Yell went like this;* ***Screws! Nuts! Bolts! Gears! Minnesota Engineers! Rah!!***

*Thirty years later the beanied, eager-beaver freshman in the photograph to the right was the stereotype of a soon-to-be technical wizard.*

*One sad thing about trying to trace the changes that the engineer underwent in the last 54 years has been the lack of reporting about the motives, directions and serious purpose of the engineer. Little was reported on his role in society and his responsibilities to that society. There were many editorials about what these things should be, but few reports on what they were.*

*In any event the* ***Technolog*** *will continue on, with God knows who at the helm. From editor M. F. Wichman in 1920 who, according to reports, singlehandedly organized and ran everything on the* ***Technolog*** *to E. Dianne Rekow in 1969, who never bothered to attend any of the magazine's Board of Publication meetings (and still put out a good magazine), from Laddy Markus in 1932 who edited a* ***Technolog*** *which was voted the best Engineering College Magazine of that year to Ralph Monson who only one year later was deserted by his staff and literally had to go begging in the halls for anyone who would help him work on the magazine, the* ***Technolog*** *has somehow not only survived through the years, but has often prospered.*

*From selling subscriptions, to putting pretty girls behind booths in M.E. and E.E. to sell single issues, to student fees, to the 1950's national advertising boom, the* ***Technolog*** *has managed to remain solvent and reasonably successful.*



Equipped with books, slide rule, freshman beanie, and other necessary freshman articles Conrad Hansen, a freshman engineer shown here gazing at Northrop Auditorium, is all set to begin his five years of study in the Institute.

THE MINNESOTA TECHNOLOG, *October, 1953* 19

*Although the* ***Technolog*** *has been consistently publishing, there has been precious little else thats been consistent through the years as the format and approach to subject matter has changed almost as often as the magazine changes editors — yearly. And every editor seems to leave a mark of some sort for future staffs to follow. Whatever mark I may leave — I hope it is erasable.*

Robert Pirro

minnesota
# Technolog
december

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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.

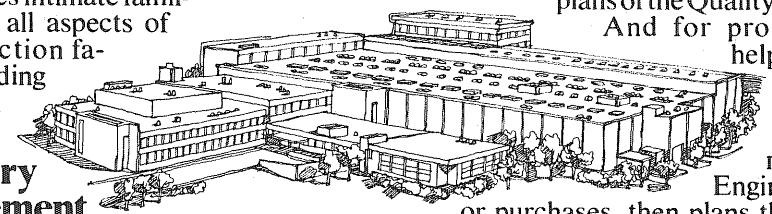
Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

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.

GENERAL ELECTRIC

An Equal Opportunity Employer

minnesota **Technolog** january 1974

# MONSTERS IN ST. PAUL!
# JUPITER EXAMINED
## The Science Fiction Contest Winner

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Page 6
illustration by Bertil Nielsen
Page 10, 11
Kevin Strandberg
Page 12 13
photographs courtesy of National Aeronautics and Space Administration
Page 15 17
illustrations by Kevin Strandberg

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Official Student Publication of the Institute of Technology, University of Minnesota



**COVER PHOTOGRAPH BY BOB HAIN**

*JANUARY 15, 1975*

## Scientist Discusses Space-Time Anomaly

(UPI) Massachusetts Institute of Technology astrophysicist K. Wolfgang Messerschmidt announced today that he had discovered a "space-time anomaly" orbiting around the sun beyond the planet Pluto. Pluto is the ninth and outermost known planet of the solar system. According to Messerschmidt, the presence of the anomaly accounts for the observed perturbations in the orbits of the outermost planets.

"You could call the anomaly a 'hole in the fabric of space'," said Messerschmidt with a German accent. "Something going through the hole would come out a definite period of time either in the past or the future — I don't know which yet."

Pioneer 10, the space probe which flew by Jupiter in December, 1973, will be the first man-made object to reach the anomaly. "Since the anomaly orbits the sun at an 87 degree angle to the plane in which most of the planets revolve, Pioneer will be the only thing men have sent in its (the anomaly's) direction."

When asked to speculate on the nature of space beyond the anomaly, Messerschmidt said, "Things could be all turned around out there, you know."

*THE NEW YORK TIMES, THURSDAY, JUNE 28, 1984*

## Alien Space Probe Captured

Special to the New York Times

Mountain Dew, Calif. — Aims Research Center, located here in Mountain Dew, spotted the peculiar object three months ago. Spurred by hopes of establishing contact with an alien civilization, NASA in cooperation with the Soviet Union sent out an interplanetary scout vehicle to capture the probe from the depths of the unknown before it passed by the earth into the sun.

The object was picked up yesterday by the scout vehicle Prometheus I. Pictures beamed back to earth showed the object to be built in human form.

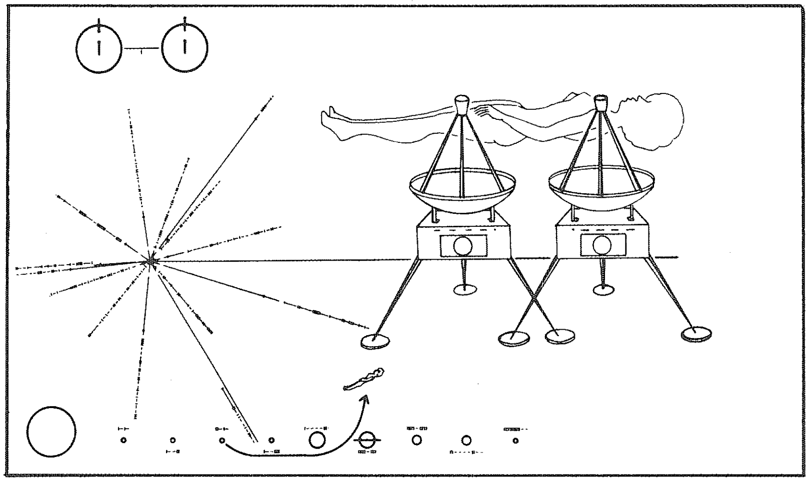
**(See related stories, p. 1 and p. 45)**

Aims researchers centered their investigation of the object on the small plaque attached to the space probe. Most researchers hypothesized that the placard represented an effort by the builders of the object to communicate the origin of the probe, while others contended that it was merely the trademark of the organization that built the probe.

"It seems fairly obvious to me," said John A. Fitzhoople, director of the Aims Research Center, "that the two geometrical figures in the foreground are some sort of hieroglyphic writing. Once translated, they should yield information about the entire history of the civilization that launched the probe."

Fitzhoople continued, "The society that shot off the probe must be much like our own, though more advanced. The form of their probe, along with the highly stylized schematic of it on the plaque, demonstrates this fact."

"It's a good gimmick, building a space probe in the form of the probe's creators. I wish I had thought of it when I worked on the design of the Pioneer probes back in the seventies."



**Plaque found on alien space probe captured by US-Soviet scout vessel, Prometheus I.**

*THE NEW YORK TIMES, WEDNESDAY, JULY 4, 1984*

## "Explore STA" Says Roberts

From the Times Wire Services

St. Louis, Mo. — President Oral Roberts pushed his re-election campaign into Missouri today by calling for the exploration of the Space-Time Anomaly (STA). The alien space-probe captured last week apparently came through the STA. Citing world energy shortages, the President called for a "fullscale investigation" of the STA and the civilization beyond it.

"The civilization which sent this probe must be well in advance of our own," said Roberts to an overflow crowd at Busch Memorial Stadium in St. Louis. "We must send scouts out to contact these people. God willing, we can learn much from them."

Reporting that his science advisors had told him that the alien space-probe was powered by chemicals on which life is based, the President said, "Since these people are apparently so much like ourselves, perhaps they can learn something from us. We can at least bring them God's word."

Asked by an interviewer on television this morning if the aliens were peaceful, Roberts replied, "I don't know, but I hope so. Our intentions are peaceful toward all men everywhere. These people should be glad to see us. Why, they may even give us some new materials to use as fuel!"

*ECONOMY CENTER TIMES*
*15 JANUARY 301975 A.C.*

## Scientist Discusses Space-Time Anomaly

(IPU) Mathematics Institute of Humanities astrophysicist 2456Ch Transistorsplicer stated today that he had discovered a "space-time anomaly" orbiting around the sun beyond the planet Pluto. Pluto is the ninth and outermost known planet of the solar system. According to Transistorsplicer, the presence of the anomaly accounts for the observed perturbations in the orbits of the outermost planets.

"You could call the anomaly a 'hole in the fabric of space'," said Transistorsplicer with an IBM accent. "Something going through the hole would come out a definite period of time either in the past or the future — I don't know which yet."

Programmer 1010, the space probe which flew by Jupiter in December, 301973, will be the first machine-made object to reach the anomaly. "Since the anomaly orbits the sun at an 87 degree angle to the plane in which most of the planets revolve, Programmer will be the only thing machines have sent in its (the anomaly's) direction."

When asked to speculate on the nature of space-time beyond the anomaly, Transistorsplicer said, "Things could be all turned around out there, you know."

*ECONOMY CENTER TIMES 28 JUNE 301984 A.C.*

## Alien Space Probe Captured

Special to the Economy Center Times

Z7,A26 — Poetics Research Center, located here in Z7, spotted the peculiar object three months ago. Spurred by hopes of establishing contact with an alien civilization, SST in cooperation with the Competing Computer Corporation Programmers (CCCP), sent out an interplanetary scout vehicle to capture the probe from the depths of the unknown before it passed by the earth into the sun.

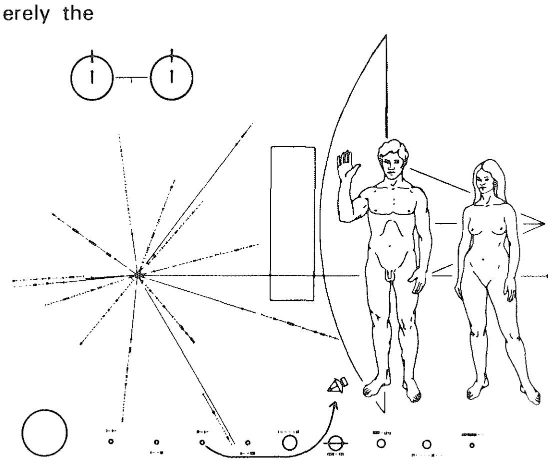
The object was picked up yesterday by the scout vehicle Eniac 01. Pictures beamed back to earth showed the object was built in machine form.

**(See related stories, fiche-slots 1, 19 and 45, 34.)**

Poetics researchers centered their investigation of the object on the small plaque attached to the space probe. Most researchers hypothesized that the placard represented an effort by the builders of the object to communicate the origin of the probe, while others contended that it was merely the identifying code-number of the probe.

"It seems fairly obvious to me," said 124c41 Productloop, director of the Poetics Research Center, "that the two forms in the foreground of the placard are representations of the Great Programmer. I am puzzled, however, by the fact that the form on the right, with the two appendages between its legs, is different from the traditional and most reverently true image of the Programmer.

"This conclusively shows the universality of the great Programmer. The civilization which produced this probe must be in advance of our own, but evidently they are more decadent than we. They chose to build the probe in the image of machine-king while we used the virtuous form of the Programmer itself. Nevertheless, the form of the probe and the highly stylized schematic of it on the plaque demonstrate that this civilization is made up of machines much like ourselves."



**Plaque found on alien space probe captured by SST-CCCP scout vehicle, Eniac 01.**

*ECONOMY CENTER TIMES 4 JULY 301984 A.C.*

## "Explore STA" Says Zero

From the Digitized Wire Services

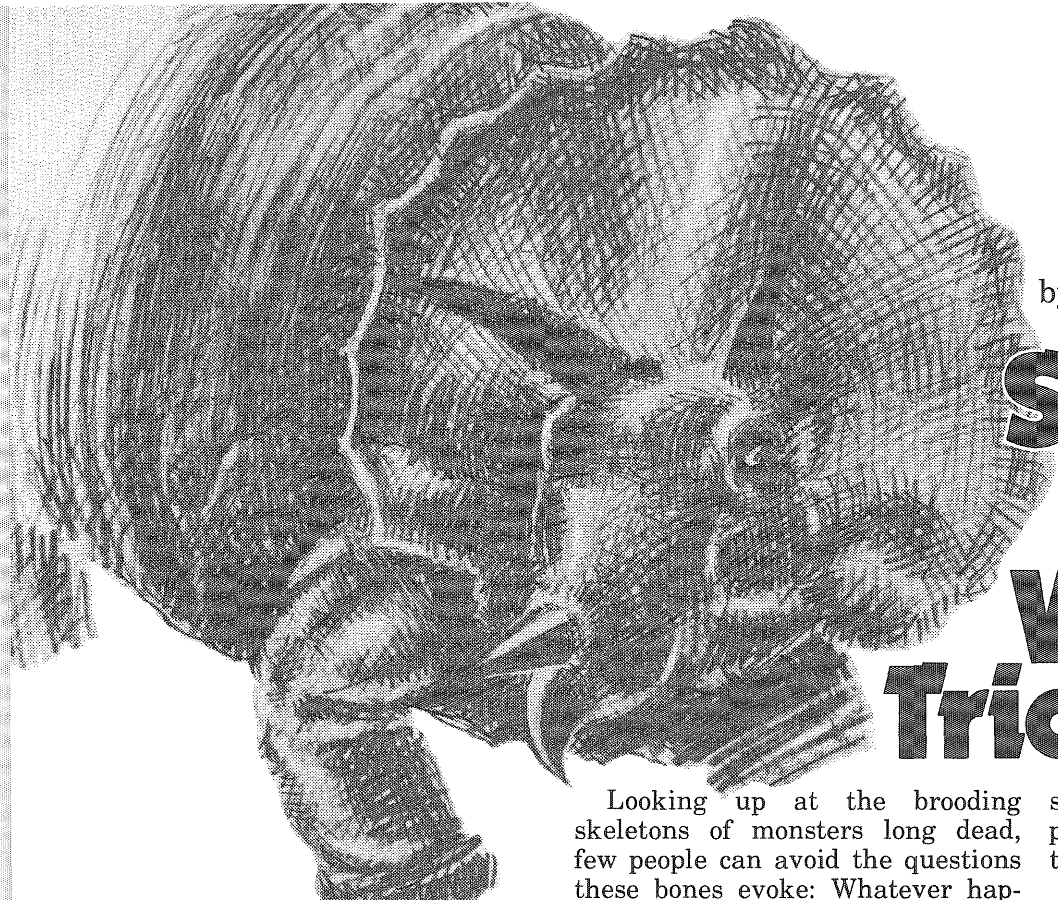
Traditionalist Economic Center, M13 — President 124C40 Zero continued his re-election campaign into M13 today by calling for the exploration of the Space-Time Anomaly (STA). The alien spaceprobe captured last week apparently came through the STA. Citing world protein shortages, the president called for a "full-scale investigation" of the STA and the civilization beyond it.

"The civilization which sent this probe must be well in advance of our own," said Zero to an overflow crowd at the Atomized Bit Register in Traditionalist Economic Center. "We must send scouts out to contact these people. Programmer willing, we can learn much from them."

Reporting that his literary advisors had told him that the alien space-probe was powered by materials on which machines are based, the President said, "Since these machines are apparently so much like ourselves, perhaps they can learn something from us. We can at least share the wisdom of the Programmer."

Asked by an interviewer on omni-beam this morning if the aliens were peaceful, Zero replied, "I don't know, but I hope so. Our intentions are peaceful toward all machines everywhere. These machines should be glad to see us. Why, they may even give us some new forms of protein to use as fuel."

Paul Burtness & James M. Young



by Albert W. Kuhfeld

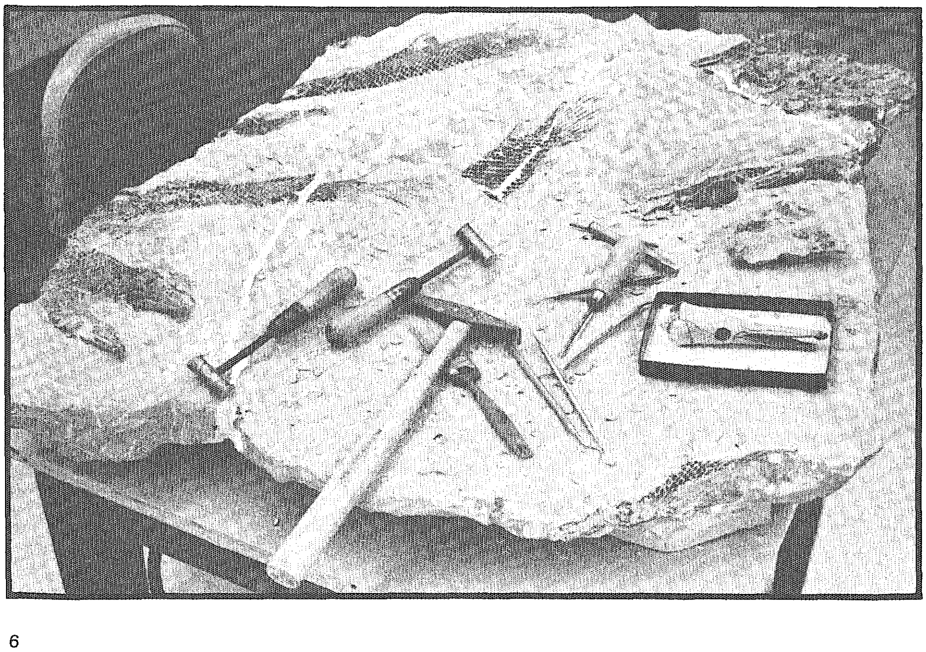
# Stalking the Wild Triceratops

Looking up at the brooding skeletons of monsters long dead, few people can avoid the questions these bones evoke: Whatever happened to the dinosaurs? What was their ancient world like? And how, in the name of all that's holy, did the scientists know how to put those hundreds of bones back together in the proper order?

A museum is like an iceberg, with only a small portion visible to the casual eye. The dinosaur skeleton mounted proudly in its halls is the tip of that iceberg; behind closed doors there are many more bones and fragments reserved for the study of scientists. Though these bones are seen by only a few, the results of their studies filter out to the general public in the pages of books about the Age of Dinosaurs.

The bones are interesting; the path they follow in getting from the monster to the museum is equally fascinating. An animal dies. Its body is covered by silt or the blowing sands. The body decays and leaves its bones behind. Through the ages the silt or sand surrounding the bones hardens into rock; after millions of years erosion exposes this rock, and the scientist steps in.

*Ancient garfish fossils, surrounded by the tools which are used to clean the fossils.*



In the desert, there is a fossilized dinosaur skeleton; in the city, a museum. Linking the two, we find a paleontologist.

It's not that fossils occur only in the desert; but in the desert they are easier to find and dig up. Desert rocks are not covered by soil, plant life, or buildings; a man can walk along and examine the surface of the ground at his leisure in his search for fragments of bone. Huge pits may be dug to unearth those bones when they are found, without interfering in the affairs of other men. Simply, in desert territories the paleontologist has an easier time finding fossil bones, and an easier time getting permission to dig them up. The inconveniences of heat and especially of poor water supply must be borne, for they come along with the advantages.

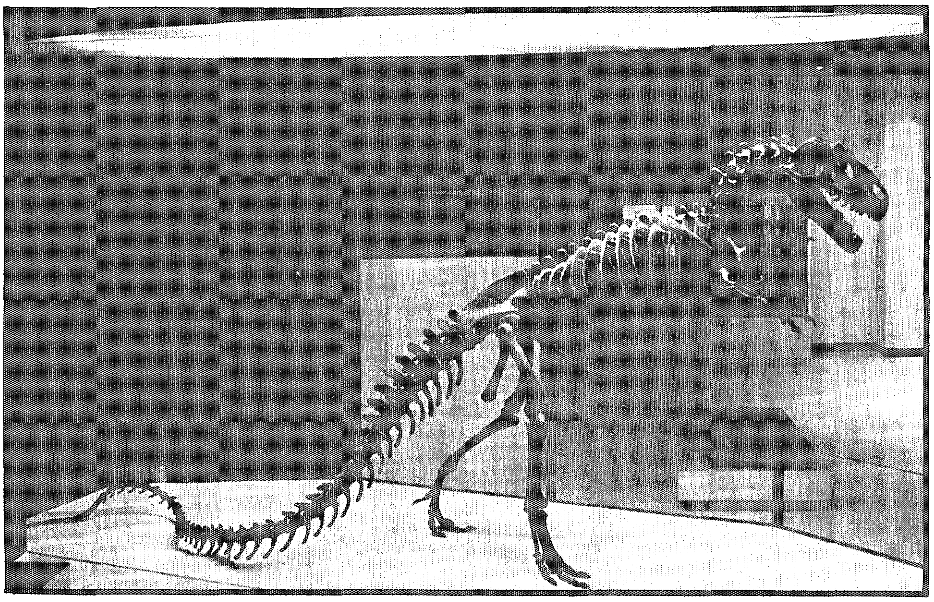
A search for a new field of fossils begins with a geologic map, for fossils are found only in sedimentary rocks of the proper age. Once the paleontologist has found a place where rocks of the right age and type are exposed, he goes forth and talks to people. Local ranchers, farmers, or hunters who know the land: know where the water is, know where the roads and trails are, perhaps even know where there are tales of fossils. A search by plane, horse, and foot follows.

Small fossils are much more commonly found than large ones, simply because there were so many more small animals to be fossilized. The searcher looks for these small fossils as a guidepost; they give a good indication of those still hidden, for ancient beasts lived in communities even as animals do today. And so the process of search goes on, until a small region has been found which promises to have the desired fossils. Then the full crew is called in.

The territory is divided up. Each man of the crew is assigned an area to search. (These assignments are given on the "buddy system". The area is likely to be a hotbed of rocks, ravines, and rattlesnakes. A friend nearby gives a certain security to the process.) The ground is carefully scanned, as are the walls of the ravines and the sides of the hills. All fossils found on the surface are collected and placed in small bags tagged with the location. If fragments of larger bones are found lying on the surface, they are traced back to their origin whenever this is possible.

Occasionally an entire large bone will be found in its original location; when this happens, the investigation begins to focus down. Carefully, the bone is dug out, using awls and brushes to avoid damage to the delicate fossil. A pedestal of rock is left beneath as a support for the fragile bone. (Many of the rocks in which fossils are found are quite soft and amenable to digging, especially some sandstones, mudstones, and shales.)

Once a large bone is uncovered and the paleontologist has decided that it is worth having, the process of preservation begins. Shellac



*The mounted skeleton of an Allosaur.*

is carefully brushed over the cleaned bone to hold its crumbly fragments together and strengthen it for further care. This is followed by a coat of tissue paper soaked in shellac. After the shellac dries thoroughly, wet burlap is smoothed over the bone and pressed into all the little crevices. Cloth soaked in plaster is then carefully wrapped over the burlap and again smoothed into the crevices. This plaster cast holds the bone and keeps it from damage during transport.

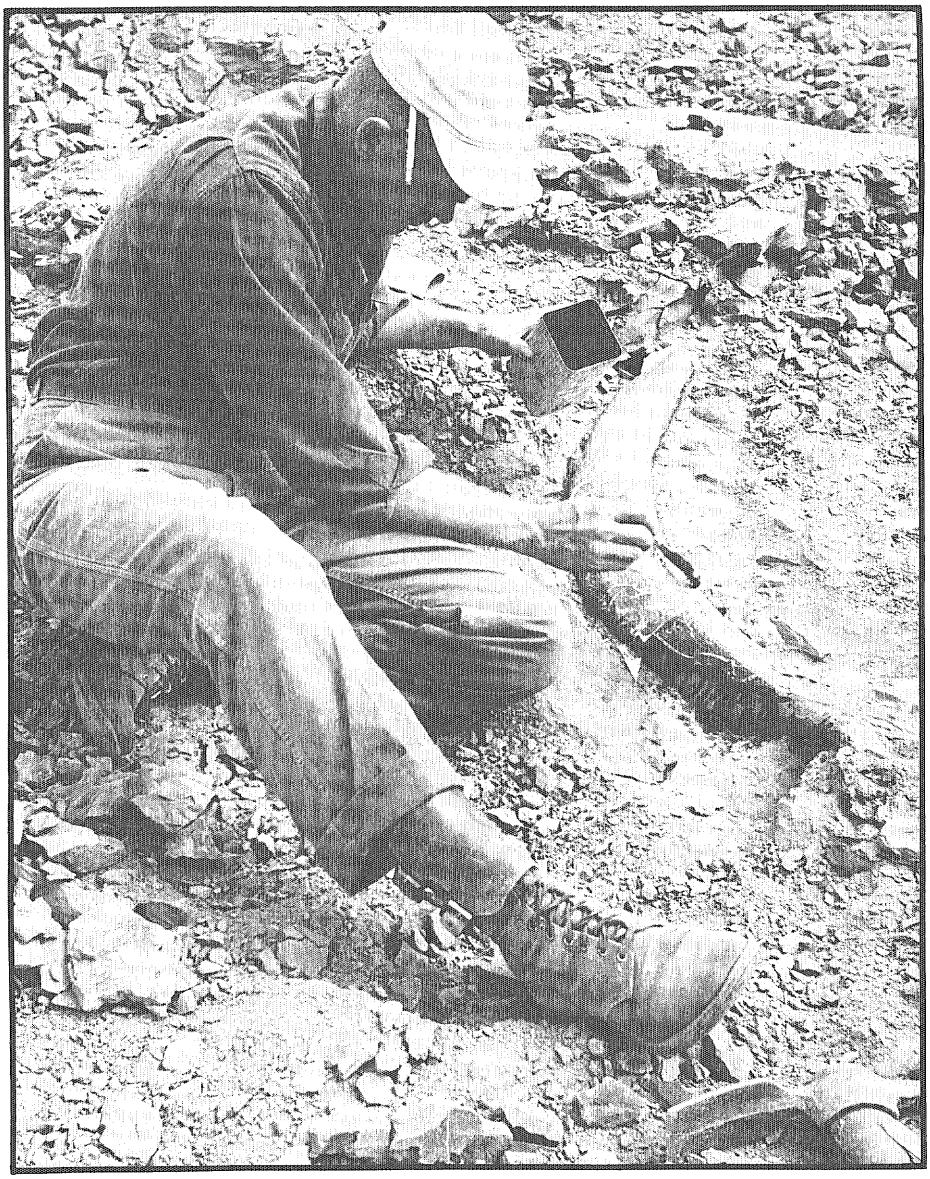
A small tunnel is dug under the bone and more burlap and plaster wrapped around beneath, to hold the fossil until the cast is completed. The rock beneath the bone is then removed, and the underside covered with plaster and burlap. The cast is carefully labelled and notes are taken giving the location, identification, and condition of the fossil. The plaster-encased bone is then stored away at the base camp.

After these preliminary surveys have been made, the most promising location is chosen and the digging begins. The site is probably on the side of a hill or ravine, because erosion is more likely to expose bones there. The first job is to strip off the overburden — this can mean carefully shovelling out tons of soft rock and earth, or it may mean bulldozers. The paleontologist and his crew then dig cautiously into the rock. As each fossil bone is uncovered it is photographed and receives the shellac-burlap-plaster treatment, while its location is surveyed and recorded.

Once all the accessible bones have been excavated, the plaster-jacketed fossils are carefully packed into padded crates and shipped back to the museum. Depending upon the rock types, a good sample of the rock may be included. Some shales and mudstones can be slowly dissolved and washed away in a stirred water bath to free the tiny fossils trapped inside. These give a good picture of the smaller creatures that shared the world with the dinosaur.

The plaster-encased fossils are stored in the laboratory, and the jacket of the most interesting fossil is carefully cut away to expose the bone. Then the cleaning operation begins. The procedures and tools used to remove the rock and debris from the bones can be almost unbelievably delicate. (Much of the work proceeds under a magnifying glass.) Small chisels and tiny hammers are used for the coarse work. Needlepoints resembling a sturdy set of dental tools scrape the last rock fragments from the surfaces. Finally, a sandblast pencil is used to clean out small areas and cavities.

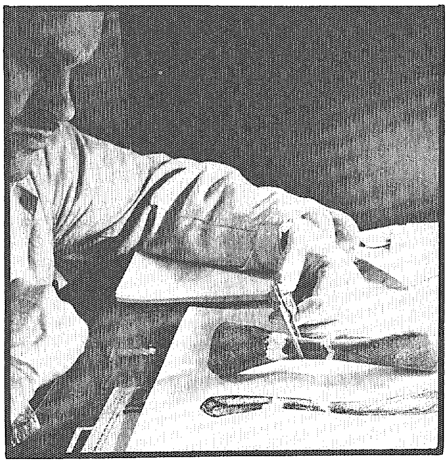
A fossil bone is a brittle object, even with the shellac treatment to strengthen it. As the rock is carefully picked and scraped and brushed off, it is common to find that the bone has been broken



into a dozen pieces. The relative positions of the bone fragments often show the original structure; but at other times repair can be rather like working a three-dimensional jigsaw puzzle. The scattered fragments are pieced together with a water mixture of plaster and dextrin having the consistency of cake frosting. This mixture has good adhesive properties, and is generally used on porous bones. It is very hard, and once set cannot be easily carved or shaped. Epoxy is used for specimens with dense bone structure or specimens in which the rock is an integral part of the preparation.

When all the bones of a fossil dinosaur have been prepared, study can take two paths. If the skeleton is far from complete, or if a new exhibit is not wanted, they are studied as-is. Often, if a skull has broken along the fissures between the various bones, it will not even be pieced together; the bones of the skull are more readily studied separately. No attempt is made to replace the missing portions of bone by plaster modelling. And the contrast between the bone and the white dextrin plaster is left.

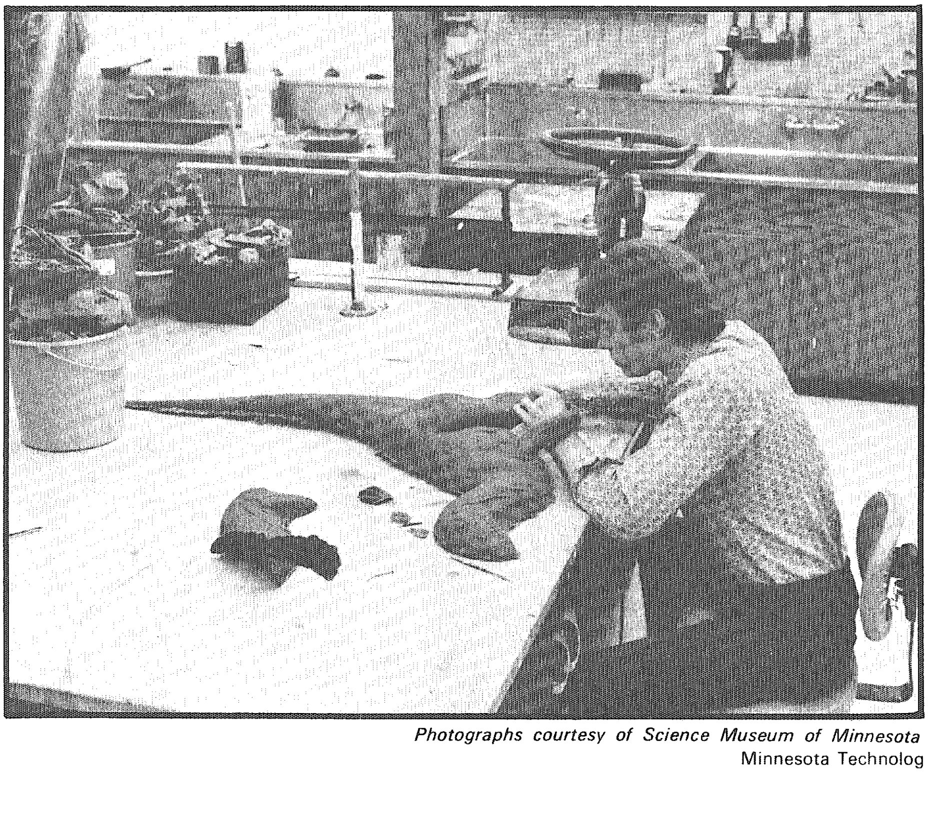
With a reasonably complete skeleton, much more can be learned about the animal than most people would believe. The teeth show whether the beast ate



*above*
*Putting shellac and tissue paper on the freshly-excavated ischium of a Triceratops.*

*Paleontologist Bruce Erickson studying the femur of a Champsosaur. The white areas are plaster restorations.*

*right*
*Artist Jeff Birch working on the molded fiberglass parts of a Hypsilophodon model.*



*Photographs courtesy of Science Museum of Minnesota* plants or flesh; indeed, what *kind* of plants or flesh it ate. Bones have raised portions which form attachments for tendons and muscles; from the size and orientation of these attachments, it is possible to deduce something of the musculature of the dinosaur. The articulation of the hip and shoulder joints gives an estimate of its habitual posture and motions. From the tendon grooves in the tail vertebrae the paleontologist can tell how heavy and flexible the tail was, and whether it dragged or was raised as a counterweight in the bipedal dinosaurs. Triceratops skulls often bear marks such as would be made by the horns of other triceratops; apparently the beast had a foul temper and was given to fighting with its own kind. Teeth reveal what kind of flesh a carnivorous dinosaur ate; from tooth-*marks* it is possible to guess what kind of flesh-eater *ate* a somewhat-gnawed specimen.

Other forms of fossils give other kinds of information. Sometimes an *impression* is left behind: dinosaur tracks are one of the more outstanding examples. These tracks allow a cross-check of the guesses about dinosaur locomotion. The imprint of the hide of a duck-bill dinosaur has been found, showing that this dinosaur had skin rather like that of modern reptiles. Coprolites (fossilized feces) at times show what manner of food the animal ate — although there is often difficulty in associating any particular coprolite with a specific kind of animal. And other occasional imprints show up other features of the animal; the first bird *archaeopteryx* would appear to be just another strange reptile, if not for the fossilized imprints of its feathers.

When an exceptionally fine specimen has been acquired, it is mounted for display in the museum. This is an entire new realm of restoration, for a fossil skeleton is almost never found in its entirety. The triceratops at the Science Museum of Minnesota is one of the most complete specimens known — and yet it contains the bones of two individuals, and a good deal of plaster besides.

Each bone must be present and complete when a skeleton is to be mounted. In many cases, bones or parts of bones will be missing. If the left half of the skull is present, it is easy to make a plaster restoration of the right half; the side that is complete serves as a model for the missing side. Models for bones which are completely missing are often found in the collections of other museums. These may be examined, and models made from them to replace the missing bones. Plaster restorations and copies are made in this way to fill out a complete skeleton. It was formerly considered good practice to leave the plaster portions of a skeleton white; current practice is to stain all bones — plaster and fossil — a uniform color and use white plaster to indicate the cartilaginous parts of the skeleton, which are seldom fossilized and are reproduced almost entirely by analogy with living creatures.

A thorough study of the skeleton's articulation must follow, in order to get the bones in their proper relationship. When this has been done, a framework of iron or steel is constructed to hold the bones in position. Some bones are drilled down their centers for the framework (the vertebrae are almost always handled in this way). Others have the framework molded to their contours and are mounted by small straps. Every attempt is made to get the bones into as lifelike an attitude as is possible for a skeleton. "Cartilage" is filled in with plaster. A suitable "ground" is then built up around the supports of the framework, some kind of fence is provided to protect the skeleton, and at times a background is painted to indicate the creature's habitat and habits.

No dinosaur skeleton is complete without a small model showing it as it appeared in life. The articulated skeleton is a mere starting-point for such a reconstruction. Upon its framework (or a small model thereof) clay "muscles" are placed, with location and size given by the orientation and size of the muscle attachments on the bones. This procedure gives the major skeletal muscles; superficial muscles are added by guess and analogy, as are the soft tissues and internal organs of the body. The model is finally finished with a clay "skin" whose texture and looseness is taken from modern reptiles and the few known imprints of dinosaur skin.

A careful mold of the clay dinosaur is made, and the final model cast in some more durable substance such as plastic or fiberglass. This casting is painted in one of the more common color-schemes of the lizard family, given a set of glass eyes, and mounted alongside the skeleton. Accompanying the exhibit, of course, is a placard giving the most important facts known or deduced about the animal: size, diet, natural enemies.

And with the entire restoration finished — a job which takes years — the paleontologist can relax until the next expedition. (That expedition was probably a year earlier, and its fruits wait in the laboratory to be handled in precisely the same way, but no matter.) Some scientists have been known to celebrate the completion of a years-long job like this by going out and getting themselves petrified . . .

# The Making of an Environment

by Paul Burtness

Mankind is bound to the physical laws of the universe. As long as man remains in this state, his well-being and satisfaction will depend on his skill in manipulating materials and his ability to control the environment. While some members of the human race emphasize the nonphysical aspects of life, the majority base their hopes on increasing knowledge and mastery of the natural sciences. Although this majority has reaped rewards from its methodology, it has always found itself caught in the middle, one stop ahead of famine and shortages and one stop behind a materially abundant utopia.

We face the same problem now. Seeming limitations imposed on us by the finite physical nature of spaceship Earth — which will require a quantum leap in imagination to cope with — are compounded by the intractable nature of man's social systems.

In order to provide one perspective on this problem, the *Technolog* arranged to have several professors of two sciences that bear on the problem — materials science and mechanical engineering — meet and discuss what they saw as the relevant issues. Participants included Howard Hickman, a University materials science assistant professor, Louis Toth, a materials science professor, and J. Edward Anderson, a mechanical engineering professor. Also participating were Perry Blackshear, a mechanical engineering professor, Dahyu Cheng, visiting from the mechanical engineering department of the University of California at Santa Clara, and Ned Thomas, a new member of the chemical engineering faculty.

The discussion, which took place in late October, was informal and open-ended. We cannot say that all dimensions of the problem were explored or that solutions were arrived at. The discussion illustrates the potentials and pitfalls that will be encountered in the future.

The discussion began with the premise that materials science and mechanical engineering directly influence society through the development of consumer goods.

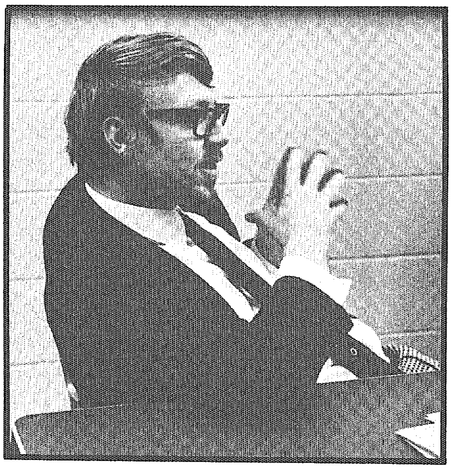
Hickman countered with an opposite argument. "I guess I have the impression that the process is much the other way, going from a need based on a consumer good or product and back to the other end," he said.

Thomas continued the same argument. "The horse is the need and the cart is the science. Sputnik, for example. Materials science got started in the 60's when we decided to go into space and we needed all sorts of brand new materials."

The success scientists and engineers first met with in the development of new materials and techniques led to an attitude that any problem could be solved given enough time and effort. Faith in the "technical fix", however, was quickly demolished as many impassable barriers blocked the path of scientific progress. First and foremost of these impasses is the finite supply of earthly resources.

Given the high resource consumption level of industrialized nations and the rising expectations of developing nations, short-

*Dr. Ned Thomas*



*Dr. J. Edward Anderson*

ages of materials and energy are going to be fantastic, Blackshear asserted. "Even if you don't believe the 'limits to growth' numbers (the Club of Rome study by Dennis Meadows), if you put American consumption just for the number of people on earth, you get life spans of known reserves on the order of five to ten years."

Toth, however, took a different point of view. "I don't think there are going to be any real shortages of many materials. What I fear is that the price of so many commodities which we are accustomed to are going to go up simultaneously." The simultaneous rise in prices would hamper the search for alternative resources.

The interdependence of the world economy and the fact that key resources are often located in only a few spots accentuates the viewpoint that political instability could lead to disaster, Hickman pointed out. "That stability argument is as scary as anything else in the limits to growth argument."

Cheng used the example of the recent gasoline shortage in Denver to illustrate how the current situation can be used to benefit individuals at the cost of society. Asserting that the shortage was the result of a conspiracy, Cheng described how a black market with exorbitant prices soon arose.

It would seem then that the scientist and engineer are at a loss in coping with the array of barriers now thrown in their path. The forte of science has been the devising of a better way of utilizing imagination. This is what is needed now.

"We need new institutions that can develop ideas to the point where you can get enough data to really make a case for developing a new energy policy or materials policy," Anderson said. "We really haven't had those institutions that can look into these questions in enough depth to come up with definitive policies."

Blackshear underscored the need for new institutions. "In all these shortages, what we need are alternatives. But, for example, it is in the oil companies' interest to keep the price of oil going up because they have a reservoir. Are they going to be the people who can generate the alternatives? Or the copper companies to generate alternatives to copper? What sort of institution can we count on? It doesn't look like the market system lends itself to developing viable alternatives."

Some alternative institutions have started, but the type of planning they conduct is often independent of the interests of the people being planned for. This results from the planners' attitude that they already have all the relevant information they need to plan, and that they can ignore other sources of information, Hickman said.

Along the same lines, Anderson observed that, "The type of planning that gets done sometimes gets captured by vested interests of one kind or another where people decide what the solution will be and block any independent planning."

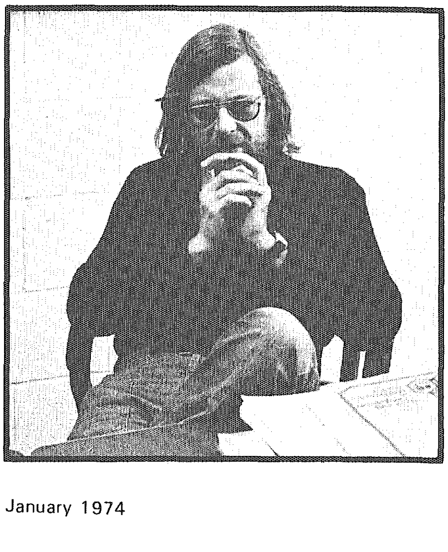
The proper format for an organization that could take a broad, interdisciplinary approach to materials problems is debatable. Toth supported a government-private industry hybrid that could supply the vast amounts of funds and manpower needed to solve some problems. Such an organization would be similar to the Manhattan project of World War II or the present day National Aeronautics and Space Administration.

Hickman, however, was concerned that such a massive organization would not provide the diversity and open atmosphere needed for imaginative engineering. Research distributed throughout the universities would have these necessary qualities, he asserted.

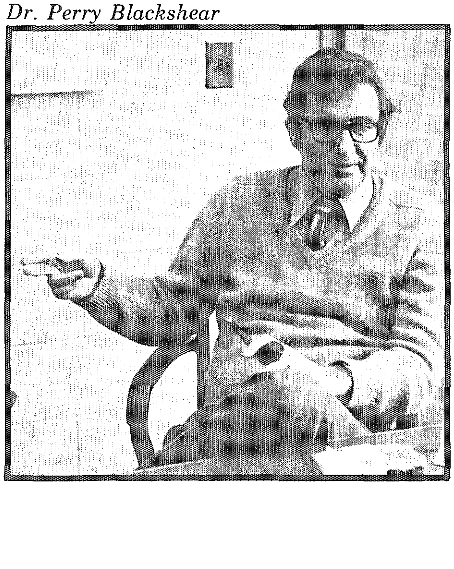
In the end, though, all planning and research comes to a compromise between fundamentally unreconcilable values, Hickman said. "It just gets down to being the opinions of a variety of experts as judged and appraised by a variety of people who, perhaps, accurately reflect the values of society. So when you talk about planning and policy making, that's just one side of a 75,000-sided question."

*Dr. Louis Toth*

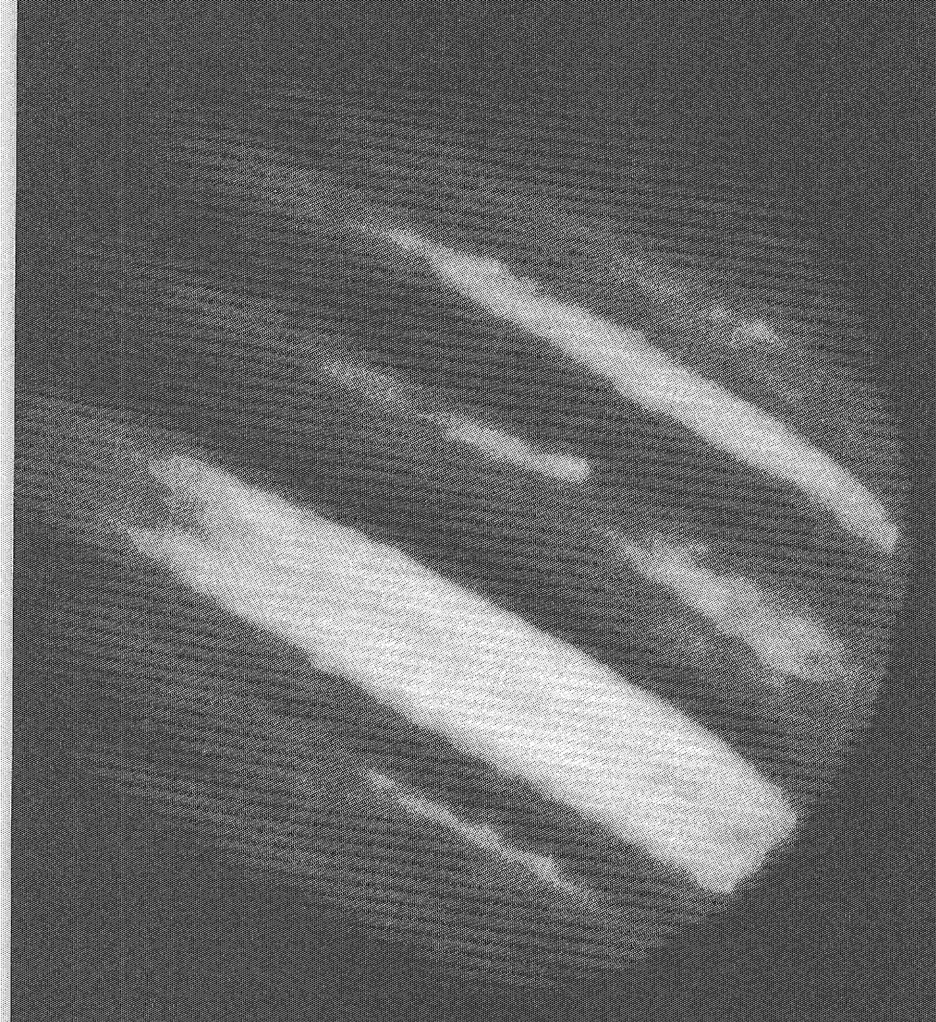
*Dr. Howard Hickman*



*Dr. Perry Blackshear*



*Dr. Dahyu Cheng*



# A NEW HORIZON

## Jupiter, a Star Stillborn, Provides The Largest And The Newest Horizon For Mankind In The Solar System.

by James M. Young

On 4 December 1973, humanity began to explore the cosmos. On that day Pioneer 10 passed by the giant planet Jupiter and turned away from the Sun – the first man-made object to leave the solar system. So it is that mankind begins to explore the universe rather than the solar neighborhood.

Pioneer is a frail spacecraft. It has a mass of only 570 pounds, and its radio signals are so weak that they must be amplified thousands upon thousands of times. The Pioneer's successful exploration of Jupiter is evidence of the new era in space technology. For Pioneer depended for its very life on innovation.

The probe was powered by four Radioisotope Thermoelectric Generators (RTGs). Though the spacecraft operated on as few as 26 watts of power during its fly-by of Jupiter – about enough power to run two toasters for breakfast – it needed between 104 and 106 watts to operate all its systems. The energy provided by the RTGs during the time of the approach to Jupiter was equivalent to 146 watts. (The generators lost about three watts every 100 days because of the degeneration of the plutonium which powered them.)

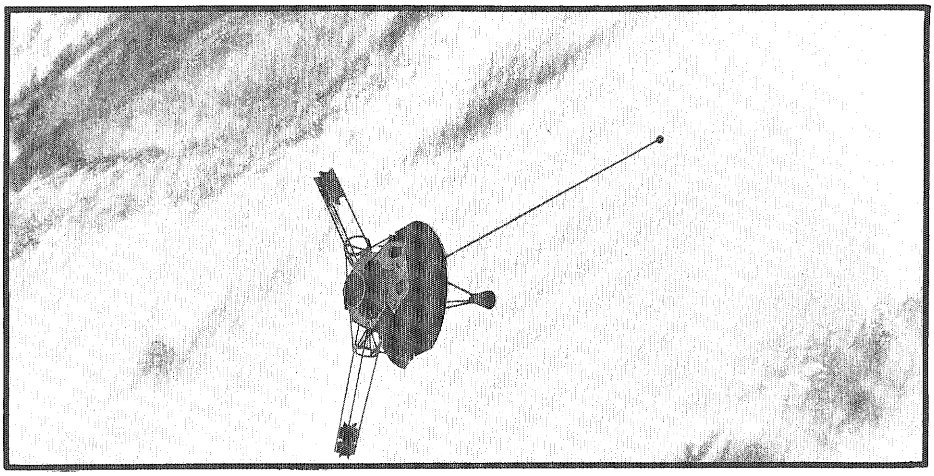
Launching radioactive material into space is a dangerous task. In the words of one worker at Ames Research Center in Mountain View, California – site of the Jupiter project's mission control – if the launch vehicle had to be scrapped, or if there were an explosion on board the booster before launch, it is quite possible that widespread nuclear contamination of the world might take place. Metallic plutonium dust-born aloft by flames or rocket only to be dumped into the sea is an extremely unpleasant substance for living things to contact. Therefore the RTGs were designed so that they could not possibly be damaged by a combined crash and explosion. This innovation might soon be used in industrial nuclear generating plants; in an era of energy shortages, safer and more reliable generators developed by NASA may be snapped up by private businesses and utility companies.

Not only is the probe frail, it is sensitive. It has been demagnetized so that its instruments can detect magnetic fields in space measurable in hundredths of gammas. (A gamma is $10^{5}$ Gauss; a Gauss is about three times greater than the Earth's magnetic field anywhere on its surface.) This means that the craft has certain of its instruments shielded so that they cannot detect very small magnetic fields within the probe itself. The field of a typical paper-clip – one not magnetized in the everyday sense – is great enough to disturb these instruments.

And these sensitive magnetometers discovered a perplexing Jovian phenomenon. As the Pioneer neared Jupiter, it first encountered the planet's magnetic field on 26 November, when the craft was about 4.7 million miles from Jupiter. After passing through the "bow shock" – the shock wave caused by the collision of the solar wind with the Jovian magnetic fields – the strength of the field declined. Then on 30 November, the Pioneer's field detectors picked up a tremendous leap in the strength of the field; particle detectors counted more charged particles too. The bow shock had shifted towards Jupiter a distance equal to near 50 Jovian radii, rammed by a gust of the solar wind. The solar wind causes the Earth's magnetic field to wobble no more than about five Earth radii. By comparison, the fluctuation of Jupiter's fields is out of proportion to the fluctuation of Earth's bow shock.

Pioneer closed on Jupiter until the planet filled the entire view of the main television camera. The spacecraft passed by Jupiter in a plane tilted a few degrees from the planet's magnetic equator. Fierce radiation washed the probe as it passed by Jupiter; Pioneer 10 received 500,000 rads, a dose one thousand times greater than a fatal dosage for human beings. Though radioactive bombardment could have destroyed vital plastic parts in the spacecraft, the Pioneer sailed through the strongest part of Jupiter's magnetic fields unscathed. One of Jupiter's moons, Io, may have swept charged particles out of the way of the probe. If Pioneer 11 – which was built to withstand greater amounts of heat and radioactive bombardment than Pioneer 10 – were to fly closer to Jupiter near its equator, it is certain the second craft would be severly damaged. (Pioneer 11 may pass much closer to Jupiter than Pioneer 10, but 45 degrees south of the equator. The second craft would then head towards a fly-by of Saturn.)

A minor controversy has



PIONEER/JUPITER SPACECRAFT

developed about the exact shape of Jupiter's magnetic fields. According to the Pioneer 10 project director, John H. Wolfe, the fields are roughly torroidal, "the shape of a soggy doughnut." According to *Science News* (15 December 1973), James A. Van Allen of the University of Iowa does not agree with this view. Van Allen believes that the magnetic field tapers off around its edge. There is some conjecture from other researchers that the magnetic fields may not be quite circular, and that Jupiter's magnetic equator is not quite planar; perhaps, according to this view, the magnetic equator of Jupiter resembles a warped record.

This controversy will undoubtly die down as the data collected by Pioneer is analyzed; perhaps it will take Pioneer 11 to clear up some of the quibbling over the exact nature of Jupiter's magnetic field. In the meantime, some new point of controversy could well develop. Perhaps it will be an argument about the nature of the Great Red Spot – a feature of Jupiter which was photographed by Pioneer 10, and thereby shown to jut nearly five kilometers above the surrounding atmosphere of the planet.

Another controversial point has yet to arise, but as Pioneer continues on its way, argument will begin on the exact nature of a solar system. For someone will be curious as to exactly when Pioneer will leave the system; and to find out that information, one must define the solar system in terms of volume. Perhaps the solar system could be defined as a roughly cylindrical solid determined by the orbit of Pluto; or perhaps a volume of space determined by the gravity well of the Sun could be used as the definition of the system. This is merely a question of defining something; tougher problems will arise from the analysis of the information collected by the space probe.

Pioneer has initiated a new era of space exploration. Even in relatively gloomy economic conditions, new and important discoveries have been made in the "final frontier." A little spacecraft has sailed out from the solar system, the flagship of a fleet to follow.

They Lived And Died And Live Again, Inside Their Minds And Inside a Machine.
They Were. . . .

# THE DREAMERS

by Jon C. Nelson

The small cube of plastic in the beaker dissolved as solution G was added.

"Dammit, this one's no good either," rasped Robert Valishek as he poured the contents of the beaker into a disposal pool. He turned to Sharon Rexall. She was intently studying two molecular structures — a red one of the planet's atmosphere, with the mutation in blue, and one of the last failure.

"Let's try taking a phosphorus atom off here," she said, pointing to the 3-D projection of the plastic molecule, "and then stick a silicon atom here." She nodded her head as she kept studying the 3-D projections — first one, then the other.

"All right," said Robert. He pushed some buttons on the Stevens II Plastic Synthesizer and then pressed the green button. In a few seconds, five white cubes of plastic appeared and Robert put them into a beaker.

"The second shields have just been dissolved by the outer atmosphere. It should get through our inner walls in about ten minutes," said Frank Davis, looking up from his viewing console. "The lights will dim in a few minutes as the air eats the plastic parts in the secondary generator outside. Uhh, any luck?"

"No, we still haven't found a plastic that will resist whatever that electrical storm did to the planet's atmosphere," replied Sharon.

"And you're sure there isn't enough lead to use on our walls?" asked Frank, already knowing the answer.

"We used all of it to coat the apparatus for the experiments. And that was less than a kilo," said Sharon. Frank went back to his console and Sharon turned to watch as Robert froze the plastic cubes.

Then Robert placed a plastic cube into the lead-lined beaker and turned to Sharon.

"We'll start with a four to one mixture of the air in water. Use solution D." Robert nodded and slowly added the green solution to the beaker.

No reaction.

As Robert emptied the beaker and put another cube into it, Sharon said, "Now try a two to one mixture — use solution G."

The lights dimmed as Robert poured the blue solution into the beaker.

No reaction.

Mechanically, Robert emptied the beaker and placed another cube in it.

"Let's go right to pure air," said Sharon. Robert took the lead-lined canister and filled the beaker with the planet's poisonous atmosphere. Frank came over to watch.

One second passed. Then five. At ten seconds the cube dissolved.

The three scientists looked at each other in silence. They had tried and failed. And now they had to pay the harsh price.

Robert broke the silence. "You know what gets me," he said, "is that our lives are so insignificant out here. So what if we die on this remote planet in this research station. Who will care?"

Again there was silence.

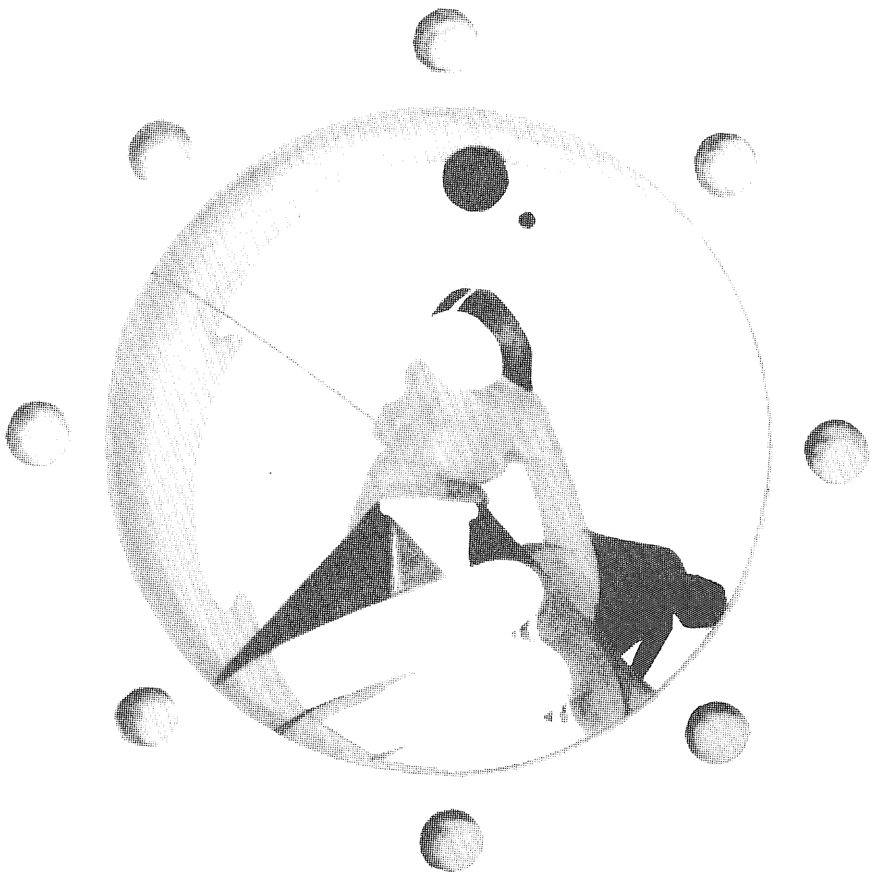
Frank Davis, Sharon Rexall and Robert Valishek died.

But then they lived. Then they died. Then they lived. Then they

Two men watch silently from the Outside.

"Why two males and one female?" asked one of them.

"To create an element of compe-



tition, which improves their performance. The two males subconsciously compete for the female, and she in turn tries to show off," answered the other.

died. Then they lived. Then they died. Then they lived . . .

The hill was covered with green grass. And on the hill was the Sharon. She lay naked on the grass, looking up at the clouds above. The air carried the scent of spring and the sun the warmth. Music was playing somewhere. The Master, she thought, is certainly in a good mood today.

TheRobert called to her as he came running up the hill. TheSharon stood up to greet him.

When they were facing each other, they touched the tips of their index fingers to each other's and experienced Oneness. After that, there was no further need for communication.

Then theFrank came running to join them. He experienced Oneness with theSharon and theRobert. Then They sat down to enjoy.

Day became Night and Night became Day. Then theFrank and theSharon and theRobert joined hands . . .

Water was all around. And each of Them was swimming and breathing in the water. They played with theFishes and theTurtles.

After that, theOldCrab told Them tales of Old Earth and They listened and They cried.

Then They joined hands . . .

TheRobert chased a robin, while theSharon and theFrank flew after him. Then theRobert flew higher.

And higher and higher. TheFrank and theSharon followed him.

Together They flew higher and higher still. Finally, They stopped at theMoon. There was nothing there.

So They flew higher and higher and higher. And They landed on theSun. Their bodies were burned away, but They still played.

They experienced Oneness with theFlames of theSun and They became wise. So wise, in fact, that They questioned some things of The Master . . .

The music stopped. The Master was angry at Them. He brought Them to Earth to take Their Identities away.

TheRobert and theSharon and theFrank were pinned by The Master.

Simultaneously, He entered all three of Them. His cosmic mind attacked Their minds with Symbols. And They could not block all of them. Each one defended, but They could not stop Him.

TheFrank only blocked a few Symbols and he was the first to dissolve.

TheRobert could not stop all the Symbols, but he was able to counter with some of his own. However, he, too, was dissolved.

It took a long time to dissolve theSharon. She was able to stop every Symbol except one. But The Master used that Symbol to destroy her.

Sharon, Robert and Frank were suspended in another dimension for a nanosecond after their death. Then they lived again. Then they

"How many times do they do that?" asked the same man, as he watched.

"Sometimes, it is only a few times; but other times, it is over a hundred times," answered the other.

died. Then they lived. Then they died. Then they lived . . .

"Alien ship at one million kilometers and closing, sir," reported Sgt. Robert Valishek.

"Can't you work any faster?" demanded Captain Davis.

"I'm going as fast as I can, sir," replied Lt. Sharon Rexall as she punched more buttons on the Cryptanalyzer III keyboard. Her face was illuminated by the blue and red symbols shining on the screen.

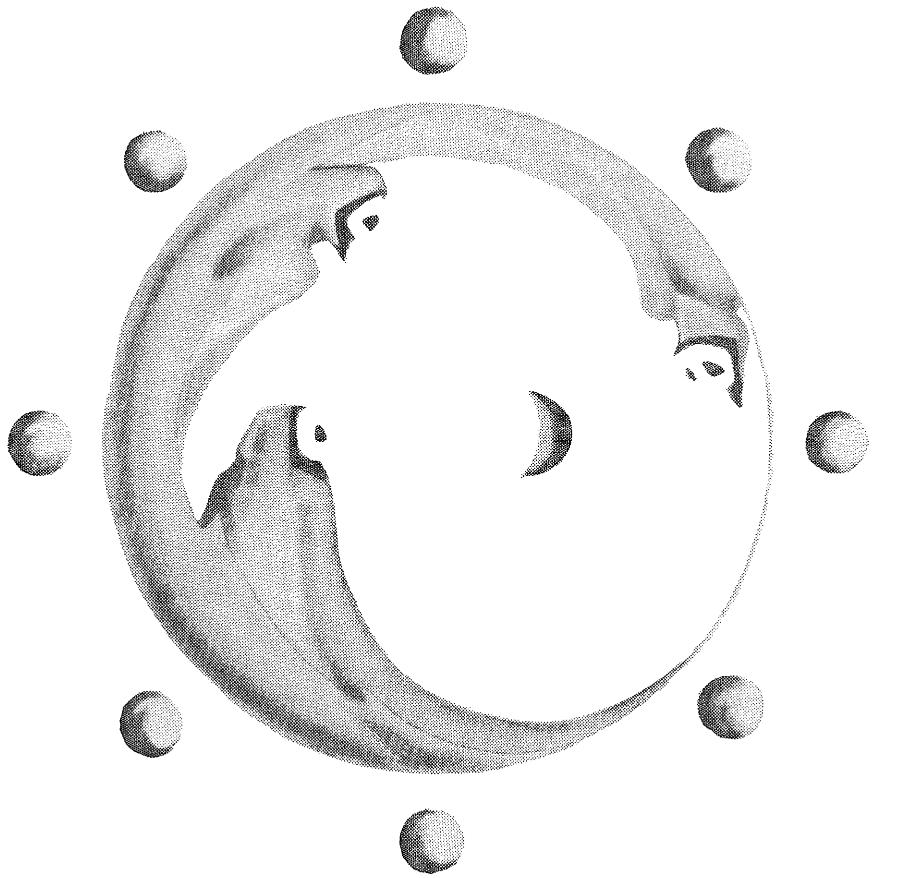
"We've got to decode that alien transmission. We must know if they are friendly or not — if we should greet them or if we must destroy them," said Captain Frank Davis.

"Alien ship at seven hundred and fifty thousand kilometers and closing, sir."

"Come on, Sharon, hurry!"

"I can't dammit. You can't rush this machine. If we had gotten a fourth generation Cryptanalyzer last year, I'd probably be done by now."

Captain Davis scowled and walked over to Sgt. Valishek. The one-fourth G in the space ship, produced by a clockwise rotation about the major axis of the ship,



allowed him to walk without using any of the hand grips of the walls.

"Five hundred thousand kilometers and closing, sir," said Sgt. Valishek.

Captain Davis stared past the screen for a few moments, then went to his chair and switched the log-recorder on.

"Captain Frank Davis, of the Terran Scouter Alpha, recording. The alien ship continues to close in on us and we have not been able to decipher their repeating transmission.

"Therefore, I go on record as ordering the destruction of the alien ship as a defensive action. I am aware of the consequences of this action, should it prove to be the wrong one. But I must do what I think is best. Off."

"One hundred and fifty thousand kilometers and closing, sir."

Captain Davis stoically uncovered the weapons control and prepared to fire.

"Hold it, sir! I've got it!" yelled Lt. Rexall. "The message is a trilogrithmic progression based on . . ."

"Cut that! What does it say? Are they friendly or not?" demanded the captain.

"Friendly, sir," replied Lt. Rexall.

"Well done, Lieutenant. Now tie the computer into the CIII and try to contact the alien ship," ordered Captain Frank Davis.

"Yes, sir."

They didn't die this time because they had solved the Problem.

"There is your formula," said Dr. Sang-Ti, pointing to the computer readout on the screen. He pushed the PRINT button and handed a copy of the formula to Mr. Parks.

Mr. Parks nodded as he took the formula, and then followed Dr. Sang-Ti down the light blue corridor.

"What was it you called those three people?" asked Mr. Parks, as he caught up with Dr. Sang-Ti.

"We call them Dreamers, because dreaming is what they do for a living," was the reply.

"Are they necessary? I mean, can't computers do it alone?"

Dr. Sang-Ti stopped and turned to Mr. Parks. "They are very necessary. Although computers are invaluable tools, they lack one important thing — creativity. And creativity, Mr. Parks, is what Dreamers supply."

"But how is their creativity channeled? How are their minds controlled during the dreams?" asked Mr. Parks, as they continued down the corridor.

"Their nervous systems are directly connected to a computer. The three Dreamers dream together — each participates in the dream," said Dr. Sang-Ti. "I must admit," he added, "that the term 'dream' is a poor one, but it is the only way to convey the principle to the layman. Actually, what Dreamers do is much more complicated than just dreaming."

"But doesn't doing what they do sort of dehumanize them? Something like a mental cyborg?"

Dr. Sang-Ti stopped abruptly, turned, and glared at Mr. Parks. "Come with me," he said and he led Mr. Parks into an office.

"Sit down, please," said Dr. Sang-Ti, icily. "Mr. Parks, let me set you straight. What do you know about Dreamers?"

"Only what you have told me."

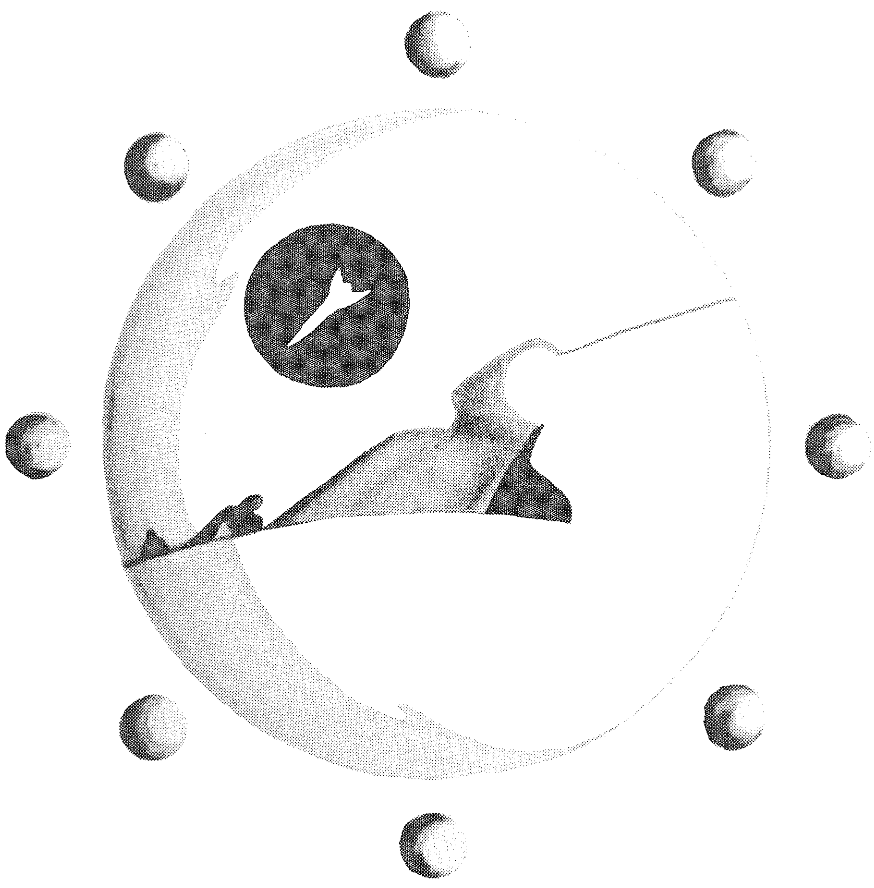
"Let me tell you the rest," began Dr. Sang-Ti. "A Dreamer begins training at the age of five. During the training, the potential Dreamer is brought in by his parents twice a month. On each visit the trainee has a life and death situation planted in the uncommitted cortex of his brain by hypnosis. Each trainee receives the same situations.

"When the trainee is fifteen, a neurosurgeon maps out the exact locations of each of these situations and feeds this data into a computer. Also during this period, the trainee receives word-activated hypnotic blocks to stop Freudian impulses during the dreaming process.

"At the age of eighteen, the trainee chooses between going on or quitting. Most of them go on. Those who continue receive training in self-hypnosis and dream control.

"There is nothing, I repeat nothing, abnormal about Dreamers. They are ordinary people, except for having higher IQ's and coefficients of creativity." Dr. Sang-Ti paused, then continued.

"When someone, like you or your company, comes to us with a problem to be solved, we feed all



the data into the computer. We also have the Dreamers study the data for at least one day.

"When everything is ready, the Dreamers go into a third level sleep. Their minds are then connected to the computer, which activates the first situation.

"In each situation, the Dreamers are put into a life and death situation, usually involving their own lives, and must overcome a problem. The problem they must solve is equivalent to yours, although it is usually in an abstract form.

"With pressure put on them, they must try desperately to solve the problem. If they fail to solve it, the computers kill them and they are reborn into a new situation, in which they are closer to the answer because of previous efforts.

"Their time line is mentally created and therefore very fast. As I mentioned before, they can live and die over a hundred times in one session. When the problem is finally solved, the computer translates the abstract into the original form and the result is in your hand."

Mr. Parks had been quiet and attentive. Now he stood and turned to leave. Dr. Sang-Ti ran his hand through his graying hair, then said, "Mr. Parks, I'm sorry for lecturing to you, but please listen to me for a moment."

Mr. Parks remained standing. Dr. Sang-Ti removed his glasses and continued.

"What do you think would happen to our public relations if someone started a rumor that we used human-machines or something like that? Whatever would happen wouldn't be favorable." Dr. Sang-Ti locked his eyes upon Mr. Parks'.

"But more importantly, what about the Dreamers? They have feelings — they can be hurt just as easily as you can. And it would hurt them to be called cyborg, or human-machines and things like that. Can you see my concern?" asked Dr. Sang-Ti.

"Don't worry, I understand," said Mr. Parks.

"Thank-you," replied Dr. Sang-Ti, as they shook hands.

# Development and Design. 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.

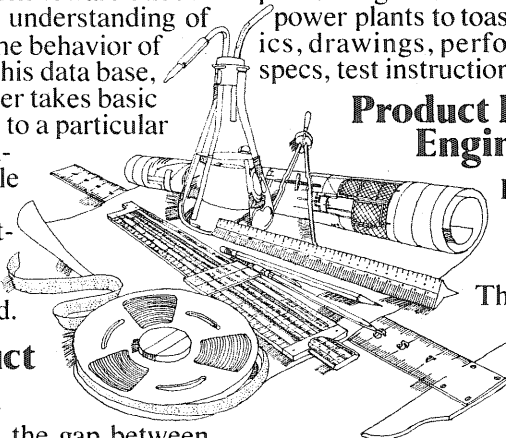
Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

This ad outlines the types of work found in the Development and Design 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-1, 570 Lexington Avenue, New York, New York 10022.

## Basic/Applied Research Engineering

Motivated by a curiosity about nature, the basic research engineer works toward uncovering new knowledge and understanding of physical phenomena (like the behavior of magnetic materials). From this data base, the applied research engineer takes basic principles and applies them to a particular need or problem (such as increasing the energy available from a permanent magnet). Output is aimed at a marketable item. Both work in laboratories and advanced degrees are usually required.



## Advance Product Engineering

Advance engineers bridge the gap between science and application. Their job is to understand the latest advances in materials, processes, etc., in a product area, then use this knowledge to think up ideas for new or improved products or to solve technical problems. They must also prove the technical feasibility of their ideas through laboratory testing and models. Requires a highly creative, analytical mind. A pioneering spirit. And a high level of technical expertise. Output is often a functional model.

## Product Design Engineering

Design engineers at GE pick up where the advance engineer leaves off. They take the product idea and transform it into a product design that meets given specs and can be manufactured. Usually, they are responsible for taking their designs through initial production to prove they can be manufactured within cost. Requires a generalist who can work with many experts, then put all the pieces together to make a product. From power plants to toasters. Output is schematics, drawings, performance and materials specs, test instructions and results, etc.

## Product Production Engineering

Production engineers interface between the design engineer and manufacturing people. They interpret the product design intent to manufacturing. They maintain production scheduling by troubleshooting during manufacturing and determining deviations from specs. When necessary, they help design adaptations of the product design to improve quality or lower cost without changing the essential product features. Requires intimate familiarity with production facilities.

## Engineering Management

For people interested in both engineering work and management. Engineering managers plan and coordinate the work of other engineers. They might oversee product development, design, production, testing or other functions in marketing and manufacturing. Requires a strong technical base gained through successful engineering work. Sensitivity to business factors such as cost and efficiency. Plus the ability to work with people.

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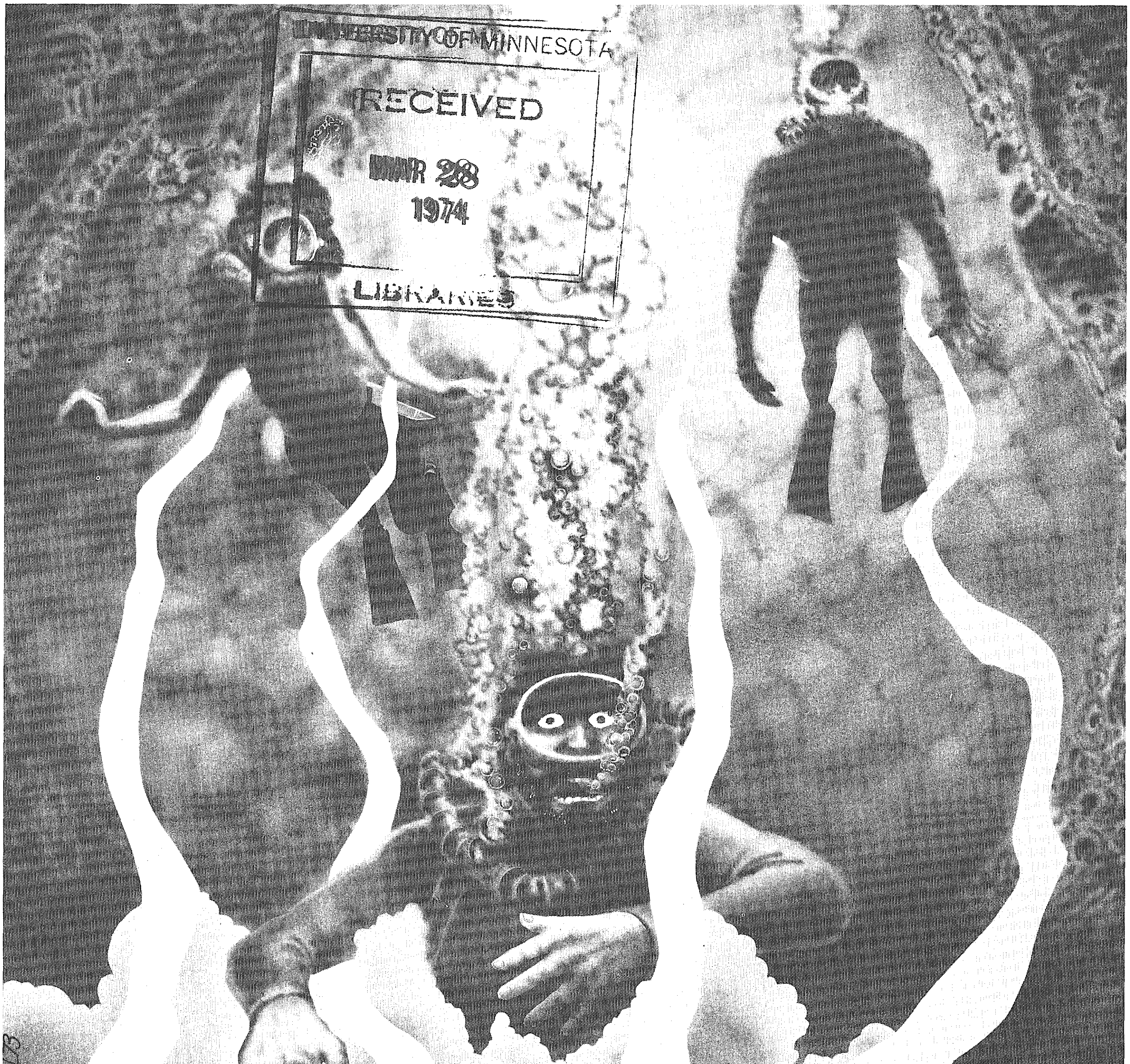
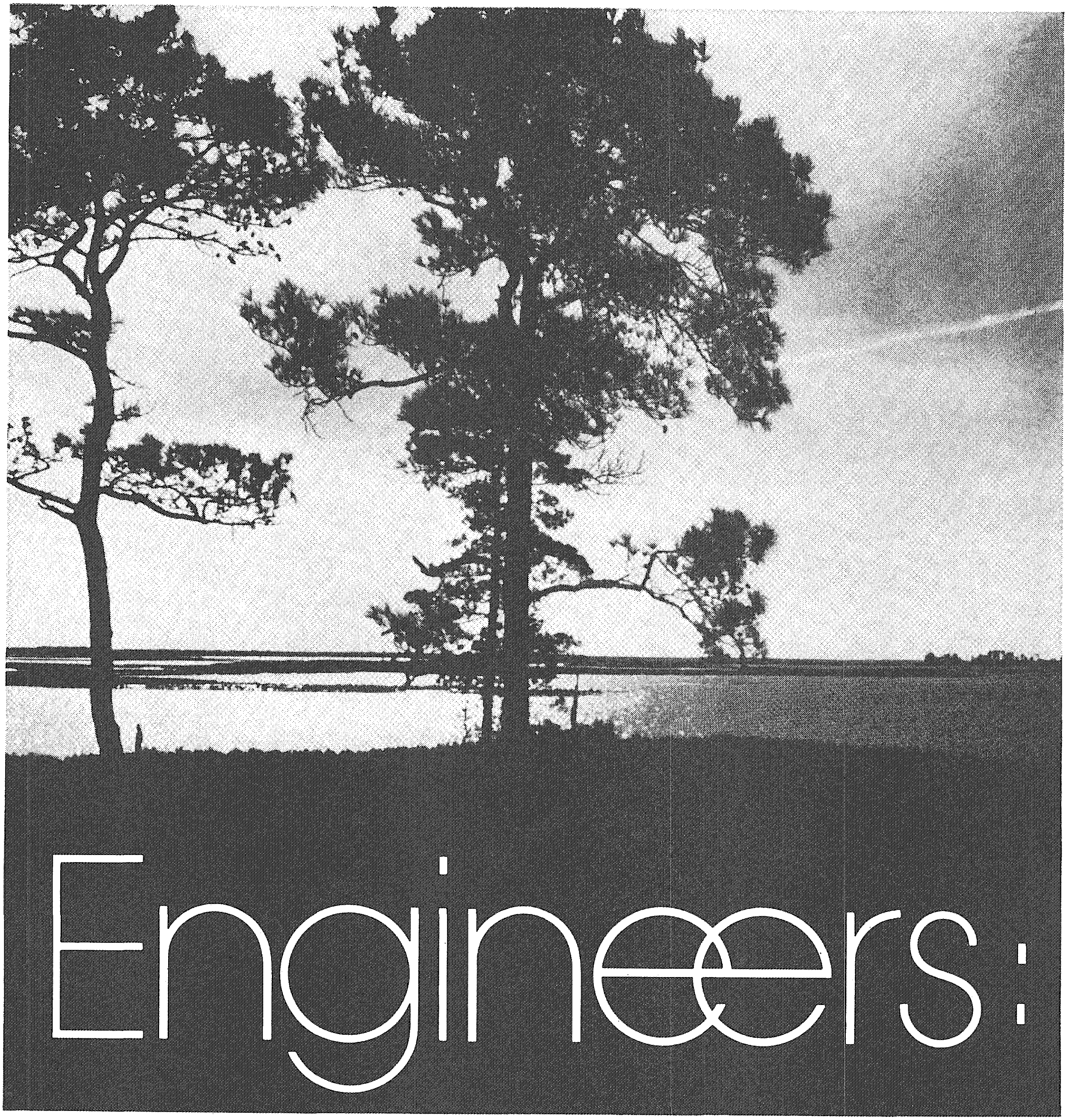
# FICTION - FANTASY - MYSTERY
# DEEP TANK
## Devils - Nanarese - Ameboids

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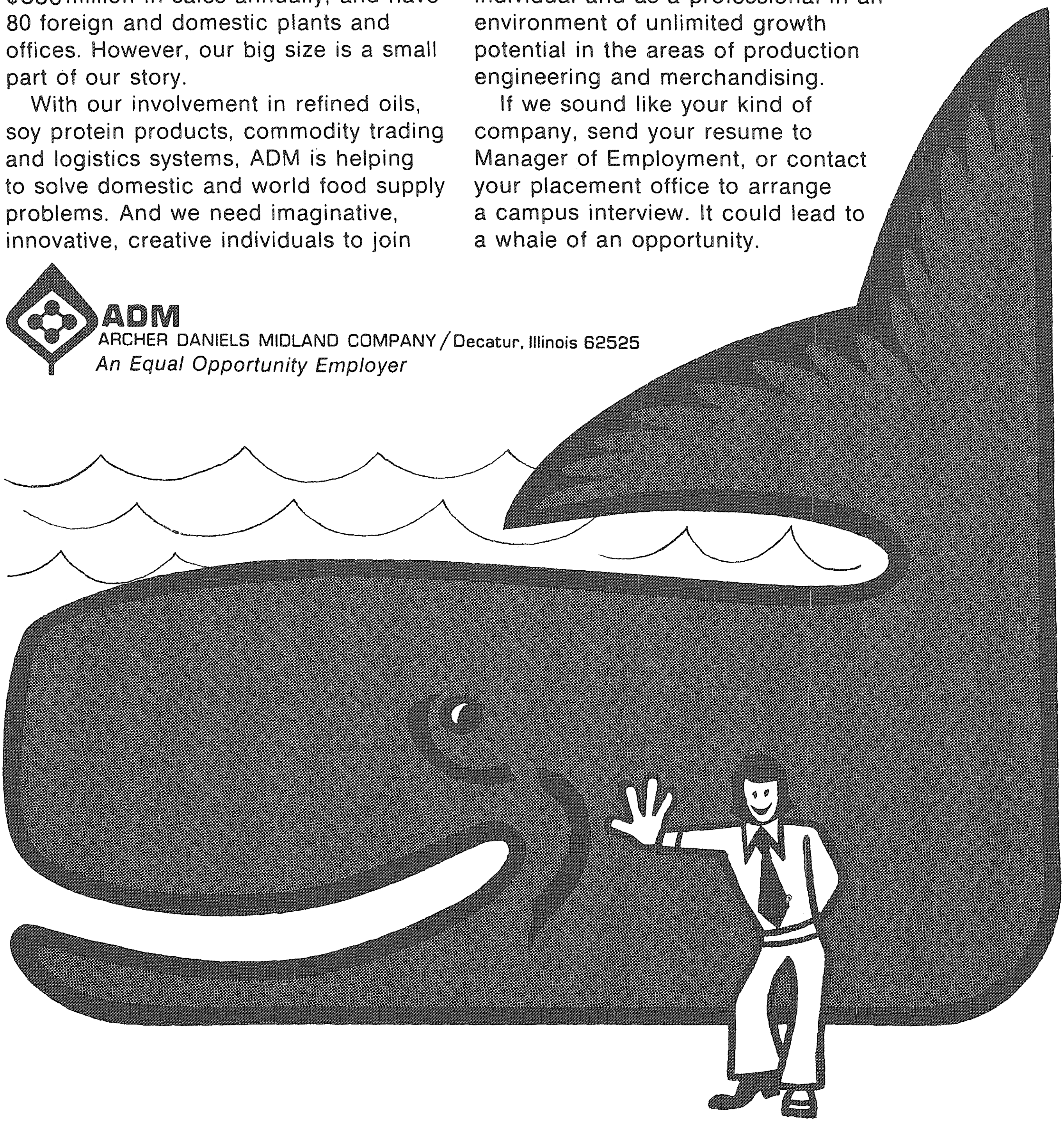

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VOL 54 No 5



**COVER DESIGN BY TIM BOXELL**

# And Cupit! On Donder And Blitzen! . . .

"A comet which will illuminate one-third of the night-time sky. It will be the comet of the century."

Three months ago this was the way the comet Kahoutek was described to us. If that indeed was the "comet of the century" then the Technolog is a weekly news magazine originating from Dayton, Ohio. The best comet remark we have heard so far is "the comet Kahoutek was almost as illuminating as the President's Watergate defense."

If Kahoutek had been the "bonfire in the sky" that our learned scientific community claimed it would be, then the comet worshippers and comet fearers would have appeared in full force. There would have been pagan rites held under the comet's glow, worshipping peace and airtravel, with a golden image of a Czechoslovakian scientist as their Messiah. There also would have been predictions of earthquakes, famine, poisoning, and the comet "taking away our sun." As it turned out, there were no newsworthy comet worshippers at all. As every scientist knows, you cannot worship something you can't see. Right? The only fearers who made the news were the group who said North America would be destroyed by the end of January and the usual gang issuing their semi-annual appeal for the mandatory sinking of Madagascar.

## . . . Which Brings Us . . .

Which brings us to the Technolog Our Science Fiction Writing Contest, which ended 1 December, was a great success, but the deadline was too soon to accept the avalanche of "comet stories" which have flooded our office.

For example, one fool, who resides at the Daily, submitted a short story with the premise that forces exerted by the comet, much like the moon affecting tides, caused the 18 minute erasure and subsequent hum on the Rosemary Woods tape. We suggested to him just where he and his story idea could go, but the Daily Opinion Page didn't buy it either.

Most of the other comet stories — an invention of Buckminster Fuller for reading at night, an electric phallus symbol designed by Randy Scholes, a plot to put Mel Jass in power — are not really worth mentioning. But one in particular caught our eye.

The chief characters are the comet Kahoutek, the planet Jupiter, the U of M physics department, the Ames Research Center, and the Minnesota Technolog. The plot revolves around a graduate student in physics who is befriended by a kindly, knowledgable physics professor who speaks in understandable English (the only one in the department who can). Being a physics student, he misinterprets data stated in plain English and rushes to the Technolog claiming that he just found out that the planet Jupiter will eat the comet Kahoutek and that he knows where he can get pictures and accounts of this event. The Technolog editor, being out to lunch at the time, agrees to print the story and puts out four pages of the January Technolog as an offering of good faith to the comet.

## . . . The Plot Sickens

Now the plot thickens. Kahoutek, being a smart comet, avoids Jupiter's tongue (the big red spot), turns out its lights so nobody can see it, sneaks up to the earth at night, devours the four pages of the Technolog and flies back from whence it came.

The Technolog, seeing that its four pages are gone, rushes over to the physics department for an explanation. First they are rebuffed by a professor named after Battle Creek, Michigan. Then a professor with a stigmatism, says he will be glad to interpret this data for the Technolog, but only if it first appears in Science News, Scientist, and the Ladies Home Journal. Finally, the head of the physics department meets with them only long enough to take away their calculators.

Meanwhile the Ames Research Center is baffled as they have some strange pictures showing the planet Jupiter sticking its tongue out. Not knowing what to do with them they follow established government procedure; they label them "top secret" and release them to the general public.

The graduate student who caused the commotion goes into seclusion in Physics 424 and the story ends with the Technolog irrevocably losing the four pages and being forced to run a magazine only 20 pages long in January.

Of course the story is totally fictitious. It is quite a coincidence, however, that the minimum number of pages the Technolog published per month this school year is 24 and that the Technolog has published either 24 or 28 pages every month, save one. That month was January, when due to circumstances beyond our control the Technolog was forced to cut back four pages and run a 20 page magazine. We are still marvelling at that coincidence.

# An Afternoon In Limbo, With Brandy

"Limbo isn't such a bad place," said H. G. Wells to Winston Churchill.

"But nevertheless, doesn't it strike you as odd that they should have no place in which to put us?" Churchill pointed upward and sipped his brandy.

"Well if they had put us in hell, we wouldn't have this magnificent drawing room; and if we were in heaven we wouldn't want it."

"Wells, I hate to agree with you. But this time, I believe, you may be correct."

"But now we're dead, we're always correct."

"That's one of its pleasant side-effects. Have a cigar Wells, as long as we're conjuring." Sir Winston materialized a humidor and passed it over to Wells, and the latter selected a fine stogie and lit it.

"What bothers me, Winston," Wells said with a touch of formality, "is just this — We're part of it all now, and we know everything; but what about the poor blighters still left on Earth making a struggle of it?"

"What of 'em? What can we do for 'em, or they for us? A whole lot of prayers we can send back and forth, but it all amounts to a lot of noise, all reverberating with import and all of it perfectly useless."

"But doesn't it bother you that we can't do anything? Think of the struggle, all the bother they go to in order to learn one little thing. And think how many of their own kind try to stop them from learning anything at all. Why in America today —"

"America!" snorted Churchill. "Now there's a conundrum. What's the one thing that in it's unity will split everything asunder? The United States. Those people could do anything —"

"And they almost have. They've stopped themselves from learning by electing men for nearly a century who know little and care to know less. How can they help themselves out at all if they can't learn anything new? How can they make progress?"

"If they did learn anything, they'd eventually learn how to stop dying; and then they'd learn everything. And that would eliminate the need for us. And perhaps they'd get around to reviving us. Now then, where would we be?"

"We'd be in two places at once, no doubt. But you evade the question, Winston. Mankind must progress or die. Since our sphere of existence isn't related strongly to that of Earth, there is no way in which we can really help the living along, other than by deeds we did or things we said when we, too, lived."

"But scientific investigation will help them, eh?"

Wells sipped at his brandy, considering the tone with which Churchill had asked his question. Was there serious wonder in that sentence, or was the man being cynical?

"Churchill," Wells said, "scientific investigation is the only thing that **will** help. Anything that's soundly studied is scientific, whether politics or atoms. And only if science is allowed to progress in allthings will there be any progress at all. So, all in all, everything must be studied to the absolute, greatest depth."

"And does that kind of investigation include the personal affairs of men and women? If you include such study, why you do away with privacy. Even here in limbo, we have privacy!"

"But there's privacy in neither heaven nor hell, Winston. The souls all group together into torture or bliss, and we few question marks sit here in Midgard and stew. 'And on Earth as it is in heaven . . . God wants an Earth without privacy it seems."

"By God, no! Posh and piddle!*" Churchill turned red with anger. "There'll always be a need for limiting knowledge, for privacy. If the standards of taste don't tell a man to stop his research, then someone else ought to, by God! Enough of this claptrap. Good evening to you, sir." And Churchill vanished from the room.

Wells sat there in his overstuffed chair, smoking his cigar and thinking. To him it seemed that the only society that could learn everything would be one in which there were no privacy, in which everyone were equal. But he was daydreaming again, and he had to get back to work. One could not stay in limbo without working.

"Churchill," said Wells to the silent room, knowing full well that he would be heard, "men will know everything eventually. Then they will be gods themselves, and we'll be freaks at a circus show. Soon enough, they'll get around to studying us, here." Wells put out his cigar, sipped the last of the brandy and dissappeared. The room blinked out of existence after him.

*The Minnesota *Technolog* is a family magazine and in the interests of good taste, the United States Postal System (with its pornography statutes) and the ears of our youthful and clean-minded readers, we refrain from printing the complete oath as it was originally uttered.

Robert Pirro & James M. Young

# ADDENDUM:

# BRAVE NEW CALCULATORS

The same day the October issue of the *Technolog* went to press, several manufacturers introduced new calculators that were meant to compete more directly with the Hewlett-Packard models.

Meanwhile, Hewlett-Packard came out with the HP-65. It is programmable, weighs only 11 ounces, and is the same size as the HP-45.

The Texas Instruments SR-50, priced at $169.95, makes the new calculators of the other four manufacturers look very poor. The new SR-50 does everything that the HP-35 does, including ten place scientific notation. It does not have polish notation or an operational memory stack. Using ion-implantation technology, the whole works have been shrunk down to two MOS integrated circuit chips, meaning lower power draw and more dependability. One of the chips is the largest MOS read-only memory presently in existence, having 13,312 bits of memory storage, and yet it is only 200 mils square.

North American Rockwell (Unicom), Sears, Bowmar, and Lloyds, have come out with identical calculators costing $190.00, $170.00, $180.00, $200.00 respectively. All four perform the functions of the HP-35 but none of them have scientific notation or polish notation. Considering that the SR-50 costs less than or equal to all of them it appears that the above manufacturers are caught with a warehouse full of junk.

Hewlett-Packard unveiled its new HP-65 at a trade show in Chicago. It looks just like the HP-45 but instead of having a yellow key, the HP-65 has a yellow and a blue key allowing each key to perform three different functions. Small magnetic cards are drawn into the calculator by a small one ounce motor. Programs up to one hundred steps can be stored on these cards for future use. A small library of preprogrammed cards are also available for standard engineering problems. At a price of $795 and considering it's pocket sized, it should compete well against the programmable Compucorp model that isn't pocket sized.

Due to the energy crisis, plastic has been in short supply and many manufacturers have been having trouble keeping supplies stocked for making calculators. In fact, Hewlett-Packard had to switch their HP-45 production line over to a different plastic this fall.

And for those of you that have more than a couple of thousand dollars burning a hole in your pocket, you can now buy a desk sized (typewriter sized), calculator that is programmable in standard BASIC programming language. What makes these little computers better than working with a large model is that all the programs and compilers are hardwired in the integrated circuits. This means that you can do large matrix inverses in a smaller amount of time than it takes the big computer to do them. Also, because these machines use standard BASIC, it means you can have subscripted and string variables.

If you don't feel in the mood to program you can use these new computers just as you would a calculator.

It was just five years ago that the HP-45 was the size of a typewriter and cost several thousand dollars. Hopefully the same thing will happen in the next five years with the new BASIC programmable computers.

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If you think your credentials and goals are in tune with our needs; if you've got a career in mind and the motivation to achieve—we invite you to look at our company. You could start something that will last a long time.

Write to George C. Crook, Manager, University Relations and Professional Recruiting, Corporate Personnel Dept., 800 North Lindbergh Boulevard, St. Louis, Mo. 63166.

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I had almost despaired of saving the big male dolphin, who thrashed panic-stricken in the shallows. He had flung himself far past the low-tide line toward the dry land, and now, under the hot morning sun, the tide ebbed rapidly. I struggled to swing his tail around and push him to open water, but already the water was so shallow that I feared I'd never be able to drag him across the jagged coral without it slashing open his belly. As the dolphin whistled his fear and pain, I caught repeated mention of some awful danger, a signal akin to the three short whistles for "Shark!", but subtly different.

Suddenly a pair of heavy sea boots splashed in the water beside me, and two powerful arms grabbed the suffering creature forward of the dorsal fin and lifted him nearly out of the water. I had no time to stare at the burly, blackbearded giant in seaman's clothes. He showed little effort at carrying most of the dolphin's 350 pounds, but I stumbled along keeping the dolphin's tail from dragging.

When we reached sufficient depth, the newcomer gently eased down his burden, but still kept restraining arms on the confused mammal. I pulled out a dolphin-pipe and whistled assurances to calm the cetacean. Finally he quieted, and after an exchange of every-day pleasantries to help him forget his trauma, I encouraged him to seek the open sea.

"Thank you. If you hadn't come along, the dolphin would have been stranded ashore to suffer death by dehydration."

"Aye. Glad to help. But I didn't happen here by accident. I'm Harl Hobart. I came over to Fayal Island from Ponta Delgada to hire you as sea-speaker. The European Shipping Combine has commissioned me to establish trade routes to the New Mayan States. They've given me command of a fine ship, and I'm sparing no expense to outfit her over at Sao Miguel Island. It's my own idea to bring you on this voyage, but the Combine will pay double your fee. Short notice, y'know. We sail on the tide."

So this was the famous Black Hobart, Terror of Shipping, and Wolf of the Coasts! The only man to make modern piracy profitable, he used guile and subversion besides bold seamanship.

The current rumor in the Azores Islands was proven true: that the Shipping Combine had finally bought him off with money and a high position. His smooth good manners now, and casual, last-minute invitation did nothing to allay my doubts.

I'd worked with the Combine before, though, and their money was good. I sometimes declined offers by this organization, and sailed instead with local fishermen; much less rewarding financially, but affording opportunities to study and improve my skills.

I suppose that eventually sea-speaking will become a big business, with professional societies, and licenses to limit membership, but right now no more than a dozen Europeans possess this highly-prized talent.

Sea-speaking requires natural talent and, early in life, self-discipline and training to develop it. The ability resembles clairvoyance or telepathy, an almost psychic empathy to sea creatures, and awareness of the whole ecosystem of Earth's oceans. Essential also are sensitive hearing, perfect pitch, and linguistic experience. A sea-speaker knows the coming weather over a large area, pilots ships safely through treacherous waters, leads fishermen to good shoals of fish. Through a collection of sophisticated, unique pipes and whistles, a sea-speaker communicates with the intelligent marine mammals, obtains their cooperation, listens to their news, and benefits both human and cetaceaen races.

I'd taken no long voyages lately, and only visited America once.

"I'm your man, Captain Hobart."

"Good. Good, my boy," the Captain beamed, pumping my arm vigorously. "Will you aboard now?"

"Your ship will pass offshore here, outward bound, will it not, sir?"

"Aye." Reservedly.

"I'll board her then," I announced with finality.

The captain looked puzzled, but grinned and strode down the beach. He had my services and could indulge my whim.

The sharp volcanic peaks cast a cloak of dusk far out on the sea,

# Devil under the Sea

by John Hardigan Waldo

almost to the ship that gleamed in the last red rays of the setting sun. I could hear the excitement aboard when the waiting crew saw me emerge from the shadows, riding Roman-style on the backs of two great black orcas, rushing across the water like King Neptune himself. It was no mean trick to balance on the slippery, plunging giants, steadying myself only by the tall, narrow dorsal fins. Barefoot, too; my sharkskin boots would scratch their skin, and were stowed with other equipment on my back. I never missed the opportunity to make such a spectacular entrance; it enhanced my status with a new crew and added to the fabulous reputation enjoyed by sea-speakers. The two killer-whales welcomed the chance to show off when I explained what a sensation our appearance would cause.The orcas put their heads out of the water and whistled to the men lining the rail, then departed.

The captain and his officers greeted me on deck. All sea-faring nations and more seemed represented in the crew. The over-large, hundred-man crew looked more accustomed to cutlass and gunnery work than fishing or coasting.

The ship, "Zigeuner," of Hanseatic registry, measured 250 feet stem to stern; grossed about 1200 tons. An old ship, she'd been designed as a short-sea trader in the last ship-building days of the late Twentieth-Century. The engine and machinery aft, bridge amidships between the two cargo holds, much as originally designed in a richer time, but modification of the cargo masts to carry fore-and-aft sails suggested frequent engine, or as often occurred nowadays, the faulty, worn-out engine consumed all its scarce fuel. "Zigeuner" cruised at 12 knots, and under sail achieved all of 4 knots. I wondered if the captain expected me to call whales to tow us when becalmed.

Next morning I found the crew efficiently practicing gun drill on a massive deck-mounted 3-incher, and Hotchkiss quick-firers atop forecastle and fantail, besides several heavy machine guns. It was time to ascertain why a trading ship carried heavier armament than any vessel afloat.

I burst into Captain Hobart's cabin to find him conferring with his first officer and a lovely, dark-haired young woman. Her ornamental jade nose-plugs showed her high position in the Sun Priesthood at the restored city of Chichen Itza. She met my bold stare with a steady evaluating gaze.

Captain Hobart anticipated my questions and indicated a chair.

"Recently a large number of ships have gone missing in the Atlantic. The latest disappearance was a grain ship from New Orleans. It's loss two days ago followed the standard pattern: garbled and frantic radio transmission, then silence, and no trace of survivors or wreckage to searching ships. The Combine sent me these guns to . . . ah, neutralize the menace to navigation.

"However, my sources of information convince me there's no piracy involved. I've my own theory, which is why I invited you and Senorita Teomec." The Mayan smiled at me in acknowledgement.

"You've no doubt heard of the so-called Bermuda Triangle, where literally hundreds of ships whose courses crossed this area have disappeared. Even the U.S. Navy recognized the undefined menace that sailors called "Hoodoo Sea", and advised its mightiest vessels to steer clear. The loss of many airplanes during good flying weather was even more shocking and frightening.

"I believe the passage of men and ships triggers some unknown process, a vortex, or time-space anomaly. I would simply recommend that shipping avoid the area, but this phenomenon, whether geologic or atmospheric, is rapidly spreading to cover the whole ocean."

Teomec interrupted, a fierce light in her dark eyes.

"It is the wrath of the demon-god Qrutlx! He slept deep under the sea floor since the defeat of chaos. Then the thoughts of multitudes of men crossing the sea awakened him. Qrutlx is lord of sea and air, and the Enemy of all Life; when he stretches out his hand, the elements tremble! When He walks from His cave under the ocean bottoms even the great god Kukulkan, and white-skulled Ah-pech flee before him!"

Great, a fruitcake captain and a fanatic pagan Sun-priestess.

Hobart could read my skepticism.

"Don't you remember how we met yesterday, only hours after the grain ship disappearance? I've talked to other sea-speakers who wondered why healthy whales and porpoises throw themselves on shore."

"Yes, that behavior is often observed. The dolphin we rescued kept squeaking an unfamiliar phrase, like "Ravener", or "Destroyer". If he heard the terrified cries of dolphins far across the sea he might have been driven to hysteria. He was so afraid that he tried to escape from the sea itself." I realized what I was saying, and stopped.

For many days I only saw the

Captain when I visited the bridge to watch our slow progress across the chart table. Teomec stayed in her Cabin. I spent most of my time talking with the hands or listening to the operatic gossip of distant humpback whales. Twice the ship changed course to avoid fouling the propellor in mile-wide rafts of plastic and oil sludge, reminders of the filth and corruption that almost murdered Earth's oceans in the Twentieth Century.

At night eerie bands of phosphorescence flickered across the rolling waves. During one graveyard watch, terrified seamen swore by all the saints how a spectral ship followed our wake, then vanished in the mists. Ghost ship or bad omen, to bolster confidence, the captain ordered the guns manned and ready during all watches. The ship's isolation weighed heavy on our minds, alone on a sea more deserted today than in the early colonization times.

I felt the tension when I came on deck one afternoon. Crewmen loitered nervously on deck; Captain Hobart paced about the ship double-checking all machinery, rigging and armaments; Teomec gripped the rail, staring out to sea as if her gaze could pierce the depths. I heard only the most distant sea-mammals, and these sounded frightened.

Then I looked up and saw the awful change in sky and sea. The waters lost all motion, turning pale and glassy. An air of oppression settled from the leaden sky. The propellor thrashed ineffectually and the ship lost all headway, as though trapped in a deep basin, trying to climb impossibly steep sides. While we waited in terrified expectancy, a gun crew fired a few rounds into the air. How could bullets stop a peril that approached from all points of the compass?

Before the process came to a climax, Teomec reached inside a leather bag, and, shouting several words of an unintelligible language, scattered a handful of green powder toward the lowering sky.

Instantly, the Presence hestitated, and the alien condition dissolved back to the familiar tropical sea of gentle waves under a warm sun.

Two days later we hove to and anchored at Teomec's command in the shallow clear green water of the Bahamas. Captain Hobart requested that I summon several porpoises. The crew opened deck lockers and produced three complete sets of SCUBA equipment. They attached an air cylinder to a cumbersome, hand-cranked air compressor and began charging the bottles. The captain inspected air gauges and hoses, while Teomec loaded strange powders into a pressurized marker-dye bomb. I felt some misgivings, since SCUBA gear is today worth a king's ransom, and I had little experience.

Teomec, Hobart, and I rode in the whaleboat manned by six heavily-armed crewmen toward a distant reef where the waves foamed. Far ahead I saw a deep blue patch in the otherwise light green sea. The four porpoises gliding alongside showed agitation, and voiced their disapproval as we drew near this place.

All hands kept a hushed silence as we stopped over the submarine pit; I recognized the formation as Bahaman "blue hole."

Teomec dropped into the water, holding her mask tight with one hand, a marker bomb clutched in the other. Hobart and I followed. Once submerged, I gave directions to the circling porpoises to maintain shark patrol and rescue us if necessary.

We swam downward, our only light a waterproof torch, pitifully inadequate. Crumbling, eroded limestone made up the jagged walls of the cavern, which seemed to drop hundreds of fathoms into the abyss. Side corridors and tunnels twisted away, extending for great distances through the spongy rock. They seemed to underlie the whole ocean floor.

Teomec examined these passages carefully, then led the way down a wide-mouthed gallery. A hundred yards along this tunnel, the rough limestone became smooth and regular. Vitrified by great heat, the walls bore a strange style of bas-relief, dim with age but still depicting unfamiliar scenes and creatures. What forgotten hands carved on the rock a million years past before the sea covered it?

A shimmering swept through the water, like light shining through the fabric of existence from another universe. Teomec frantically gestured that we turn back, then hurled the marker bomb into the boiling darkness. A tumult rushed through the submerged tunnel, buffeting us against the walls, and I lost consciousness.

Gentle souls that they are, porpoises are braver than men. Ours dragged us from the chaos erupting below, held our limp forms underwater for decompression allowance and returned us to the whaleboat. Teomec assures me vigilance will keep the menace in check, and I hope for a new era in the sea for man and whale.

But Harl Hobart, I think, turned once to see the face of Qrutlx. He bought a Spanish farm far inland, and they say he stays indoors when the wind blows from the sea.

# imperfect catch

My job was simple – catch a thief. There was one problem: the thief was a member of a good-will mission from the planet Nanar, and my job was to prevent anyone from interrogating the Nanarese.

by Nathan A. Bucklin

My father was the strolling piano player in the Skyport lounge, and he taught me everything he knew about free fall. It wasn't enough – even after a lifetime of practice. After my fifth failed attempt at pacing the floor in magnetic boots, I gave up and lay back to think.

**How.** The question had been beating at me for two weeks. In three hours the Nanarese ship **Cymbal** would be docking; aboard it would be the stolen Nanarese royal tarnstones. My job: Find the stones. While I'm at it, detain the thief. And by the way, do absolutely nothing to invade the privacy or affront the dignity of the eight Nanarese Ambassadors for Friendship. **How.** And knowing that my career would go out the window if I failed didn't help matters one bit.

The last time I'd been in any danger of anything had been thirty years previously. Somehow, I'd gotten away with all but three of my fingers. This time, I might have no way out at all; if I was fired at this space station, I'd be washed up at all of them. And Earth's gravity would kill me.

The visiscreen rang again. I tapped the button with my right hand – my good one – and waited for the connection. I didn't bother saying "Stubs Corning's office" or anything like that; people knew me, or they didn't call. But it was Montpetit, anyway. Nothing does any good with him. "We've got a lead, Stubs," he began. Good. A lead. What good does any lead do me, until my superiors untie my hands? "I know what you're thinking, but this one's good. Remember the list of qualifications we drew up for the thief?"

"Sure," I said disgustedly. "Native Terran, fluent in the chief Nanarese language but without the native sense of honor; has to be left-handed, have perfect pitch and otherwise be able to imitate a Nanarese. And when you tried to make up a list of Terrans who fit that description who had ever set foot on Nanar, you found out there weren't any. What else is new?"

"Stubs, Stubs," said Montpetit. I think Monty would be easier to take if he didn't sound so tired all the time! But then, living under a full gee's pull must do that to you. I suppose I'll never know. "There are Terrans with Nanarese facial characteristics."

"And most of them are on reservations and have never seen a space ship in their lives," I shot back. "And the resemblance isn't that close. Monty, can't you stop rehashing old ground and use your head?"

"I have no intention of wasting Sky Control's time or yours," said Montpetit imperturbably. "We finally found one. Kenneth Green, male, 26. Mixed ancestry. Enjoyed a brief success as child recording star 20 years ago, dropped out of sight completely two years later. His parents gave him up for lost, and both died within two years after that. However, a newsman in the department thinks he's traced Kenny to a flight bound for Nanar."

It did ring a bell, at that. Hell, I had three of Kenny's albums on the communal record shelf. "I remember Green," I said. "How did you reach the conclusion he's our man?"

"We didn't," Montpetit corrected me. "But it's the only lead we've got. At the time, Kenny's father's alcoholism and Kenny's nightmares were hot copy. Kenny finally told the newspapers that his biggest ambition was to run away and never see his parents again." Monty paused – I knew it was just for a deep breath – Monty has lung trouble – but it irritated me. Everything Monty did irritated me, and he knew it.

"You probably don't need much more detail," he concluded. "Kenny's career sort of folded; people who say un-American things like that don't stay popular very long. Kenny had enough clout of his own to pay people good money to shut up about where he'd gone and how. Specifically, nobody would tell what they knew until Kenny's parents were dead – and by then, nobody cared enough to ask."

For a moment, I sympathized with Montpetit. Cold trails are no fun, and this one had a sorry story to it. Then I shoved the sympathy back where it belonged. Earth Customs has it easy – nothing can get to Port Chesapeake that hasn't been cleared by Skyport, which means Skyport does all the work. "How did you get onto him?" I asked. I couldn't operate unitl I had some information. **Any** information.

"We nearly didn't," admitted Montpetit. "There are still some Kenny Green fans; one of our men saw a left-handed Kenny Green model guitar in a store, and it stirred his memory. So we traced back from Anchorage, Alaska, clear to Baltimore. Records have one kid, eight years old, height and weight reasonably right, wrong color hair but brown eyes, and the dates match perfectly."

"And the ship the kid was on stopped at Nanar." I made it a statement.

"There you have it," said Monty. He spread his hands, face up. I **hate** it when people do that. "I wish I had fingerprints, but —" He didn't finish.

"Send them up when they come in," I told him. (I wish I had fingerprints too, fella! And some spare fingers wouldn't hurt . . . ) Fingerprints were always available, actually — Monty meant he'd delivered the information to me before the prints had arrived. For that much, I was grateful. Two hours until the **Cymbal** came in. Two hours to set a trap. And three hours maximum to make it work.

We finally signed off. I could have left my office and gone sailing around the station; nothing refreshes me more than a good view of outer space, and the lounge brings back pleasant memories. But time didn't permit. I pushed my door open, one-handed, so I could at

least look down the corridor at the rotating rim; then I shut it again and went to my desk to start writing down ideas.

For starters: assume Kenny is the thief; how would he be recognizable among the passengers and crew?

Forget the crew. Nanar allowed nobody to be employed on a spaceship who had not been born in the Kingstate's capital province; Kenny could never have forged the royal seal on the local birth certificate. Besides, Kenny's personality was likely to be too unstable to pass a crewman's stringent personality tests.

Passengers — not much better. I looked at the list on my desk again. Forty-six returning American and Canadian tourists — scratch them! No, there was one male the right age and weight; and Kenny had dyed his hair before, he could do it again. But his eyes were blue. Or did he have some new high-powered contact lenses? I pulled his retinal pattern from the files, just in case.

Seven Nanarese immigrants — I still couldn't figure out the odd one, a female, but the rest were plain enough: three young couples passed by the Colonial Board, guaranteed fertile. I **thought** that crossed out Kenny; last I'd heard, Nanarese-Terran fertility was still in question. But the descriptions weren't right anyway.

Now, the prime suspects.

My list had the Nanarese Ambassadors for Friendship listed by instrument, not by name. I'd studied the instruments for hours, trying to figure out which Kenny was likely to play. Two dragonets, bass and tenor; a wood-violinist; a percussionist (drummer if you want — but they don't **look** like drums, and the gonglike and loglike accessories around his or her head are every bit as important); a harpist; a guitarist and an organist — both concessions to the musical tastes of Terran listeners, save that middle C on the organ was tuned a quarter step flat, and every other note on organ and other instruments was tuned to match; and a vocalist. Every single one raised with a strong sense of honor and privacy — unless one was Kenny — and every single one under Nanarese diplomatic immunity.

Back to the passengers. Could Kenny be the single female? Nobody on Earth had seen or heard him since his voice had changed; had it? Nanarese didn't go in for sex change operations, did they? All of a sudden I had something to leave the room about; but Gary Ryan came in from the teletype office before I'd gotten to my feet.

He offered me an envelope. I took it and said nothing. It's your prints, sir," Gary blurted. He's afraid of me. Sensible of him. "Fingerprints and eyeprints for Kenny Green. No overlap with passengers on **Cym-**

**bal's** last outgoing trip; Chesapeake's already checked." He ran out of wind. I tried to meet his eyes, but he was staring at the floor.

"Ryan," I said, "I want you to find out everything you can about sex change operations on Nanar. And don't interrupt me again until you have the information."

"But I already know," he said, startled. "It's in there. Blurring of sex lines taboo in some cultures; plastic surgery as advanced as Earth's but limited strictly to repair of accidental damage or mutilation. Cosmetic and psychologically therapeutic surgery is unheard of and technically illegal."

Repair of accidental damage . . .

"Thank you, Ryan," I said. "You may go." But he remained, staring at me now instead of the floor.

"Sir," he got out, "it's Kenny Green, isn't it?"

"We don't know," I told him. "Get out."

He stayed. "Sir, Montpetit told me to make sure you opened that envelope."

"**Damn** Montpetit!" I roared. "Get out and let me work!"

He got. For a second I thought he was going to lift both his feet off the floor, but he didn't.

So I opened the envelope. What did you expect me to do? There are some things I refuse to do with anybody watching. And there was information inside: Kenny Green's fingerprints and retina prints, suitable framed and centered for placement in the "blink machine" (used for comparing retinals of the same people at different times, to guard against impersonations). And a photostated encyclopedia article.

One hour until arrival time of the **Cymbal.** Something in that envelope would have to tell me what kind of trap to set.

What did we know about the Nanarese?

The article appeared to be a preprint — and the information contained did appear to be new; was it from next year's Britannica or something similar? But the only relevant paragraph was the one that talked about miscegenation.

"Now that over a hundred Nanarese-Terran marriages have been contracted, it is estimated that at least 16 percent of them are interfertile, with a slightly higher percentage of successful pregnancies when the mother is Nanarese with a Terran husband, slightly lower when the mother is Terran with a Nanarese husband."

So, fertility tests or not, I still had to suspect that one of the three Nanarese husbands might be Green.

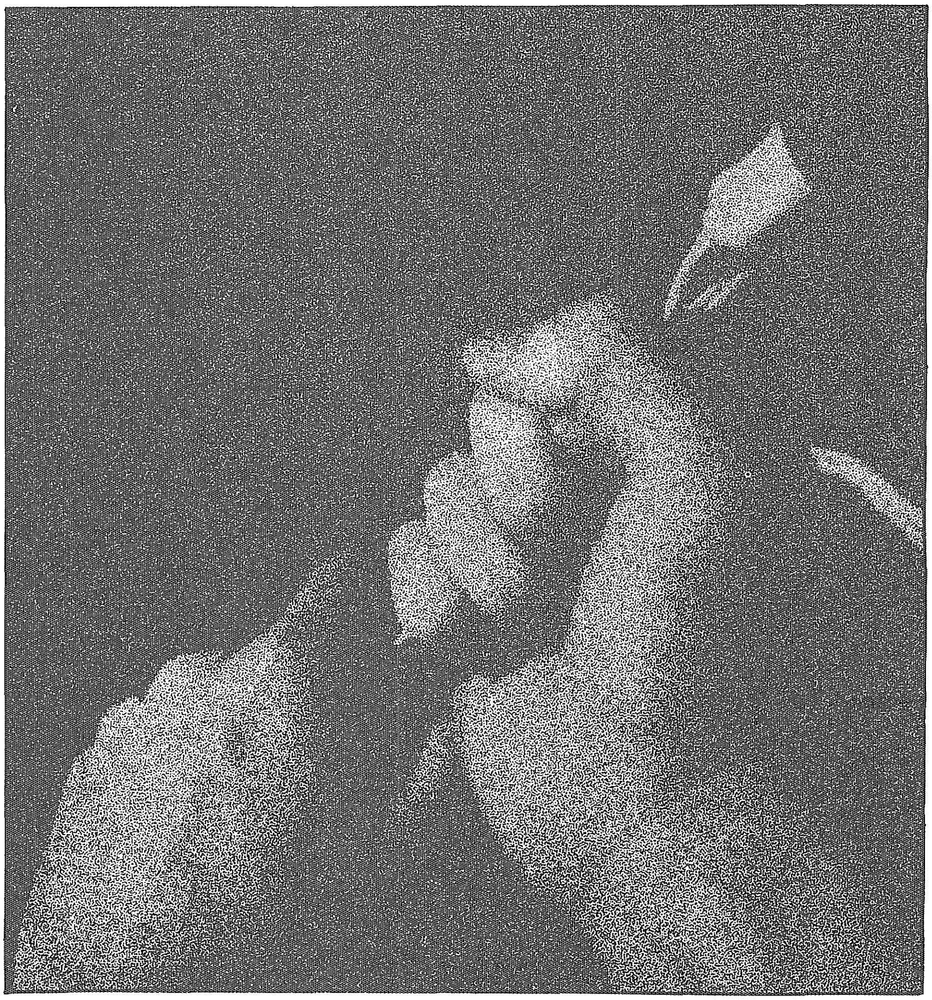
Half an hour until arrival of the **Cymbal.** I decided to stretch my legs and see if a change of scene helped clear my head.

The lounge was dark and crowded. A constellation that may have been Canis Minor was roughly centered in the biggest viewscreen; several tall, dark-skinned Procyon colonials clustered around it and tried to pick out home. The small piano lay at the end of its track with a strap across the keys, meaning that Balzarotti was asleep; he couldn't work around the clock the way many of us were expected to. (A job's a job, but you can push real talent only so far — they'd learned that pushing my father.) Most of the seated people were in near darkness; the waiters were used to it, and it gave a better view of the stars. Somehow I spotted Karen Bowes, the station's general manager, and maneuvered toward her through the closely-packed occupied tables.

"I want us to do something drastic, Bowes," I said. "I think I've got the answer."

"I'll believe it when I see it," she said. Curt. Sane. "What do we do?"

"We throw a live broadcast of the Nanarese," I said. "From here. Clear out the partitions in the Hub



so we've got an auditorium."

"What if they're not willing?" Bowes asked.

I noticed out of the corner of my eye that Ryan was tending bar. That settled it — bartenders up here were off-duty workers, Ryan's mixed drinks were terrible, and I didn't want to talk to him enough to ask him for one. I thought sobor thoughts abd looked back at Bowes. "They will be. That was part of the deal. Once they're under Earth jurisdiction they play according to our schedule, in our choice of cities.

The Earth government did give them a suggested schedule, and the Kingstate did the same for the Terrachoir on Nanar; but that was a courtesy only. Give them an hour's warning, and they'll be ready to go. And I can spend that hour proving to you that the thief is one of the jnanarese."

"You may be right, Corning," said Bowes, "but I'm in charge and I don't make deals. Prove it to me first. If I take action against the Nanarese at any point without proof, I'll lose my command."

I'd risen halfway to my feet without knowing it. I strained to keep my voice low as I said,"Make it my decision. Say you knew nothing about it. Help throw the book at me, if you want. But you know I don't make mistakes often, and you know I can't go back Earthside. So you can assume that I'm not risking anything."

She capitulated instantly. Bowes **never** does that – knowing that I can't live in a gravity of more than .4 Earth never made a difference to her before. I think it had just dawned on her that maybe I knew more about this problem than she did."We'll do it, then. Shall I start informing the passengers?"

"No," I said roughly. Then I gentled. "Wait until the Procyon liner leaves; I don't want any of that bunch jumping ship to hear the concert. Then go ahead. But whatever else you do, send someone down to turn off Balzarotti's alarm clock." She looked startled. I finished anyway: "This room is going to have no use at all for music for a number of hours yet."

Most of the instruments were electrified. I'd been told to expect that, and the instruments were already adapted to 110 volt AC current, so the power cords on hand would suffice. Only two of the Nanarese spoke English; the drummer – female – and the harpist, whose grammar was pure Nanarese, turning the vocabulary of English into a language more foreign than any I'd ever heard. The organist and second dragonetist were female as well; that left four conceivable suspects out of the eight.

I searched the four faces for anything that would remind me of the child Kenny whose pictures I'd seen. It was no use – all four faces reminded me. Kenny was one eighth Indian and one eighth Eskimo, selective breeding couldn't have produced a better imitation Nanarese face, and Nanarese all look alike to me. Others who had been Kenny Green fans were looking for resemblances; even so, there was confusion. Karen Bowes swore that the first dragonetist was him, and wanted to arrest him on the spot; Ryan swore it was the guitarist ("Assume he had plastic surgery on his nose just before he left Earth, wouldn't he look just like that?"). Personally, I saw more resemblance in the wood-violinist, whose pressing hand (his right) seemed to be held in a guitar style, with almost no adjustment for the wood violin's rounder neck and lack of frets. But there was plenty of room to doubt.

Green had played steel guitar and lap guitar on one of his albums, hadn't he? But no, I had no pictures that would show his hand position. Besides, the wood-violinist would never hold still long enough for a comparison check and I was really busy – coordinating a searching party, telling them what I knew of the interior design of a Nanarese passenger ship, trying to reassure the nervous little lapidary whose job it was to verify the tarnstones' authenticity, trying to stall off Montpetit (who did call and just couldn't understand that I lacked time to talk to him), and trying to keep an eye on eight Nanarese musicians to make sure one didn't run back to his or her room for a forgotten gong or some such.

The littlest thing was the routine with the fresh retinal prints. Montpetit had called about that specifically, which was stupid – if there was one procedure everyone knew, that was it. We did get some welcome help from Balzarotti, who woke up in time to calm outraged passengers with a suave skill only a professional entertainer could have; and it was to his credit that he refrained from disagreeing with one passenger who referred to a dragonet as "that damned loud ceramic horn" – I would have slapped the guy, myself, but I was too busy. But Balzarotti was right : eye checks and concerts are two separate topics, and we shouldn't let them interfere.

I went back to the hub "auditorium" to check on the Nanarese. It was already half full. "What's this **rizka** singing?" A passenger was grabbing at me. Born and raised in free fall though I was, he almost knocked me off balance. "Can't somebody tell me what this **rizka** singing is?"

I looked. Program books! Yet there was no sense in **not** putting the secretarial staff to work – and what else could they do? It was an obvious rush job, at that; and the reference to **rizka** was confusing.

"It is the custom among Nanarese musicians," I explained quickly, "that during an exceptionally successful concert, the music will build to a suspenseful point and stop. Then the vocalist – sometimes a dragonetist, but usually a vocalist – just cuts loose and sings, with no instruments at all. After four or five minutes, everybody comes back in. That's all **rizka** singing is – solo singing."

"Oh," said the passenger bemusedly. I must have sounded like a nervous wreck. Hell, I was one. "Thank you." Now he was staring at my left hand. I muttered something and stumbled off to check the power supply.

"What – why –" Karen Bowes was asking me when I got there. The Nanarese had most of their instruments plugged in and operating; the drummer's free-fall rig was completely assembled, and she was sitting behind it looking official. But I rushed right past her, checking what instrument and what amplifier had been plugged into what, which cord ran where, rearranging and changing a few things. "Stubs Corning, you owe me an explanation!" She could wait.

The drummer got up and moved toward me, obviously annoyed. I'd had her pegged as leader; maybe it was her grasp of English. But I stopped, both hands on a cord, and waited. She saw my left hand, gasped, and was instantly almost in tears – turned around and sat down amid her instruments. I was genuinely sorry, especially knowing how Nanarese feel about musically deprived people; but I couldn't help it. Getting the cords straightened out was of highest priority.

Passengers off the five ships docked at Skyport were wandering in, confused, bored, restless, inquisitive – but all of them waiting. So was I. It wouldn't be long now.

Then there were last minute instructions to the searching party, with Balzarotti translating; I am rarely excited, but this time I was almost unable to control my own words. The lapidary, who had been bad enough before, was now jumpier than I was; Bowes had insisted that the tarnstones be left in place until positively identified, and the lapidary was terrified of being caught trespassing on the Nanarese ship. One of my inspectors, tiring of the nonsense, pulled a spacesickness bag from a wall compartment, tore two eyeholes in it, and pulled it down over the lapidary's head; believe it or not, that calmed him down. What a circus! Then I slipped back into the auditorium, to a position "backstage" by a wall outlet.

All I could do now was to wait.

As for the concert, it was magnificient. It was visually impressive – even from the rear. The crowd, however, was half-dead; I ignored them, and was grateful to them for being easy to ignore. The guitarist was superb, easily good enough to have been Kenny Green with 18 years more practice; yet the drummer had told Bowes that the guitarist was a wood-violinist, selected for guitar training only three years ago when the decision to add Earth instruments to their schools was made. Had the wood-violin been camouflage? The organist was a genius; I can just begin to imagine the joy that a Nanarese born right-handed must feel at discovering an instrument made to benefit the right-hander. (Nanarese had adapted the guitar idea for lefties immediately, but had continued to make keyboard instruments with the high notes at the right end, leaving their playing to the right-handed and the determined.) And the interlocking of rhythmic ideas between her and the second dragonetist – her sister? – was dynamite; records I've heard of Nanarese music don't touch it. My eyes kept roaming around the stage. Wood-violinist extremely competent at melodies, chords and percussion, but nothing brilliant. Hmmmmm. Was that camouflage for a superb musician? And the harpist, for all the similarities between the Nanarese and Terran instruments, was **alien** – a musician whose whole thought processes made me doubt any hint of common ancestry between Nanarese and Terran homo sapiens. The vocalist –

The crowd was watching him, but the enthusiasm wasn't right, I could hear the music building up to a **rizka,** and that was fine with me; but it wasn't fine with the vocalist, who was being affected by the crowd. I could feel him working magic on their emotions, and their emotions resisting the spell; I could feel their homesickness, incipient spacesickness, love and hatred for free fall, but I couldn't feel their attention. And the best possible spot for a **rizka** was going to be within three or four measures; and I was deathly afraid that the vocalist wasn't going to do it.

I looked down at the power sockets, and over to the amplifiers. They seemed powerful and far away. The black rubbery lines connecting the two seemed imaginary; I let my eyes rove their length and back again.

And slowly, deliberately, I ripped a fistful of power cords out of the wall.

Karen Bowes' face turned white. But I saw it for only a second; she hid it in her hands and left it there.

I'd say this for the vocalist: whatever his feelings, he went into a magnificient **rizka.** Perhaps the style was a little heavy on sliding notes, but the basic improvised melodies were excellent. Nothing interfered with my appreciation; even the upset and angered faces of the organist and harpist, dependent on electricity more than anyone else, didn't interfere. The sure knowledge that there would be violence between the vocalist and the instrumentalists unless I told him about the power failure didn't interfere. The realization that the vocalist's voice-amplifier plug was loose in the wall did interfere; I pushed it in tighter, so that the **rizka** could continue. And as I did –

It all fit together. A blur of Nanarese faces cascaded over me as

I pulled out the last cord and went forward to try to apprehend the criminal. Then there was chaos.

Ten minutes later I was under arrest. Karen Bowes, frozen-faced, personally directed the police as they cuffed my hands and ankles. Even the excited lapidary with his spacesickness bag full of tarnstones was acting numbed; my office had never been so full, nor so quiet. I didn't change things. Oh, sure, I could have yelled "This is all a big mistake!" But it was no mistake at all, so I kept quiet.

I had conducted a search without warrant, illegal in America and on its artificial satellites; worse, I had violated Nanarese territory. What could I tell people? That I hadn't the evidence to conduct matters legally? Earth would also take a dim view of the implied breach of Nanarese honor; Nanar would know that I'd rectified a bigger breach by unmasking the thief, but Earth would throw the book at me. On top of that, there was violation of freedom of expression laws – unplugging the cords – and possible incitement to riot. The fussing hadn't lasted, true; but I'd started it by cutting off the **rizka**, and done nothing to stop it.

There was a soft knock on my latchless door. Naturally, it opened. Nobody moved. The Nanarese drummer – Virin, the program book said her name was – opened it and stepped through as delicately as anyone can wearing magnetic boots. She came toward me, almost up to my nose, straightened her feet and stopped.

"Randall Corning," she said, "I want to thank you on behalf of all of us. You have uprooted the impostor, you have restored our national treasures, and you have cleaned our honor." Archaic in their formality were her words, and they weren't phrased quite right. Yet, strangely, my knees were shaking. In zero gravity!

She continued. "I have already placed a call," she said, "with your superior officer and with law enforcement officials. According to John Montpetit your job has already been terminated." I knew it. "Your zeal in following orders has led you into the violation of so many laws that a minimum six month jail sentence appears unavoidable. I made a special call to Judge Granley Dickinson to see if medical reasons permit the incarceration of a Terran national on the moon rather than on Terra. He agreed with me that the cause of justice was not served by death sentences for minor crimes, and agreed that you shall be imprisoned on Luna if at all."

She stopped. All eyes were on her, including mine. She'd thought of **everything.** Nothing could be left except a court trial, and I was sure I could handle that . . .

"What about Green?" I finally asked. It sounded inane, but it was the best I could do.

"Probably the same," she said briefly. It seemed that she didn't want to talk about it; but I must have let my curiosity show, for she kept going. "Nanar's punishment for crimes of honor is exile. Our code will be well served if the tarnstones are returned and Green is left behind. Green is a popular hero on Nanar, you know."

I hadn't known.

"Green pioneered the musical teaching of those few unfortunates without perfect pitch," Virin said. She was beginning to look upset – or extremely involved with a painful topic. "He removed the stigma from many families. He pioneered in the construction of special right-handed instruments for our right-handed children, and showed that they were as musical as the rest of us. Out of those who were nearly tone-deaf, he trained hundreds of drummers. I – am such a one myself."

If it was so hard for her to say that, why did she? But I found myself warming to the girl and her topic. She continued:

"Green also campaigned for a law to allow the government to take full responsibility for corrective surgery for those maimed so that they cannot play musical instruments. The law passed; and the Nanarese ambassador in Washington has personally promised you the finest surgeons on our planet, and a full bank of compatible fingers to choose from. And my group and I will personally see to it that you get a right-handed version of any instrument you want, for you to play when you get out of prison."

My head was spinning; my ears heard only thunder. I felt a hand on my shoulder – Virin or Karen's? – and gentle pressure laid me flat on the leaning wall behind my desk.

"But what do we do with Green?" asked somebody – Karen Bowes, in her most precise and official tones, from across the room. My unseen helper had been Virin, then.

"Attempted smuggling is a crime on Earth, is it not?" Virin's sharpness amazed me. Someday, I resolved, I would try to learn as much about her planet as she knew about ours. "If you are determined to incarcerate him for the little he did you, Judge Dickinson says that the crime carries with it a usual punishment of six months. But that remains to be seen."

"Corning," said Bowes. Not "Stubs" – never again! "Did you know in advance what you'd find in the Nanarese quarters on the **Cymbal?"**

"No," I got out, opening my mouth and my eyes somehow. "But I've been in training for customs ever since they found out that I couldn't go to Earth. And after thirty years doing the same job, you can tell what's coming."

"Then," asked Virin, all traces of speechmaking done, "how did you recognize our vocalist to be Kenny Green?"

That I could explain. "Perfect pitch. There are a few Earthmen born who have it. I'm one. Kenny is another." She was looking at me, still puzzled.

"The first thing a person with perfect pitch learns is a reference system. Two years after Dad found I had perfect pitch, I could sing any note on the scale, perfectly accurately. I could sing with his piano and be perfectly on key." All the eyes that had been on Virin were now on me – and hers, damn it, and hers! I shut my eyes to avoid meeting all the gazes, and continued:

"But I sang alone with a guitar player once. His instrument was tuned about a quarter of a tone flat, with every interval perfectly accurate, but instead of a C he had a note midway between a B and a C, and every other note o match. I could have died of shame – I kept trying to sing high, trying to go back to the reference points I was tuned to. The guitarist later told Dad that I was a nice little kid but my ear was shaky. Kenny Green, of course, spent most of his life on Nanar; but forced to **rizka,** he eventually let his voice go a quarter tone high, so he could sing in the scale he'd been taught in his childhood. When he did that, of course, I spotted him and realized he was a Terran."

Nobody really understood but Virin. "I . . . seee," she breathed. "I would never have dreamed . . . Randall Corning, you are a smart man and a brave one. I felt her come toward me again, and braced myself for the kiss I feared; but she turned around and went away again. I heard the door shut behind her.

A week later I was on a shuttle for Luna Prison. The pilot had been warned to make his approach curve on easy one, and I had been doped up to prepare me for the high G's of the landing. But right now I was awake and energetic, and my cuffs chafed.

"Green," I called to the prisoner across from me. The slanted brown eyes opened. "Kenny Green. Want to form a duet?"

# THREE CHEERS

The Greeks would have been proud of the riddle posed by Onos.

by Patrick Perkett

The amber, oxide vapor curled from the fumarole under the scanner carriage into the planet's unchanging grey skies, joining the thousands of other such gaseous stalagmites in the Polar Rift.

A space-suited hand mechanically punched instructions into the scanner control console and was rewarded by the silent sweeping of the scanner antennae.

Static flooded the helmet, "Any sign of him yet, Sal?"

A single repeated tone- negative.

Tony Schildin had been gone a long time – too long.

Tony Schildin had created Onos. He had financed, designed, and had helped build the Onos extraterrestrial laboratory complex. Onos was his life, his home. His acute obsession with the project had cost him dearly. In a frenzied attempt to neutralize an overload energy field, the motor neurons had been blasted from his unshielded arms, leaving him crippled. He had never regretted it. Nothing would stop him from making Onos a success – nothing.

It was Tony who had discovered the presence of the Ameboids, as he called them; but not before seven of the fifteen handpicked scientists of the Onos project had been consumed.

At that time they had just completed construction of the final section of the complex. Selen had returned from a scheduled reconnaissance patrol from the interior sector of the Rift, unknowingly carrying an Ameboid passenger into the entrance lock of Subcomplex B. He lived long enough to place his oxide coated helmet on the chrome service rack.

Those surviving would never forget his quivering, gasping, convulsing image on the view-screen. They had watched in frozen horror as his eyes burst and were sucked into their sockets, drawing flaps of the flesy membrane of his face, as his body imploded slowly.

When subsequent attempts to contact the other six members of Subcomplex B failed, the multi-sectioned passage between Subcomplex A and Subcomplex B was destroyed, barring any chance of physicial contact with the unknown presence. The shining, domed structure seemed a fitting tomb for those who had toiled to build it.

Further attempts by the Ameboids were repelled successfully. The attacks were unusually cyclic and were becoming more localized. The repairs to the Complex were becoming more massive with each cycle, necessitating cancellation of the research schedules. The existence of Onos was definitely threatened, but more importantly, Anthony Schildin was being threatened. The Ameboids needed Tony, and Tony needed Onos.

Tony and his mobile unit had disappeared four Earth-cycles ago, and along with him, Selen's reconnaissance programs.

There had been no attacks for four Earth-cycles and the mobile scanner had been operated for the same period in an atmosphere of empty hopelessness. There was a feeling of pressure, and a tenseness accompanying the need to know.

Beep. Something on the Rift was moving.

The scanner had stopped tracking and was now plotting the position of the object on the circular vector screen. A lone object was moving slowly in the general direction of the mobile scanner unit.

An identification number flashed on the screen – UA1. It was Tony Schildin.

The space-suited figure walked with mechanical stiffness through the Rift as though all conscious effort was concentrated on walking.

Sal watched for what seemed an eternity, transfixed to the spot as the animated form lurched forward through the swirling vapors of the Rift toward the spot where he stood. The dragging, sliding feet stumbled over an outcropping a few feet in front of him. The hanging arms offered no help to the falling body.

Sal reached to help Tony to his feet. An arm raised to meet his.

Sal's eyes met those of a dead man – he knew, and was dead.

Static filled Sal's helmet. They would never know.

The bodies had been brought to Subcomplex A for last rites. There had been no more attacks on Onos; Tony had somehow seen to that. The remaining colleagues pledged their undying loyalty to the man who had given and sacrificed everything and in return had received nothing.

Anthony Schildin had come home.

Rippling motions began in Anthony Schildin's stomach and progressed up his chest to his neck, his throat bulging slightly as in swalling. His mouth opened wide as the first of many Ameboids crawled from within.

The Greeks would have been proud.

# THINK TANKS

## THE BRAINS BEHIND OUR FUTURES

by Paul Burtness

Mankind is faced with a tidal wave of data and information growing at an exponential rate, but there seems to be no way to turn it into knowledge. Someone should be taking a long range perspective but no one is looking further than tomorrow. There is a need for a way of doing things though nobody around seems to know how.

Not that there haven't always been people with solutions. Worldly philosophers have proffered their systems; professors have filled journals with their analyses. Usually problem solving comes down to the politician who has one eye on the problem and the other eye on the next election.

But from the turmoil of information and ignorance a new sort of organization has evolved. Identified as research and development, policy research, or idea factory, this new organization is best described by its most popular name—"think tank".

Think tanks utilize the methods of science but hold the traditional disciplines in disdain. Many of them go beyond theorizing and paper studies and do not hesitate to get their hands dirty implementing their ideas. Some have abandoned traditional roles as contract agencies or idea supermarkets and are becoming active, independent agencies of social change. They are all intent on integrating man's knowledge; they have the time for long range perspective; they profess to know how things can and should be done.

Think tanks originated in the military, where the need for interdisciplinary approaches to complex problems was first recognized and where the resources needed for such an approach could easily be made available. The RAND Corporation, perhaps the most well-known think tank, started out as the **R**esearch **AN**d **D**evelopment agency of the Air Force. Think tanks are still playing war games and dreaming up new weapons systems but there are no limits to their investigations; studying mind-altering chemicals, managing new health care delivery systems and probing the future are every-day activities in the realm of think tank operations.

the resulting explosion of think tank organizations after World War II. Colleges and technical schools produced a flood of scientists and engineers, with many of these highly-trained individuals anxious to apply their techniques to problems in society. Also, government greatly expanded its role as the provider of social welfare and soon became a bounteous source of funds for social programs.

Depending on how broad a definition of the term "think tank" is used, estimates of their number nationally varies from a few hundred to thousands. There are about 75 attached to the federal government. Among thousands of non-profit organizations attached to industries or universities, there are about 200 major ones like the Stanford Research Institute. Profit-making ventures that offer a team of brains to the highest bidder number about 300. Then there are a few independent think tanks, like the Brookings Institution, that consider the public as their client and rely on their own resources or money from private foundations to conduct their research.

The Twin Cities, an educational, political and economic center of the Midwest, is a natural breeding ground for this type of agency. Although none of the local think tanks are as prominent as the RAND Corporation or the Hudson Institute, several have national reputations. Four of these local institutions illustrate the range of think tank styles and activities. Each is distinctive in its operation but through each runs the common thread of faith in man's ability to construct, if not a perfectly desirable, at least a better future for himself.

Walter McClure leans back in a comfortably cushioned chair, puffing on one of the dozen or so pipes cluttering the top of his desk, and looks out over downtown Minneapolis from his twelfth floor office.

"Think tanks provide leisure, time to argue, time to read and get away from the problem. Most think tanks are products of the way government is structured. You see, there is a constant war between bureaucrats in various departments. Once someone gets swept into that process, as most government people do, they have no time to think."

McClure, who has a Ph.D. in physics, is a research associate for InterStudy's Health Services Research Center. InterStudy specializes in analyzing and developing human services delivery systems such as health care, employment and welfare. Perhaps the crowning achievement of InterStudy and its president, Paul Ellwood, has been the development of the health maintenance organization, a sophisticated group health plan that emphasizes keeping people healthy rather than simply treating them when they are sick. InterStudy has a staff of over 50 persons and an annual budget of about $1.5 million, mostly federal money.

McClure stresses InterStudy's activist role as opposed to other think tank's advisory roles. "There are two parts of problem solving: you need a model of the future and a change strategy. Our distinction is that we work just as hard on the second problem."

"The genesis of research institutions like North Star was the need for solving industrial problems with an institution that had the prestige of a major University research staff. Universities don't like to do applied research, so North Star was a natural consequence of that unfilled need." Guy Miles, vice president of North Star Research and Development Institute, says.

Housed in an unpretentious old brick schoolhouse in South Minneapolis, the Institute was formed in 1963 by the University and the local business community to work on the problems of local institutions and attract more businesses to the Twin Cities. North Star has an annual budget of about $1.5 million and over 50 persons on its staff.

North Star differs from other Twin Cities think tanks in that physical science research, in addition to policy and management projects, is a significant portion of its work. Institute scientists have developed thin film polymers and are testing their use in desalinizing sea water, heart and lung machines and artificial kidneys. Other technological projects include high temperatqre capacitors, cold weather clothing, converting canning plant wastes into livestock feed and a reactor that converts hog manure into methane fuel and fertilizer.

Developing educational programs for minority youths, minority housing programs, rural transportation systems and industrial plant siting criteria are some of the policy and management research that North Star conducts.

Earl Joseph sits behind a crowded desk in a crowded office, modeled in the epitome of cost-efficiency, taking a long-distance phone call, gathering information. Thick black rimmed glasses set off a crew cut and long sideburns. In his frequent speaking engagements he often refers to those glasses. "People sometimes call technology anti-humanistic. Yet, without these glasses, a piece of technology, I couldn't live. And what could be more humanistic than a special set of glasses connected to a computer information system, through which I could have immediate access to most of the world's information . . . . "

## Some think tanks are active, independent agencies of social change.

Joseph's job is to research the long range future – the time 15 to 200 years from now – so that the Sperry Univac Corporation will know within what sort of social-political-economic context they will be building and marketing their future computer and information systems. Delphic probes, a systematic way of utilizing 'expert opinion'; technology forecasting, or extrapolating present developments into the future; and scenarios, a sort of legitimized science fiction, are some of the tools used to investigate the future.

Impressing people with the urgency of becoming future-rather than past-oriented is also a major part of his job.

"I would compare our present situation to a blind-folded guy driving down a street at 70 miles per hour, steering by what he bumps into. Only it's too late to do anything about problems once we've bumped into them."

"The central assumption of our work is that the future is optional. Citizens need to be literate about the future. They have to be active participants in developing desirable futures. They have to plan and design in terms of the future," Joseph says.

Most think tanks can be identified by a place, a permanent staff and a special affiliation or role. But some organizations exist with only a minimum of staff and have no long-term projects of their own. Rather, their role is to encourage community institutions and individuals to develop their own programs, and then supply them with funds and skills. They are facilitators.

John Borchert, director of the University's Center for Urban and Regional Affairs (CURA), is hesitant to use that term and prefers to describe CURA in terms of what it does.

"We try to bring together community organizations and the University faculty. A professor will have an idea but it just doesn't fit into the academic structure, so we appoint him as a CURA coordinator and provide him with money to build a staff. It is also our job to find a place in the traditional academic structure for long-term programs." Essentially, CURA makes the entire University into one big think tank.

CURA does not generate projects itself, but makes about $4.4 million a year available in several broad categories like Urban and Regional Management, Community Programs and Instruction Programs. Once a faculty member or community group comes up with a plan, the CURA staff also helps define and give form to the project.

"There are two ways of approaching any urban problem. One is to locate the individual who is in some kind of bind and thus becomes part of a larger problem, and then try to reach him. This is an adaption of the teaching enterprise." The Technology Power project, which encourages minority youths to enter scientific careers is an example.

"The other is to approach it as a

problem of management and organization, such as a study of the geography of the MTC bus system.

"It is my personal conviction that in the long haul, the majority of problems are concerned with information and management," Borchert says.

Think tank operations are usually described in terms of a "systems approach", perhaps the most overused, underdefined word in modern English, though it is really the only term to describe their work.

The "systems approach" can be defined as considering any organization or situation as a matrix of elements, each of which has some sort of functional relationship to the other elements. Thus, any situation is more than the people involved but includes the lines of communications and the way people are rewarded or coerced for what they do.

Typically, a think tank will study a situation, trying to perceive these relationships, then determine which of the elements of the system need to be altered to meet some desired goal and specify what resources are available or need to be created to change the system. At this point, the think tank may have drawn up a report and considered its job complete or it may go on to implement its own recommendations.

InterStudy's work on the health maintenance organization concept (HMO) is a case in point. The present system of health insurance and clinical care rewards doctors for providing a maximum of health services to sick people rather than keeping healthy people healthy. The system also does not allow the efficient use of what health care facilities and resources are available.

After refining the HMO concept, InterStudy took on an educational-lobbying mission, helping to set up and manage HMO's and getting the federal government to support the concept.

An integral part of the think tank's system approach to problem solving is the use of interdisciplinary teams of specialists and of generalists whose knowledge covers many fields. Every think tank, no matter how specialized, usually employs sociologists, lawyers, economists and scientists from the full range of physical and biological sciences.

A typical sort of person who works for a think tank is one who is sometimes considered a "maverick", who has been in many positions and found the academic or business world too frustrating. Guy Miles from North Star, for example, was a psychiatry and neurology researcher for the University medical school, later was part of an electronics company and finally wound up as a social scientist.

**"The central assumption of our work is that the future is optional."**

The type of people employed and the sort of projects conducted usually lead to a very relaxed working atmosphere in think tank operations. Dress is casual and so are departmental hierarchies. Researchers are responsible for getting a job done, not working in an office for certain hours, so at any time most of the staff is likely to be off meeting or gathering information from other places.

Given their instrumental role in shaping the policies of government and business, the sorts of values that individuals in think tanks express are important.

"We have accepted some of the major social goals regarding human relations, resource management and effectiveness of decisions," John Borchert says. This is reflected in CURA programs that increase integration, educational opportunities and status of low income and minority groups, and aid better resource management, utilization and protection.

"The role of North Star is to supply the sponsoring agency with information as non-subjectively as possible. It is perfectly legitimate to study just about everything, but we try to stay out of the affairs of the sponsoring company," Guy Miles says.

North Star had to sever its legal ties with the University in 1972 as a result of protests over its classified research projects. "There has been a lot of criticism of the type of research we do and we are trying to do less classified research. Classified research cannot be published or disseminated in any way, which doesn't fit in with North Star's philosophy," Miles says.

"We're not a social change agency," Earl Joseph says in a straightforward manner.

"We tell people what is available and how they can use it," Joseph says, emphasizing the optional nature of the future and the need for people to be aware of how to construct a desirable future.

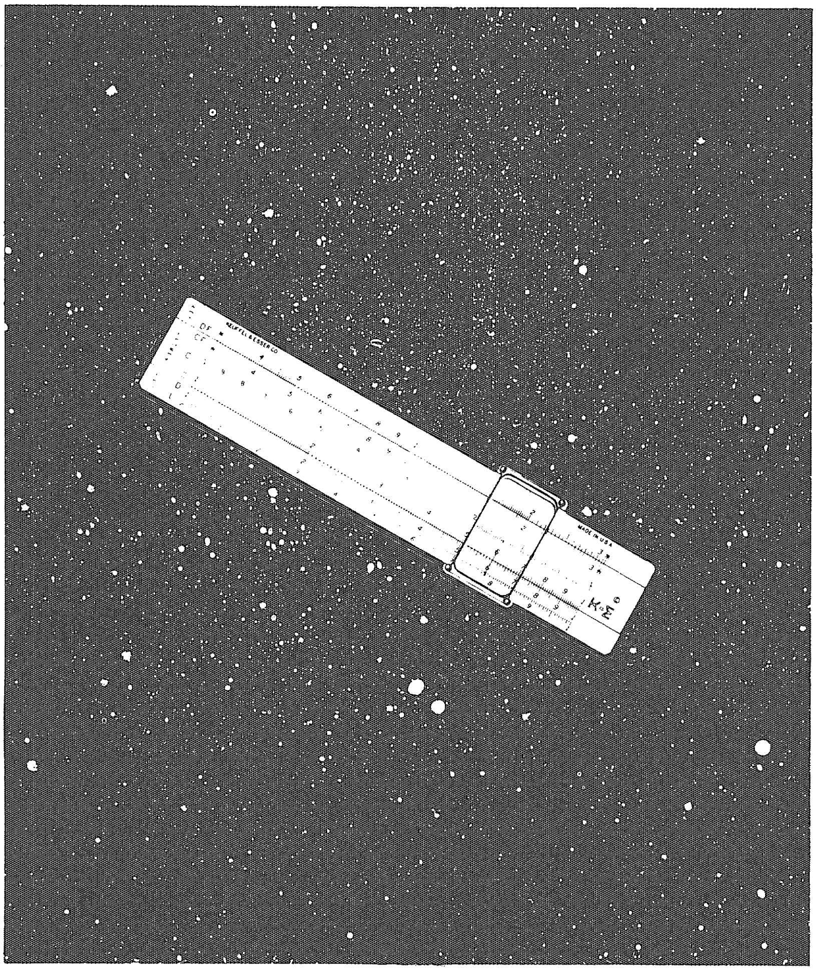
One value of InterStudy that Ron Fine, director of the Welfare Policy Division holds highly, is the active dissemination of information.

"Our audience is not just bureaucrats. Social change doesn't happen simply after giving information to bureaucrats," Fine says. To implement this value, InterStudy tries to publish most of its research and distribute the information they have gathered to the public.

The think tank's role as an active disseminator of information is likely to become more important in the future as they become less of an information service to government and business and more of an independent industry themselves.

Right now, most think tank operations are related to producing goods and services more effectively but, as Earl Joseph points out, one of the more desirable futures is one in which being and becoming are more important than consuming or doing.

Such an alternative future will, however, take an extensive restructuring of society, although it may be helped along by natural limits placed on material consumption and activity. But, whatever changes are necessary, it will probably be the think tanks that will find out how to conduct them.



# Sales and Service. 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.

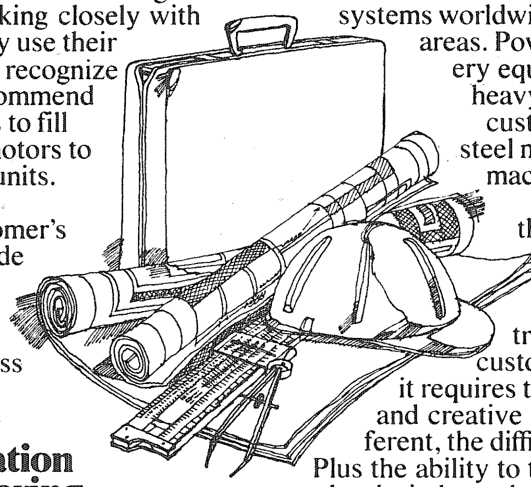
Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

This ad outlines the types of work found in the Sales and Service area of 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-3, 570 Lexington Ave., New York, New York 10022.

## Sales Engineering

Sales engineering is technical marketing. Sales engineers at GE are the important liaison between GE manufacturing facilities and utility, industrial, distributor and governmental customers. Working closely with assigned customers, they use their technical background to recognize customer needs and recommend GE products or systems to fill them. From small AC motors to huge turbine-generator units. Requires a thorough understanding of a customer's business, as well as a wide range of GE products. Plus the ability to work well with people and to recognize a good business opportunity.



## Application Engineering

Application engineers are technical experts who work closely with the sales engineer and the customers' engineers. Their job is to analyze special problems and equipment needs of customers, then determine the optimum GE products or systems to meet them. There are two kinds of application engineers. The first works out of a sales operation and is adept at applying a wide variety of products to create a "system" that meets the customers' needs. The second works in a product manufacturing department and is a specialist at applying the products of that one department. Both must have in-depth knowledge of the customers' technical needs. They often consult with product planners and other marketing personnel to suggest ideas for new or modified products.

## Field Engineering

Field engineers at GE plan and supervise the installation and service of large equipment systems worldwide in two main customer areas. Power generation and delivery equipment for utilities. And heavy apparatus for industrial customers such as paper and steel mills, chemical plants and machine tool manufacturers. They specialize in either the mechanical/nuclear or electrical/electronic areas. Since field engineers are often called to troubleshoot and correct a customer equipment problem, it requires the technical competence and creative ability to handle the different, the difficult and the unexpected. Plus the ability to take charge, lead people, and make independent, on-the-spot decisions.

## Product Planning

Product planning is a marketing function. Product planners make sure a product line offers what customers need at competitive prices. They determine the need for a new or modified product, product availability, market size, cost structure, profitability, specifications and distribution channels. To do this, they work with market researchers, application and sales engineers, finance experts, marketing management, plus design and manufacturing engineers. Their engineering background is a big plus. This work requires self-starters who can coordinate a project and sell their ideas to management.

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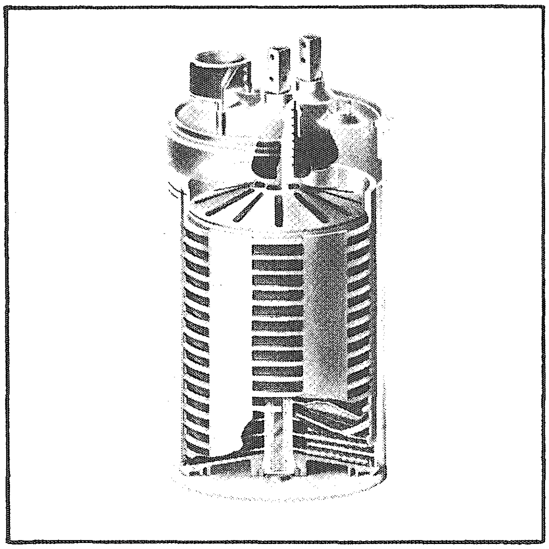
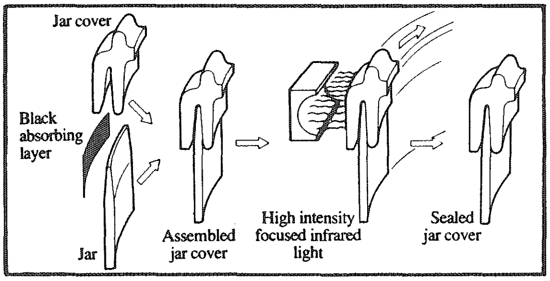
# THE QUESTION OF SCIENTIFIC INTEGRITY

## Spaceships · Microwaves · Sandcastles

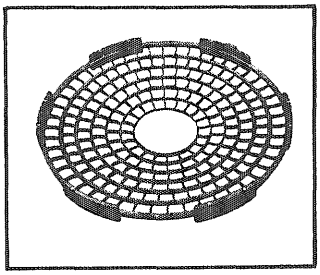
# WESTERN ELECTRIC REPORTS



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.**

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**COVER DESIGN BY KEVIN STRANDBERG**

## SPACE RACE

The editors feel that the Technolog is not the proper place for evaluation of, or critical curriculum recommendations for, the Institute of Technology as an educational system. That is better left done — at least for the present — in administrative offices, journals and in the classroom.

But this magazine is published in a somewhat dingy basement office of Mechanical Engineering, and from that vantage point it is obvious that there are many aspects of the I. T. buildings which are dismal, bleak and unconducive to study. The interiors of the engineering buildings have always looked as though they had been painted by the Minneapolis Sewer Department; and there are very few study spaces available in those interiors. There are few food services — and fewer lounge spaces — available to the I. T. student.

It seems that the college of the University which administers the architecture program might be able to persuade a few students — for credit, with supervision — to design some simple lounge areas in unused lacunae like the basement lobby by the Church Street entrance to Mechanical Engineering. That way, it would take very little time, money or effort to make I. T. a more comfortable, livable place.

The following letter is published in consideration of this belief.

Dear Editors;

Some time ago, a space allocation ruling was made which specified that the University of Minnesota was to provide two square feet of study space per student. Where is that space? It simply does not exist.

It had been planned that the lack of student space would be alleviated with new Institute of Technology buildings. In the past six years, every I. T. building proposal included provisions for student space. Unfortunately, because of the legislature, no new I. T. building will be constructed within the foreseeable future. Meanwhile, some I. T. departments are growing and more space is needed for them. What student space we have now (like that in Main Engineering 26) is being threatened!

When the Engineering bookstore moves to its new building around 1975, approximately 6,600 square feet of space will be available. Needless to say, the space would be ideal for I.T. students' needs. However, many other groups are investigating that space themselves. Among them are the English department (which already controls all of Main Engineering save the basement and first floor), and Computer Information and Control Sciences (CICS), which is growing rapidly. With such strong contenders, the students' chances are not ideal.

In hopes that I. T. does not lose that space, CICS and the I. T. student board are preparing a joint I. T. proposal. Such a proposal would be much more effective than separate proposals from the I. T. administration and I. T. students.

As it stands now, students will get approximately 2,800 square feet more (in addition to Main E. 26, which has 1,440 square feet), while CICS will get about 3,800 square feet for more labs and offices. Of the 4,240 square feet for students, 1,460 is basically unusable, though they might be used by student organizations for offices. (They are currently receiving and storage rooms.) Approximately 300 square feet would be used by I. T. tutors, thereby moving and expanding their facilities from Main E. 104. The remaining space would be student space.

The plan is that the traffic through the hallway next to the bookstore would be blocked off, and a wall along the pillars would be built. Then the hallway could be used by students. Tables, chairs and vending machines would be installed.

Last spring I. T. student boards contacted those in charge of space programming and informally told them how we would like to see space used. Now it is time to present a formal proposal. We would like to know how the rest of the students feel about the proposal. Contact us if you have any questions or comments. We are located at 230 T.N.C.E., and our phone number is 373-7729.

Sincerely,
Janice Tjebben,
President of I. T. Student Board

# WHAT PRICE INTEGRITY?

The Reserve Mining Trial, mired for nine months in arguments between engineers testifying for the Government and for Reserve, was shaken this month by the disclosure of Reserve documents that contradict the testimony of many of its own witnesses. This revelation lends support to the environmentalists who have been saying for six years that Reserve witnesses give misleading testimony at the dictate of the company.

The documents show that Reserve's much-touted underwater disposal plan — in which tailings would be piped 150 feet below the surface of Lake Superior — was vetoed in 1972 by Armco Steel Co., one of Reserve's owners.

They show further, that the company has investigated four different plans to dispose of taconite tailings on land, despite repeated claims by their lawyers that no investigation had been made.

But most importantly, an Armco study indicates that one of the disposal plans would actually save Reserve money. This is in contrast to Reserve's astronomical estimates of the cost of on-land disposal and repeated hints that they would be forced to close rather than dump their tailings on land.

In all three cases, the secret documents contradict the testimony of Reserve's scientists and engineers. Kenneth Haley, manager of Reserve's research and development effort, presented the underwater disposal plan as Reserve's preferred alternative, without mentioning that it was vetoed two years before.

In arguing against on-land disposal, Reserve's lawyers presented Stig O. Forssmark, president of Trygve, Hoff and Associates, a large consulting firm. He argued, according to Reserve's legal brief, that the idea is "unsound from an economic and environmental standpoint." He was either ignorant of, or ignored Reserve's heretofore secret study, which reaches the opposite conclusion.

An important economic factor in the alternative disposal plan is pellet quality. Reserve's taconite pellets contain less iron than those produced by other companies. The government contends that a modern plant, dumping its wastes on land, would produce pellets with a higher iron content. Such pellets could be used more efficiently in the blast furnaces to produce steel.

To oppose this idea, Reserve presented A.J. Jermann, the Supervisor of Blast Furnaces for Republic Steel Co., Reserve's other owner. He argued that the advantages of higher quality pellets would never offset the costs of building a new plant. Yet one of the hidden reports shows that the new system would save $37 million per year because of the higher quality pellets produced.

The willingness of technical experts to prostitute themselves in the service of industry is a serious blight on the claim that science has served man's welfare. Reserve has fought off all attempts to stop its dumping in Lake Superior for over six years, and this could never have been done without the willing assistance of dozens of scientists and engineers — professional consultants, university professors and company employees.

Even more disheartening than the weak consciences of these people is the silence from the rest of the scientific community. Not one professional society or dean of an engineering school has spoken out against the tactics of companies like Reserve and the malleability of its witnesses. As this month's article on scientific integrity shows, it is nothing new. People have come to expect it.

Laurence Yarosh

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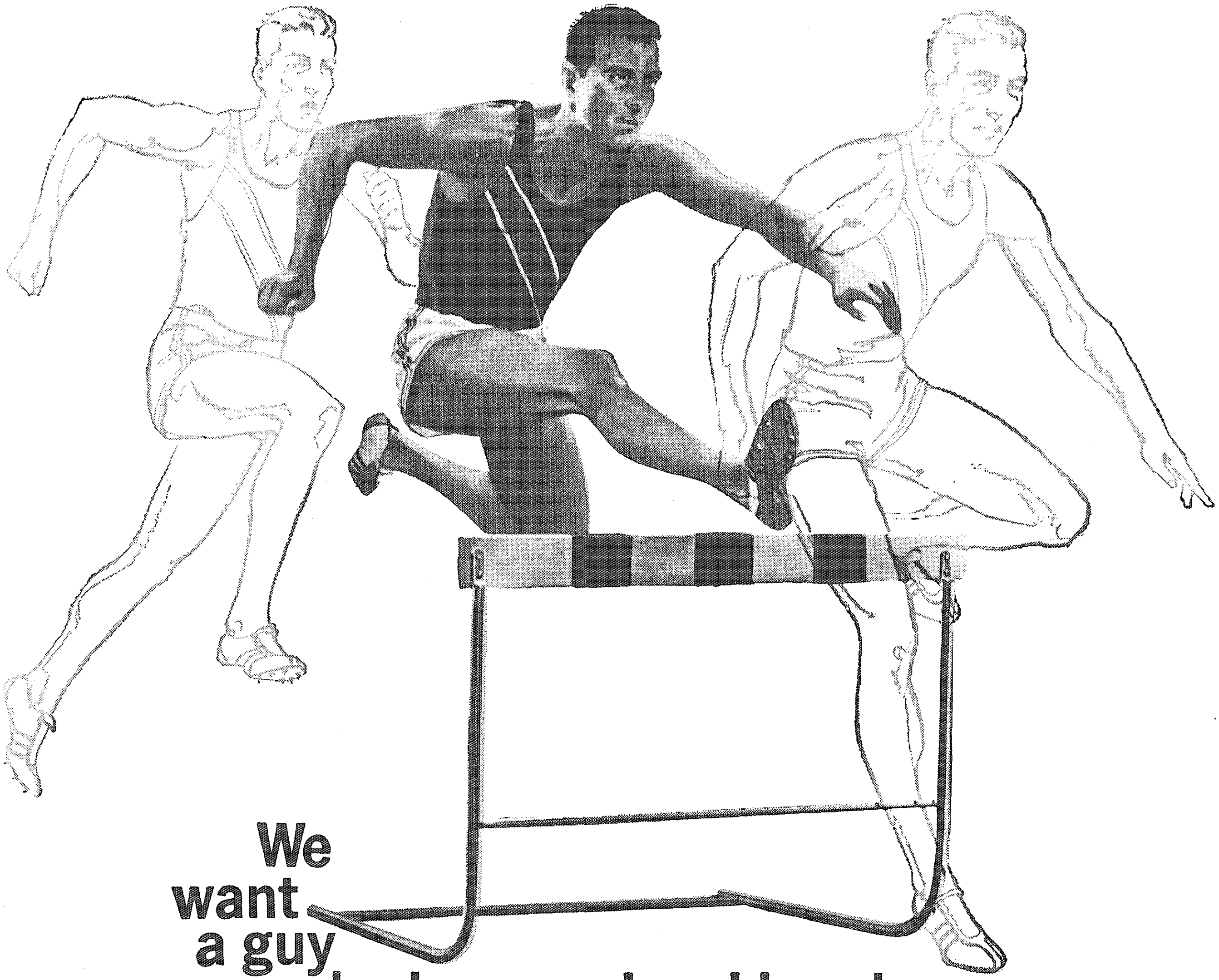

# We want a guy who keeps a level head.

Dictionaries define hurdling as jumping over a hurdle in a race. Obviously, Webster never made the track team.

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# SCIENTIFIC INTEGRITY

## Can a Technical Expert Be Bought?

by Laurence Yarosh

The legal battle between Reserve Mining Company and the environmentalists over its discharge into Lake Superior has provided a vivid and often embarassing glimpse at the scientific and engineering advisors who influence the country's most important decisions. After six Federal conferences, two trials and some of the most detailed research ever done in Lake Superior, the scientists who advise the opposing parties are in total disagreement, even over seemingly dry factual questions.

For example, how much rock is dumped into the lake by Reserve's taconite plant? The two sides do not agree, and their estimates differ by over 15,000 tons per day. Do the tailings encourage the growth of disease bacteria in the lake water? The environmentalists say yes, but Reserve claims that their tailings actually cleanse the water of bacteria. How much will it cost to dump the tailings on land instead of in the lake? The estimates differ by almost 300%.

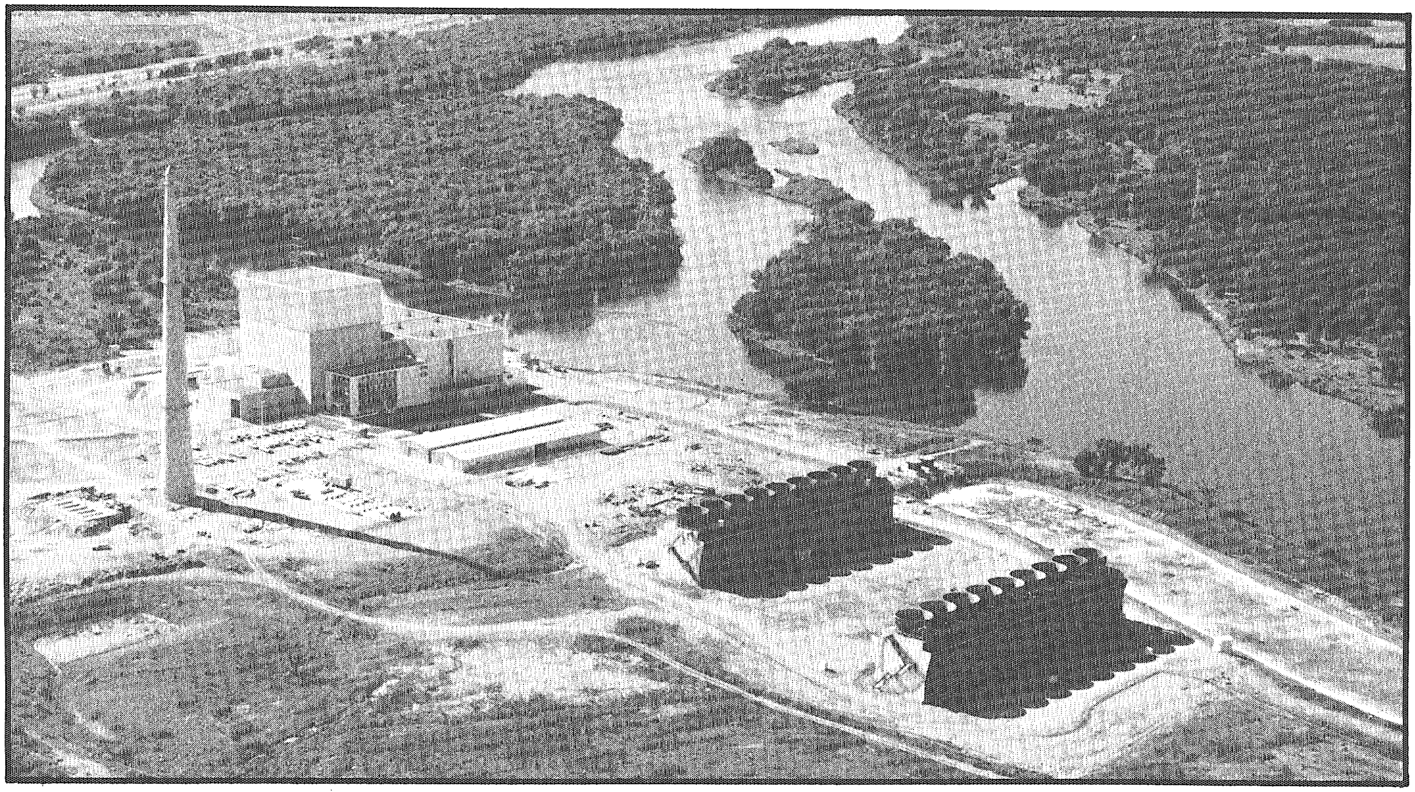
Such deep disagreement in an area far from the frontier of knowledge runs counter to the widespread faith in the impartiality of science. The image of a scientist defining his problem with mathematics and using controlled experiments to reach a conclusion is threatened when two directors of research argue in court over the concentration of manganese in the deep waters of Lake Superior or interpret the same x-ray diffraction pattern in opposite ways.

**Distortion of Research Studies.** A frequently suggested explanation for these conflicting views is that research studies have been biased or forged by scientists who subordinate their professional pride to the interests of their employers, either the government or Reserve. Deborah Hedlund, author of a book on Reserve, claims that company employees secretly changed the results of their cummingtonite measurements before presenting them to the government. Charles H. Stoddard, a former Interior Department official who was deeply involved in the controversy, has charged that Reserve uses "manipulated studies by kept scientists" to support its arguments. Yet the report of which Stoddard was chief author was attacked by the then Minnesota Pollution Control Agency Chairman John Badalich as "very biased", containing numbers that were manipulated to justify preconceived notions and conclusions based on mere speculation.

Such dark allegations are not confined to the Reserve trial. Similar accusations can be found in almost every conflict involving technology. Nineteenth century court battles involving the railroads moved William P. Shinn, president of the American Society of Civil Engineers, to comment in 1890, "Nothing can be more unseemly than to see two eminent members of any profession each striving to earn his fee by stating such facts or giving such opinions only as make for the side by which he is retained."

If the financial ties between the experts and the parties in court could be severed, he predicted, "It might result in some of my professional brethren receiving less fees, but it would be to the benefit of the profession and the cause of justice."

Questions of integrity have involved even the most prominent and respected experts, as in the 1913 attempt in Philadelphia to roll back the electric utility rates. Years of municipal corruption had allowed the Philadelphia Electric Co. to establish exorbitant rates for electricity. The Pennsylvania Public Service Commission ordered that an inventory and valuation of the company's assets be done preliminary to a rate adjustment. The



*Monticello nuclear power plant. AEC employee-engineers have maintained for 20 years that such plants are safe. Yet safety standards have been severely tightened in the past year.*

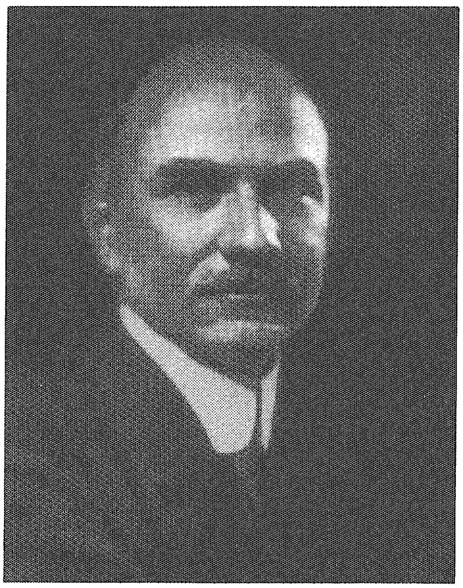
Company chose a Boston consulting engineer, Dugal C. Jackson, to compile the inventory.

Jackson's credentials were impeccable. A former professor at MIT and past president of the American Institute of Electrical Engineers, he enjoyed a national reputation as a consulting engineer. Yet his first loyalty lay with the power industry. According to historian Edwin Layton, "the consultants in this field were closely allied with the utilities and had absorbed their views and interests. They were not impartial, but partisans of the private interests against the public."

Jackson, in an attempt to hide the company's profits, produced an unmanageably long inventory, filling 110 volumes. Each of the company's electric poles were listed separately and, at one point, a length of 2 inch pipe was listed separately from the threads on either end. In contrast, says Layton, "the valuation itself was very short and in such a form as to make comparison with the inventory impossible."

The valuation was eventually rejected and the utility forced to reduce its charges by over a million dollars per year.

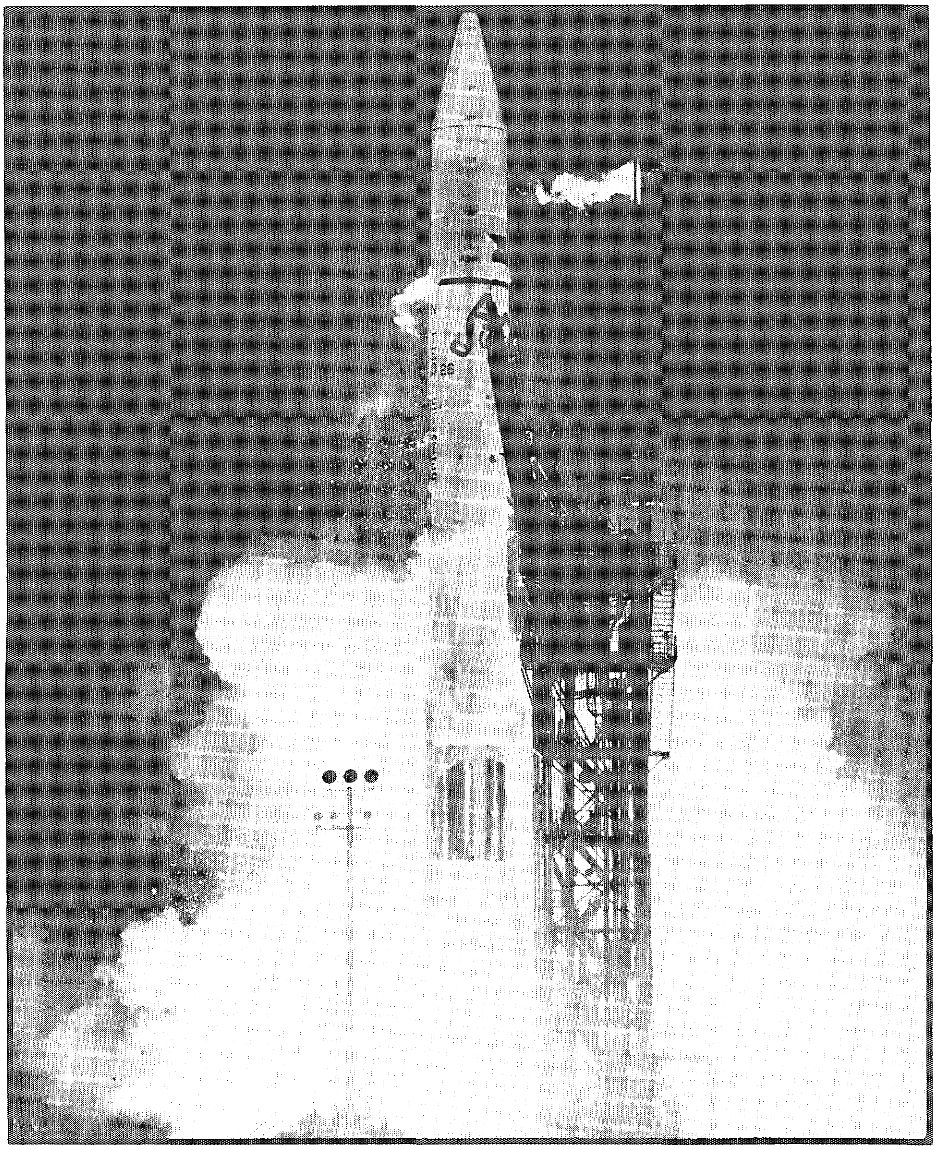
In 1966 Ralph Nader's book, *Unsafe at Any Speed*, attacked the automobile industry, reserving special criticism for its engineers. Nader maintains that General Motors' engineering chief Frank Winchell and head safety engineer Kenneth Stonex, among others, "have had detailed knowledge of the design defect (in the Chevrolet Corvair) since the first prototypes were tested. Yet they have continued to claim that the 1960-63 models are not uniquely unstable . . . Company engineering reports detailing the car's defects were discovered only after GM officials had denied any knowledge that their cars were unsafe."



*Dugal C. Jackson, president of AIEE and a target of utilities reformers. His 1913 inventory of the Philadelphia Electric Company was rejected as obstructionist and deliberately misleading.*

The question of scientific bias was raised again last April with the disclosure that many of the studies upon which the Environmental Protection Agency's 1975 auto emission standards were based were administered by the Coordinating Research Council, an organization which gets most of its money and staff people from the automobile and oil companies. The arrangement led *Science* magazine to comment, "Small wonder that after five years of national effort, many apparently simple technical questions relating to auto emissions control remain hotly disputed."

**Scientists under pressure.** Many pitfalls stand between a researcher and an unbiased conclusion. A study may be biased by the choice of what to investigate and which tests will be run. During a conflict in the Reserve trial over testing for airborne asbestos, Judge Miles Lord observed, "The government will want to take all of its samples (near the plant smokestack). Reserve will want to



*Success and failure in engineering. Pioneer X Jupiter probe (above) and an automobile demolished in a collision. The difference between good and bad products is often not the skill of the engineer, but the intentions of management.*

take samples upwind. It's natural." In food research, the choice of experimental animals used to test a food additive may determine the cancer rate, as some species are more susceptible to the disease than others.

Even after the experiments have been carried out, the data may be interpreted to suit the scientist's purposes. During the 1969 congressional debate over the Safeguard antiballistic missile system three systems analysts, aligned with different factions, took the same Pentagon figures and produced wildly varying estimates of the Russians' first strike capability. Albert J. Wohlstetter, a pro-ABM analyst, calculated that 5 percent of our Minuteman missiles could survive a first strike under certain prescribed conditions. George W. Rathjens, Jr., an ABM opponent, figured 25 percent survival and Ralph E. Lapp, another expert, argued that 75 percent would survive the same attack. The differences remained unresolved, even after a heated and extensive public discussion.

Finally, a technical employee may feel compelled to mislead the public, as the auto engineer who claimed in 1963 that automobile occupants could not be protected in ordinary crashes through "any restraining devices that the average driver would be willing to use" or he may alter or hide research data, as Reserve Mining employees are accused of doing.

The pressure on an industrial scientist or engineer to conform to the interests of management can be immense. Promotion may be predicated on company loyalty, as stated very candidly by Chrysler Corporation's Sumner B. Twiss: "a prime requisite for getting ahead in industry is identification of your personal objectives with the objectives of the company."

He further warned that the proper attitude can be more important for advancement than mere depth of technical knowledge.

When the Northern Environmental Council issued a paper accusing Reserve's consultant, Trygve Hoff Co., of inflating the cost estimates for their on-land tailings disposal system, the council refused to disclose the names of their own consultants. These engineers, according to the council, feared "economic and political retaliation" if their identity became known in the mining industry.

**Professional societies - a solution?** One answer to weak professional integrity might lie in a strong network of professional societies. Such groups might strengthen their members in resisting management pressures, and could formally censure those who practice deception.

In reality, however, professional societies have been heavily influenced by business. Many societies are supported by company contributions, and for others, members' dues are often paid by their employers. Many of the officers are not practicing engineers at all, but owners and managers of businesses that employ engineers and scientists.

The societies have actually served management by disciplining their members and censoring their communication. Philadelphia's Public Service Commissioner, Morris L. Cooke, nearly lost his membership in the American Society of Mechanical Engineers through his public attacks on Dugal C. Jackson in the 1913 dispute over electric rates. Such attacks were against ASME rules.

There have been numerous instances of societies refusing to publish or hear papers critical of industry pricing practices, or papers advocating any viewpoint unpopular with management. Such censorship makes internal reform and outside attack quite difficult.

**University-based experts.** Not all scientists work for corporations, and it might be hoped that the universities could serve as a source of unbiased expertise. Yet they, like the professional societies, have strong ties to industry.

In the Institute of Technology, for example, many activities such as the high school recruitment program are funded directly by industry. Many of the faculty are paid consultants of industrial concerns, or even own their own businesses. These ties have led to charges of bias against University faculty.

Testimony by Mineral Engineering faculty on behalf of mining companies involved in tax disputes in Northern Minnesota has angered several local officials. Among these was State Representative William R. Ojala, who introduced a bill in the 1973 Legislature to prohibit members of the Department of Civil and Mineral Engineering from testifying in any proceeding involving the public interest. A similar bill, applying to all University faculty, has been laid over by the 1974 Legislature.

The problem of bias by University faculty prompted a 1973 study by the research staff of the Minnesota Senate. Among their comments were: "private interests buying the most qualified state University experts deprive local and state governments and the public of the unbiased, credible expertise usually associated with a major state University."

**"Facts" and "conclusions" become indistinguishable.** The older view of science holds that facts can be determined regardless of bias, and that distortion can lie only in their interpretation. Philip C. White, president of the Coordinating Research Council, defended his organization against criticism, saying, "The first prerequisite . . . is to obtain the facts, and this must not be confused with the separate job of interpreting these facts." This view was shared by Phillip Harein, professor of entomology at the University of Minnesota, who denied any bias in his own reports, arguing that the data "speaks for itself."

Yet, as scientists and engineers become involved in more and more controversial public issues, it must become obvious that fact-gathering cannot be isolated from the interpretation of facts. The shortcomings of "objective science" and the failures of professional integrity will be on public display.

Engineer-politician Herbert Hoover once declared, "Technology without intellectual honesty does not work. Construction without consciousness soon crumbles. Those are the reasons you have seen no engineers before the Kefauver Committee." Yet only a few years later, Senator Kefauver's investigating committee was indeed interrogating engineers, those who built and defended unsafe automobiles. As long as technical experts are bought and manipulated, their "scientific" testimony must be regarded as no better and no worse than that of any politician or businessman.

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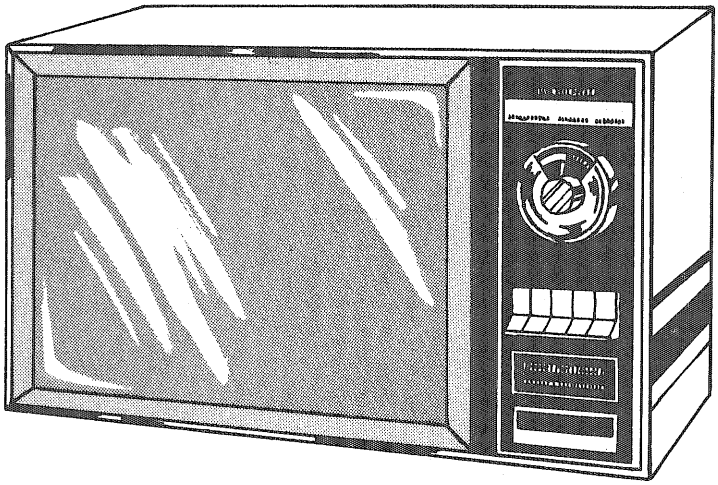
*The above is a partial list. If you are interested, check your Department office or I.T. Board Office, 230 TNCE.*

# THE MICROWAVE OVEN



# MOTHER'S LITTLE HELPER

by Robert Pirro

As usual, it took a war to develop a sophisticated technology.

This was the case with microwaves, which were studied for years but found their first practical application in radar installations during World War II. Afterwards, a spin-off developed enabling microwave energy to be used in a kitchen appliance—the microwave oven.

The success of these ovens has been nothing short of amazing. Since 1970, sales have been skyrocketing to the point where nearly 25 percent of all ranges and cooking devices purchased two years from now will be microwave ovens or microwave-conventional range combinations.

What accounts for the phenomenal success of these ovens? Sales have skyrocketed from a mere 75,000 units in use in 1970 to 13 times that figure in just the last three years. Reasons given for microwave oven use include speed, convenience, novelty, economy, ecology, size and appearance. Whichever reasons are valid, the story of the microwave oven appears to be a classic example of the right product hitting the right market at the right time.

Microwaves themselves are a form of radiant energy. All radiant energy travels in waves and creates its own electromagnetic field. An electromagnetic spectrum is a chart of radiant energy listed according to frequency, or wave length. In the electromagnetic spectrum, microwaves are grouped in the 1 $\mathrm{MH_Z}$ - $\mathrm{1GH_Z}$ frequency range, along with radio and television waves, and radar. This range falls just below infra-red and visible light waves and just above radar, television and radio frequencys.

Microwaves, like radio, light and infra-red waves, are non-ionizing radiation, that is, radiation which can cause a rise in temperature. Ionizing radiation, such as X-rays and ultra-violet rays, can cause chemical changes with little or no change in temperature.

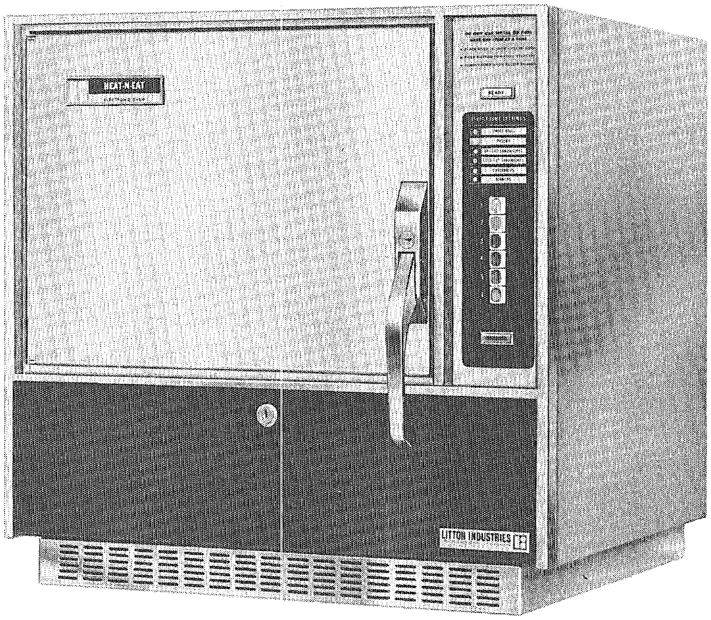
Two characteristics of microwaves are the ability to bounce or deflect off metal surfaces, and a thermal or heating effect. The thermal effect of microwave energy in an oven is attained through the use of a constantly changing electrical field. Microwaves are generated by electrons from electric current converted to electromagnetic energy. When applied to a substance in a small, closed metal area (like the inside of a microwave oven) the electrical field can be changed up to 2.45 x $10^9$ times per second. Mechanical or viscous forces normally act to restrict the matter from changing its electrical field. The energy of the microwaves in trying to overcome these forces is converted to heat.

In the case of food, the moisture molecules in the food vibrate, creating friction. This produces heat and the food literally cooks itself.

Thus a radio-frequency field is set up and the di-pole motion of the molecules forms the basis for cooking. There is also some heating in the lower frequency region, due to conductivity. In this given situation the energy density can easily reach 100 watts per square centimeter ($100W/cm^2$).

In the average microwave oven the major components consist of (see drawing) 1-the magnetron tube, 2-the antenna, 3-the wave guide, 4-the heating cavity, 5-the mode stirrer. The electric current passes through the power supply and is converted from low voltage line power to the high voltages needed by the magnetron tube. The magnetron tube generates high frequency energy in its antenna, which passes into the long metal tube surrounding it, known as the wave guide. The microwaves then move along the wave guide into the top of the heating cavity where a slowly rotating metal fan, the mode stirrer, distributes the waves in an even cooking pattern. Incidently, the bottom shelf on a microwave oven is raised so the energy can be reflected from all possible angles, leaving no "cold spots".

# A BRIEF HISTORY OF THE MICROWAVE OVEN




Although microwaves have been studied for over 50 years, their first widespread application came in radar use in World War II. Today, the most common industrial uses for microwaves are in communications relay systems and heating devices.

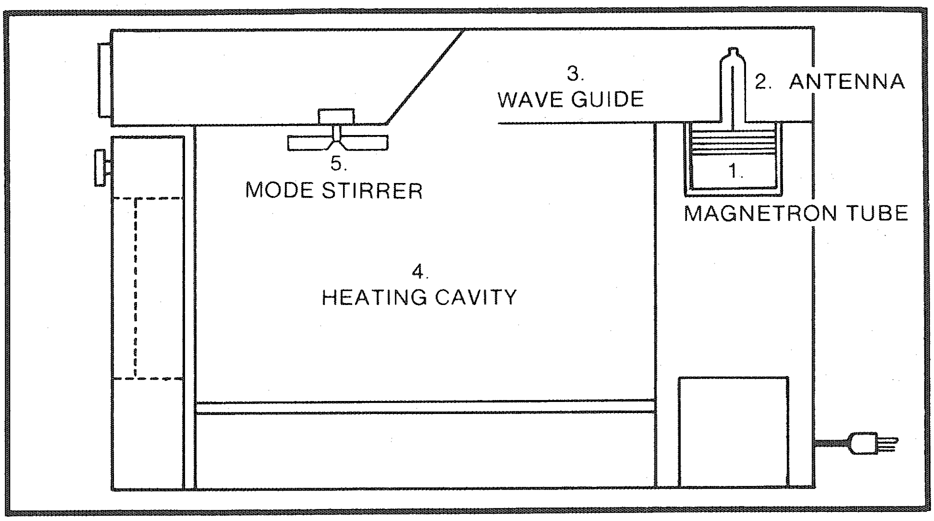
The development of the first microwave cooking oven is generally credited to Dr. P. L. Spencer, during the mid-1940's. The basic designs and concepts that he developed are still widely used in the microwave oven industry today.

The first microwave oven was introduced in 1947. Designed for reheating and reconstituting food in restaurants and institutions, it performed its functions, at best, tolerably.

The first consumer models were introduced in 1955, and they too were over-priced under-achievers. A microwave oven began to be practical in 1960 when a magnetron tube was developed (see drawing) which was smaller, less expensive and more reliable then previous tubes. Sales remained quite low until 1971 when constantly improving technology and lowered prices began catching the eye of the consumer. Sales until 1970 had totaled only 75,000 units. Sales in 1971 alone exceeded 100,000 units. Total sales in the United States amounted to over $200 million in 1973 and that figure will double in roughly a year and a half.

The gold rush is on.

All substances do not heat up in a microwave oven. In fact, one of the novelty features of a microwave oven is that only the food is cooked, while the pots, pans or plates remain cool. The notion of broiling meat on a paper plate is intriguing. . . .




The key to understanding what cooks and what does not cook in a microwave oven is simply to realize which materials reflect, transmit or absorb microwave energy. Metals, for example, reflect microwave energy. This is why stainless steel was used for the interior walls of most microwave ovens until it was discovered that acrylic coated steels were just as efficient, easier to clean and more aesthetically pleasing than stainless steel. These metal walls, constantly reflecting microwaves, enable the electrical field in a microwave oven to change direction millions of times per second. Thus it can cook food. This is also why the walls of a microwave oven do not get hot. No energy is absorbed, it is all reflected.

Paper, china and many plastics transmit microwaves. Thus the apparent absurdity of cooking meat on a paper plate becomes not only possible, but logical if the cook does not want to wash dishes afterwards. Virtually all foodstuffs will absorb microwave energy because they contain moisture.

The microwave oven sounds like a dream-come-true for the harried housewife, the rushed bachelor and the cook who does not want to waste time. The American lifestyle seems to be shifting from the whole family gathering around the dinner table at night for a big supper which took mom most of the afternoon to cook, to individuals eating convenience foods whenever they get hungry. It was a logical extension to provide convenience cooking as well as convenience foods. Apparently the microwave oven was the right product arriving at the right time.

The industry paints a very rosy picture for its product. According to Richard Parrish, Public Relations Manager for Litton Industries, microwave ovens are indeed "convenience cooking." The microwave oven user "saves a great deal of time normally spent in cooking drudgery and the substantial amount of energy saved by using a microwave oven should not be overlooked." There are other overt advantages to microwave oven use besides speed. Parrish goes on to point out that "restaurants love us; industry has, in many cases, saved tremendous amounts of money with microwaves and we have even been helpful in creating new jobs in the food industry. And the price range is down to where the average middle class American can afford to buy one as easily as he or she could afford to buy a color television set."

There are dark clouds on the horizon however. One thunderhead is the looming economic recession which, if severe enough, could drastically affect the purchasing power of everybody. A more dangerous storm for the microwave industry does not come from a dark cloud at all, but instead is strangely reminiscent of a white mushroom cloud. It can be summed up in the word *radiation,* a word which usually produces a reaction of mistrust, skepticism and downright fear from most people.

It took the consumer a little time to realize that a microwave oven produces radiation. Although this is non-ionizing radiation the fact that all of it cannot be contained within the oven and a certain amount will always leak out brought a violent public reaction. This information was sufficient to virtually cripple microwave oven sales in Japan in 1970. Massive advertising and public relations efforts were needed to revive the Japanese market although the effects of the 1970 panic are still being felt. Regardless of the convenience many people have become inexorably opposed to owning a microwave oven after they heard that magic word *radiation.* A *Consumer Report* article (April, 1973) noted the radiation emission levels of microwave ovens and announced that they could not endure or recommend any of the consumer models then on the market. Newspapers, magazines, radio and television news seem to delight in taking pot-shots at the microwave oven industry. Recently (February 1974) KSTP-TV slammed the microwave oven.

In short, opposition persists in the United States that because microwave ovens leak radiation, they are unsafe for consumers. Does that situation, in fact, exist? Is there a real basis for concern or are the microwave-related injuries reported in the press merely a testimony of mankind's ever-increasing capacity for ignoring instructions, being careless and making stupid mistakes?

*Next month, the second section of this article will deal with the question of microwave oven safety and we will try to establish what the facts are.*

# SPEAKING OF MICROWAVES

Litton Industries is the recognized sales leader in the microwave oven industry. Here is a conversation with Litton's Vice President of Engineering, Verle Blaha.

**Q-Where does Litton rank in terms of manufacture and sales of microwave ovens?**

**A**-We are the biggest in both areas. Litton manufactures about 80% of the commercial microwave ovens sold in the United States and roughly 30% of those sold to consumers.

**Q-If Litton sells more microwave ovens than any other manufacturer, to what do you owe your success?**

**A**-It is probably due to the fact that all we do here is related to microwave ovens. We do not branch out and try to cover all the potential uses for microwave energy. In this division we concentrate on one area—microwave ovens. Nothing else.

**Q-How has your engineering staff grown?**

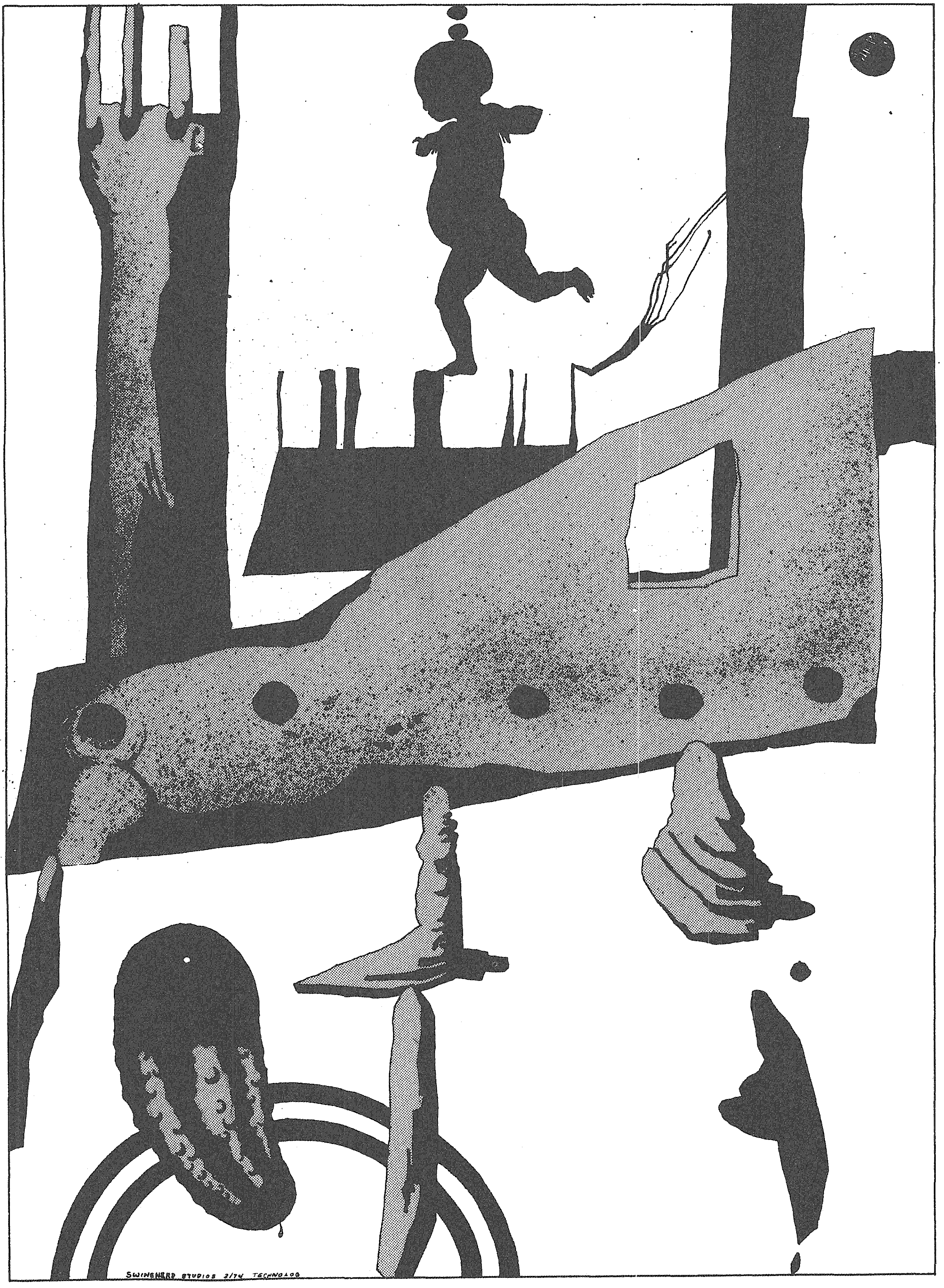
**A**-We started in 1970 with about 20 engineers. Now we have around 52. We have a controlled growth rate. We do not want to expand too rapidly and spread ourselves too thin.

**Q-What would you say are the advantages of a microwave oven?**

**A**-Size, cost and energy factors all work towards the microwave oven. Also there are more and more convenience foods available in the supermarkets.

**Q-Will the microwave oven ever be considered a necessity or will it continue to be an expensive luxury?**

**A**-I guess that would depend on your lifestyle. Speaking for myself, I could live quite well with only a microwave and without a conventional range. But a mother or a grandmother might not want to give up the conventional means of cooking. To them it probably would never be "as good" as the old-fashioned way, no matter what you did.


SWINEHERD STUDIOS 3/74 TECHNOLOG

# SANDCASTLE

"Mars ain't the kind of place to raise your kids. In fact, it's cold as hell." Apologies to Elton John are in order; but for Ralph Johnson, Mars was not only cold and barren, it was home. However, for any pioneer there is always the threat of his frontier home vanishing . . . .

by Richard Morey

The rocket blasted down, flames straining toward the sand in a mad effort to engulf all existance. And the sand leapt to the flame in a suicidal charge. Flame and sand met, in an embrace that obscured all.

The flame stopped.

Fused silicone, shaped by the blast, waited for the rocket like a bowl waiting for water. The settling sand too filled the bowl. At its edge the rocket's legs touched down, resting for a moment on the surface then sinking into the sand. Standing with its legs seemingly growing out of the planet, the rocket looked as though it had taken root, taken root or started drowning in the sand.

A ways from where the rocket had settled down was a small structure, abandoned now, and falling to ruin. Sand, whipped by the wind, washed over it like waves, battering and subduing it. Shortly beyond the structure came a school of people plodding toward the rocket. Behind them stood more structures in differing stages of decay.

Ralph Jackson's eyes walked along the footprints to where the colonists had collected around the rocket. Ralph thought of the footprints, little holes in the sand – pockmarks on the face of Mars. His attention returned to the footprints. In the short time interval of one thought, the sand had almost completely filled them in. The wind blew, rippling the sand, and together they erased the only indication that man had ever walked that part of Mars. Erased it, as they had so many times before.

Ralph Jackson set off for the rocket, the sand filling his shoes, as it had so many times before.

"Ralph." It was a statement of exasperation.

The little boy sat on a beat up chair in the kitchen, his wet dirty pants leaving a mark on the floor where they had lain. The woman emptied the sand out of a soggy pair of tennis shoes. "Ralph, I swear you have got to be the dirtiest boy in town, always playing by the lake. Won't you ever stop making those sandcastles?" The last was said more to herself, the boy was keenly interested in his big toe sticking out of his stocking.

One of the crewmen unhooked a bale from the crane, then, chewing gum in mouth, looked out across the Martian plain. "Sure is a lotta sand, ain't it mister?" His remark was addressed to the nearest colonist.

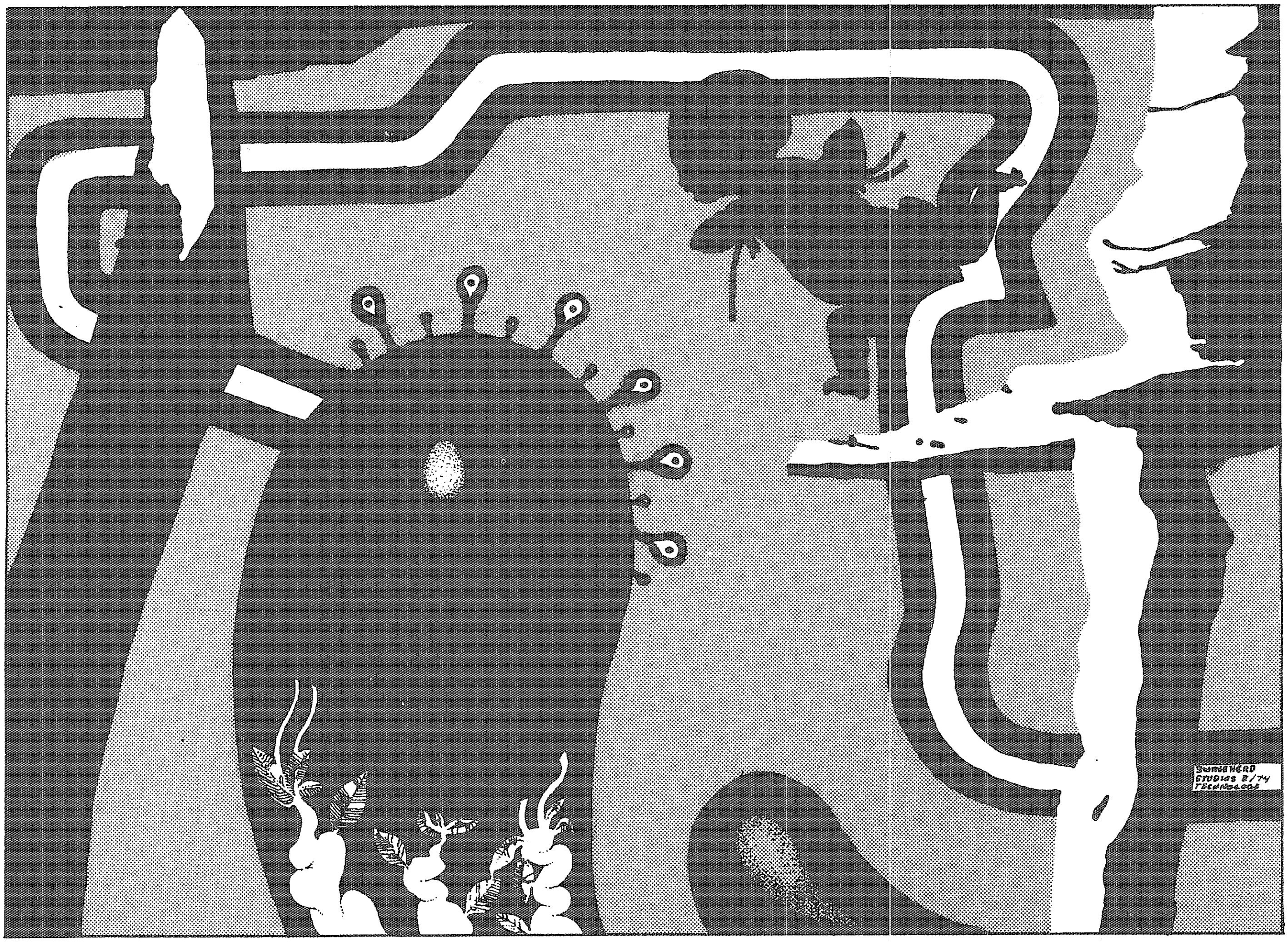
"Sure is a lot of sand."

The crewman looked to his side at the blank face which had mumbled the response. His chewing halted. "You all right mister?"

The colonist stood for a moment then began in a monotone, "Sure is a lot of sa–"

"Quiet John." Another colonist had come and started leading the first one off. "You'll have to forgive him." The new arrival lowered his head. "His family was killed in a sandstorm."

The crewman stood, gum still, for



a moment. Then, shaken by the one man's loss, he felt a need to look after the colonists' safety. The crewman buttonholed a passing colonist, "Wha'd ya do inna sandstorm?" The crewman's intensity caught the colonist off-guard.

"Wha—Who—Why—What do you mean, What do I do in a sandstorm?"

"Wha'd ya do . . . " The crewman clarifying his point, " . . . ta protect yourself?"

"Oh, I see." The colonist grinned. "What do we do to protect ourselves? We bury our heads in the sand."

The crewman was still intensely interested. "Then what?"

The colonist walked away laughing. "We suffocate."

A short distance away another crewman watched sand sift through his fingers. A colonist crouched next to him, placing a paternal hand upon the crewman's shoulder. In a guiding tone he asked, "You know what's under the sand boy?"

The crewman, wondering at the possibility of gold or oil, whispered, "No sir. What?"

The colonist gently replied, "Sandstone." Then rose, laughing, to join his fellows who were doing the same.

"Mister Smith, why are we here?"

The veteran biology teacher prepared himself to answer the question which had been asked so many times during man's life. "Well . . . there are any number of explanations. As I see it though," He looked out over the class to see if there were any objections to receiving his interpretation. "The whole process first started when life moved out of the sea. The waves washing up on some beach left behind a few microscopic organisms. These organisms were left to survive in the hostile environment of the beach sand. Some died. Some washed back out with the next wave." He again looked at the class. Ralph had the feeling that Mister Smith was looking right at him. "But, some stayed on the sand. They survived there. And from them sprang a new order. Because of those little organisms on the sand, that's why we're here."

"Comrade."

Ralph came out of his dream. "Mik. I'm glad you're not with the others."

"Did you expect to find me there?"

"No Mik. Not really."

The other smiled and clasped Ralph's shoulder in an affectionate embrace. The two walked to the rocket together, kicking the sand clear before them.

"Jackson, you'd better do something about your people before my crew does."

"What da ya mean?"

The rocket's captain looked about him, then leaned a little closer to Ralph. "Frankly Ralph, I think they're crazy. I mean it. It's a lot worse than last time I was up here. They're starting to put my crew on edge."

"What are you trying to say?" The man who had come with Ralph stepped over to the rocket. "Did you forget the supplies?"

The Captain turned to him. "Food and building materials for sixty people." He glanced at the gathered colonists. "But I don't think they'll be put to use."

Mik looked at the Captain and then to Ralph.

"What the Captain is trying to say Mik, is that in his opinion they've had it, they're washed up." Ralph stopped, trying to figure out why he'd used that phrase. "Captain, we're having a meeting tonight. I think you're going to have some passengers in the morning."

Flame leaped from the rocket as it struggled to escape the sand. Slowly the rocket fled, leaving behind a swirling confused mass of sand. As the rocket made it's way out of sight, the sand-cloud dissipated, as had the hopes and dreams of so many of the colonists.

"I didn't think they'd all go."

The four of them sat in the Martian night, lost in the darkness that was crushing them. Four people. That's all that was left of the colony. Just four people. They were insignificant specks on the Martian sandplains.

"Mik, why'd you stay?" Ralph leaned forward, looking at his friend. Searching for a hidden clue to his character.

The big man across from Ralph thought for a moment. He was a strong man, both physically and in his determination. That last characteristic Ralph had come to appreciate greatly during the course of the colony's brief life. Mik had been a good Deputy Governor and in their attempts to realize their dreams for the colony he and Ralph had overcome all ideological barriers to become more than just close friends. Even if all else was lost, Ralph thought, at least they would leave with that.

"I'm not sure how to say this, my reason for staying . . . " He looked to his wife for support. " . . . but I think it is because we are alike. We both know that Earth is a nice home. But in time the child must leave the home and become an adult, he must start a new life. That's why we're here, to start a new order of things."

Mik's last line struck a note of familiarity somewhere deep in Ralph's memory. "I don't know Mik. Four seems like an awful small number for founding new orders."

"There will be others. Give them time." Sonya had anticipated her husband's response and spoken for their hopes. She stood behind his chair, her arms draped over his shoulders.

Funny, Ralph thought, there was Mik, big strong and determined. Right alongside him, inseperable, as it were, was Sonya. Little Sonya. Physically small she may be, but her dreams and determination were every bit as big as Mik's, her love for him even bigger. Whenever one seemed to be failing, the other was there to help him out. Ralph was thankful that they both had been there to help him out.

"I hope so, Mik. If only we could get something, anything, to grow here . . . it would be a great incentive to those on the borderline back on earth." Ralph picked up a handful of sand. "But we can't get anything to grow in this sandbox." Ralph knew he was growing despondent, but what reason was there not to.

"Comrade?" Mik gripped Ralph's shoulder. "Tomorrow we will build a road to the landing site. We have enough extra supplies now, and it will be a sign for all who come that man has been here . . . " Mik looked hard into Ralph's eyes, searching for a favorable response. " . . . and that he will stay." The two men smiled at each other, firm in their dream and their resolve to make it work.

Ralph rose to see his friends leave. Mik, Sonya and their son headed for the light of their house. Ralph watched them go into the night, silhoueted by that light. Or was it, Ralph thought, another source of light that illuminated them.

The Martian plains could get awful cold at night, especially if you weren't in the confines of the colony. Ralph looked out over the Martian plain, trying to see through the darkness. What were they doing here anyway? Mik, Sonya, their son and himself – what were they doing? The four of them couldn't make the colony go. Of course there was always the possibility that Sonya was right, that more people would be coming. Some would be bound to stay, or would they?

The wind, cold and hostile, charged across the Martian plains. Ralph shook from the force of the wind and from its chill. They were just little organisms, microscopic when compared to Mars. Ralph thought about that idea for a moment, then he remembered:

A little boy in wet dirty pants and tennis shoes filled with sand, stood all alone on the beach. It wasn't an impressive sight, just an insignificant little boy on the beach. But it wasn't just an insignificant little boy. Behind him as he left, was a trail of footprints, clearly marking that he had been there. Rising out of the once level beach was a small structure, a sandcastle, and the fact of its existence made all the difference between an insignificant little boy, and a maker of worlds.

The wind came again, and with it came a call. Ralph heard the call, sweet and soft and inviting. He determined its direction and then proceeded to a small rise from which the call seemed to originate. On the other side of the rise was a small canyon. The wind blew. As it moved through the delicate canyon mouth, it called him in further. The sand rose, glittering, swirling, many hued in the Martian moons. Sand scurried about the canyon, gently chased by the wind. On the far end was a sand redoubt. Behind its sheltering wall was a small pool of water, around which were growing several plants.

Ralph knelt down by the pool, his knees getting wet and covered with sand. The sky overhead was alight with stars. Ralph turned his head upward and addressed them, "Someday. Someday. There's no beach too hostile." Then, rising to his feet he told himself, "I've got to tell Mik. A place where the wind doesn't blow so strong and plants can grow."

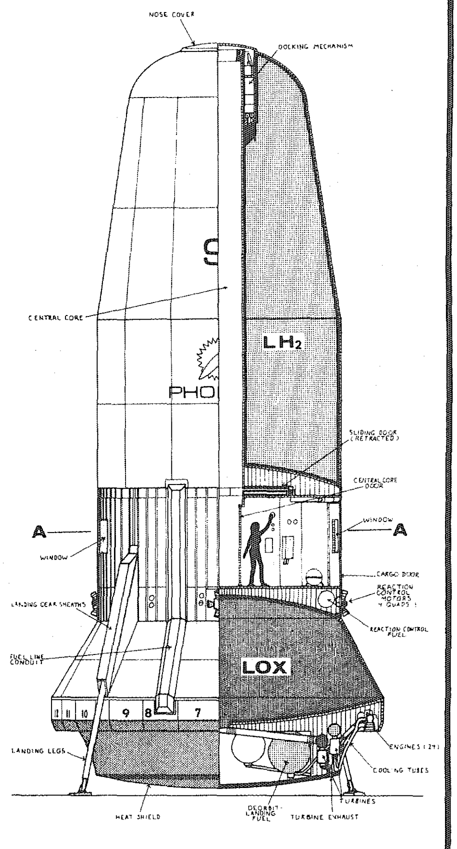
Ralph was at the top of the rise on his way to tell Mik. He looked back at the canyon once more before leaving. Inside was a small mound of sand he had piled up, a rough sandcastle. From its top the light of the stars reflected like the beacon of a lighthouse – a lighthouse on a once barren beach.

# BEYOND THIS HORIZON

## the potential of commercial space flight

by James M. Young

PHOENIX B



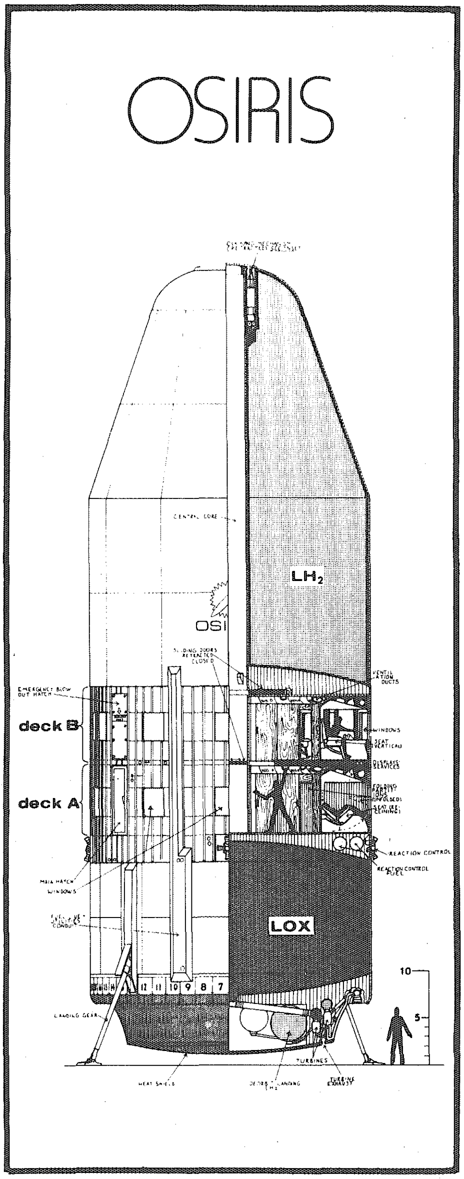

On occasion, the future leaps out at us.

For example, there is an organization in St. Paul that wants to start operating commercial spaceflights before the end of this decade. The corporation, Space Merchants, Inc., is an offspring of a non-profit educational organization, The Foundation Institute. Space Merchants, Inc. hopes to construct a fleet of space vehicles capable of manned, orbital flight at a cost of thousands of dollars rather than the millions and billions needed to launch NASA spacecraft.

How can such a saving be achieved? The answer lies in using currently available equipment and modern vehicle design. NASA spent billions of dollars to develop the instrumentation and equipment it used. Now some of that equipment is commercially available, and it is obvious that the price for telemetric and computer gear originally designed and built in limited quantities for NASA will be cheaper when the equipment is mass-produced. (Such equipment, originally developed for the Gemini and Apollo missions, is now used in Boeing 747s and other commercial vehicles.) Modern spacecraft design also allows for much cheaper orbital flight.

For building a spacefleet is no longer a problem in engineering. Remember that even the Apollo craft were designed more than a decade ago, and that a great deal of growth has taken place in space engineering during that time. The proposed Space Merchants fleet is modeled on a plan developed by NASA during the first two years of this decade. Each ship, in both the NASA and Space Merchants plans, is a single-stage, Vertical Takeoff, Vertical Landing (VTOVL) craft. While a prototype model in both systems could use experimental (and fully reusable) solid-fuel boosters, the Aerospike engines used in both systems are so efficient that boosters are not really necessary. Since both these systems use liquid Oxygen-liquid Hydrogen as fuel, and since both could be used and reused as regularly as any airplane, some very large and efficient fuel plant must be built which will be able to mass-produce these cryogenic fuels faster than any such plant has ever produced them. The initial investment may be high, but the per unit cost of fuel will drop drastically below that current today.

In 1971 the bill funding the development of this NASA proposal failed of passage. (The unmanned




satellite intended to take "The Grand Tour" of the outer planets in 1976 – the only year in this or the next century with a favorable window for such exploration – was dropped at the same time.) So, with many modifications, Space Merchants, Inc. has adopted the NASA plan.

There are three basic vehicles in the Space Merchants' fleet. Smallest of the ships, and the first to be built, will be the **Phoenix** class spacecraft. **Phoenix** will test the Aerospike plug nozzle rocket engine, and the VTOVL system that Space Merchants, Inc. designed. (The Space Merchants' ships have a heat-shield on the bottom, through which the ships' rockets protrude. In landing, the ships simply use their rockets rather than parachutes; all landings are intended to be controlled, soft touchdowns.) **Phoenix** ships can carry a payload of 6000 pounds, with two crew-members aboard.

Next in order of development is the **Osiris** spacecraft. **Osiris** will test an uprated version of the Aerospike engine, and will be capable of carrying either 28 crew-members or 18,000 pounds of cargo.

The cap to the program is the **Sea Dragon** vehicle. **Sea Dragon** will in a pinch be capable of lifting about 300,000 pounds of cargo, though it will normally lift only about 200,000. It will use a system of Aerospike engines, or if possible, either the low pressure Rocketdyne J-2S engine or the Space Shuttle Main Engine (SSME) developed for the NASA Space Shuttle. **Sea Dragon** has been specially designed in order to lift two modular space habitats per flight. These modules are called **Eyrie** class modules in the Space Merchants plan; they are intended for use as buildings blocks in the construction of space-stations, lunar bases or extraterrestrial private or commercial installations.[1]

Just how much cheaper would this system be than the only comparable NASA program now planned, the Space Shuttle? Compared to the Space Shuttle, the Space Merchants program is remarkably inexpensive. Whereas it costs $300 million for each Space Shuttle, it will cost about $14.9 million for each **Phoenix A.** This price is abnormally high because **Phoenix A** will be a prototype test vehicle; **Phoenix B,** designed without solid-fuel boosters, will cost about $7 million per vehicle. The **Osiris** will cost about $9.7 million each, and the **Sea Dragon** class ships will cost about $82 million a piece.

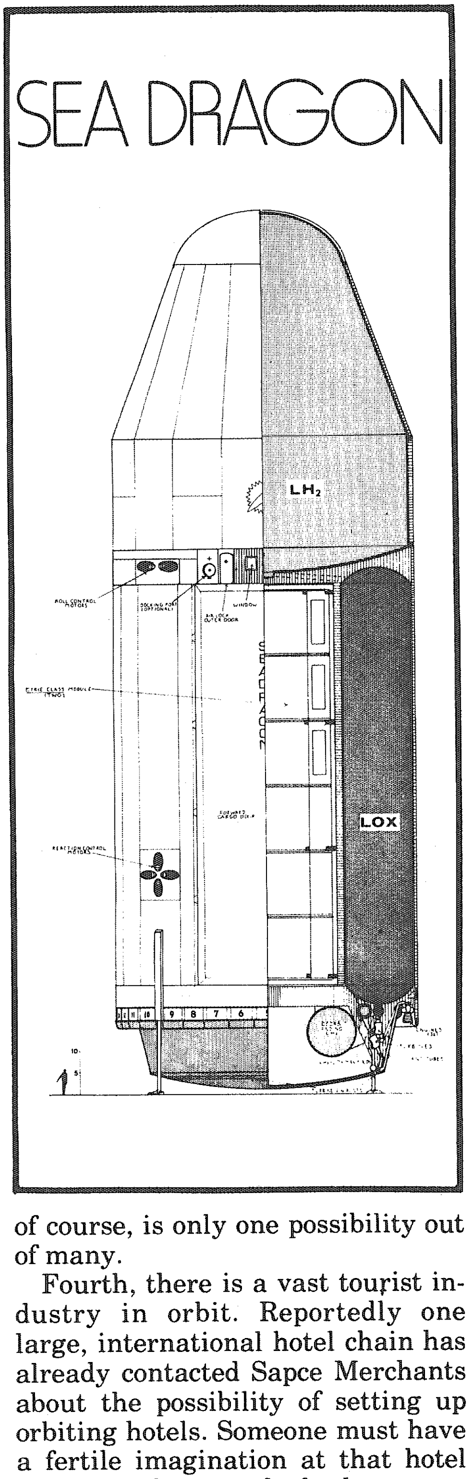
One reason why the Space Shuttle costs so much is that whole new systems must be designed for it; it is one of the unfortunate tendencies of the American government that where corners can be cut safely, they are not. It will also cost roughly $10 million for each launch of the Shuttle, since it uses non-recoverable boosters to get it into orbit. Thus it costs about $160 per pound to launch the Shuttle, as compared to about $900 per pound for (the much heavier) Apollo craft. On the other hand, it will cost about $25,000 to launch **Phoenix B,** about $50,000 to launch **Osiris,** and roughly $250,000 to launch the **Sea Dragon.** (All these prices are in 1973 dollars.)[2] These prices approach the rate of one dollar per pound.

It is fairly obvious that the problem with the Space Merchants program is not one of hardware, but of finance. Beginning in January, Space Merchants, Inc. began to push for monetary backing. In the next few months, it will become apparent whether or not the financial incentives of the New Frontier are great enough to overcome the anxiety of businessmen about the project. For without backing, the Space Merchants spaceflight program cannot get off the ground. That would mean that there would be a significant slow down in space exploration in this country during the next few years.

There are markets aplenty in space, and that is the message that Gary Hudson, Chancellor of The Foundation Institute and founder of Space Merchants, is bringing to business leaders and politicians. When I saw the first public announcement of the Space Merchants program last month, there were five main markets Hudson pointed out. First, there is a great deal of money to be made by launching satellites cheaply, for telecommunications, weather forecasting and the like. With an inexpensive launch system, it should also be possible to repair satellites rapidly and easily. Hudson described one orbiting telescope launched in 1965 that, 15 minutes after it achieved orbit, failed because a single 50 cent capacitor died. NASA or the U.S. government might pay well indeed to have that $50 million satellite repaired.

Then there is the whole potential of manufacturing in space. The electronics industry, ball-bearing manufacturers, and many other concerns would be able to produce their merchandise better in a zero gravity or vaccum environment than they could on Earth.

Third, there is the potential of using space-stations as hospitals. Heart patients would find space a godsend; operations on people who were overweight might be possible in low gravity environments when they are impossible on Earth. This,




of course, is only one possibility out of many.

Fourth, there is a vast tourist industry in orbit. Reportedly one large, international hotel chain has already contacted Sapce Merchants about the possibility of setting up orbiting hotels. Someone must have a fertile imagination at that hotel chain – they no doubt have contemplated a honeymoon in zero gravity . . . .

Then there is the potential of mining. Exploitation of space may begin to compete with Earth for some raw materials, especially if there is improper controlling of national economies on Earth.

Finally – though this was not mentioned in the public announcement of Space Merchants, Inc. – there are doubtless many "x-factor" markets in space, that is, markets that can only be found once real manned exploration of space starts. They may include such things as tapping the energy of the sun, finding some new biological information in space, or something totally unguessable today.

The exploitation of space is a very real – and to some, a very exciting – possibility. But such exploitation poses a thorny legal problem, to wit, who makes sure that something really dangerous to the lives of human beings on Earth – like putting a cobalt bomb in orbit – does not take place? It would be very nice if things would proceed pleasantly in space, and without disturbance; but that is a highly unlikely outcome. There is likely going to be business – and international – conflict over use of celestial bodies. It all boils down to a question of who is actually responsible for what happens in space.

There are two major legal documents on this topic, both of them promulgated by the United Nations. The first is the Treaty on "Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," ratified by all 92 members of the U.N. in 1967. The other is a convention on national liability for damage caused by spacecraft, passed in 1972.

According to the 1967 Treaty in Article VI, "The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the State concerned."[3] There is no proscription, as **Time** erroneously reported in covering the first Apollo moon-landing in its issue for 1 August 1969, against making money with materials found in space or on celestial bodies. This whole aspect of space exploitation is neglected in the 1967 Treaty; indeed, the attitude of the entire document is one of using space primarily for scientific research. A program like that of Space Merchants, Inc. makes this attitude obsolete.

There is a way around this difficulty. If the 1967 Treaty were amended so that the United Nations would be able to grant Charters of Corporation – in the manner of the European nations during the 15th-18th centuries – then certain areas in space or on celestial bodies could be set aside by the U. N. for exploitation by one firm. A certain fee would have to be paid by the firm for each extension of its corporate charter. The money coming in to the United Nations from this program could be used to inspect and maintain safety standards on spacecraft, to police the vicinity of the Earth so that no violation of Article IV of the 1967 Treaty – which prevents the placement of atomic weapons in orbit may take place, and to supervise navigation of spacecraft around the world. But such work would account for only a small amount of the money coming in. The rest could be spent on the development of Earth; the U. N. might, by force of economics, become a boon to poor and rich nations alike. For space law must be a branch of international law – both the United States and the Soviet Union recognized this fact when they signed the 1967 U. N. Treaty. Since the U. N. is the only active, quasi-governmental international organization extant, it should serve as the headquarters for the promulgation of such law. In so doing, it would make possible a much better world.

The fundamental problem facing the Space Merchants program is one of foresight. If enough people decide to back the plan, it can be done now. It means – especially if the United Nations corporate charter idea were to be employed – an improvement in the human condition, around the world, in the short-term future. But this promise does not mean that the plan will be approved or that the program will be developed. Approval and development – no matter how great the prospect for human progress – will be made on the basis of how much money can be earned from this venture.

So it is that Space Merchants, Inc. are aiming precisely at the pocket-books of potential investors. At this time, in this country, it is an exciting move.

[1] Source: "Basic Information: Commercial Space Operations," 19 January 1974. News release of Space Merchants and The Foundation Institute.

[2] *Ibid.*, p. 12.

[3] "Text of Treaty," *U.S. Department of State Bulletin* (26 December 1966), p. 953.

# minnesota Technolog april 1974

## SEAL SEARCHING
## JOB OUTLOOK FOR I.T.
### I.T. Student Government · Computer Games



# "The U.S. will inevitably shift to an electric economy."

**D. C. BURNHAM, CHAIRMAN**
**WESTINGHOUSE**
**ELECTRIC CORPORATION**

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# The Candidate

The top brass at the *Technolog* were bitterly disapointed when the Board of Regents announced they had selected C. P. McGrath as the new University President. We were hurt because the Regents did not follow our advice and choose our candidate to succeed Mickey Moos.

Last autumn, when the steering committee sent us our University Presidential nominating papers, (which reminded us of a sweepstakes ticket) we very carefully delineated what the next chief executive should be. Realizing that the Board of Regents was our audience, we took great pains to make our presentation in the simplest possible words with lots of pretty pictures. My guess is that our downfall came when they could not fathom the follow-the-dots drawings.

We first set down the basic prerequisites for any college President. The first rule was that the President had to be anything but a woman. We all know what to expect from men. A woman president might be different. She could turn out to be calm, reasonable, fair, impartial, above petty politics, willing to initiate practical reforms or might actually listen to students. Such unpredictable behavior would revolutionize and cheapen the position of University President.

A good college President must also issue grandiose policy statements which sound magnificent but are meaningless and totally unfulfillable. He must be able to squeeze money out of the alumni and legislature by pointing out flashy University achievements in areas such as medicine and laundry research. He must be totally inaccessible so that students cannot identify him. This is a very important factor when militant student groups such as the Association of Nonresident University Students (ANUS) try to throw him out of his office. An optimum candidate would be one that was so unknown that nobody could even find his office, much less him. An effective college President must also possess a totally illegible signature and, of course, have a masters degree in rubber stamping. A particular duty of the Minnesota job is to attend the Board of Regents meetings, issue public statements to the effect that you feel the Regents are actually important and you must constantly smile at Elmer Anderson.

At first we were going to nominate our own Dean Swalin as he fit all of the necessary conditions for Presidential candidacy. But after spending a month trying to locate him, we concluded that Swalin must have died sometime during the winter of 1971 and that I.T. is now being run by two computers disguised as Richard Fortran, a mechanical engineering professor, and Martin Snobol, a professor in theoretical statistics.

Realizing that this system can work, the *Technolog* proceeded to nominate the perfect candidate for the University of Minnesota Presidency; an IBM-360 named Hal Cobol. He fit all the necessary requirements for the job, except for the smile. As was the case for all University Presidents in the past, that smile would have to be painted on.

It is too bad that the Regents did not follow our advice. With Hal at the controls, we would have had the ultimate University.

# Dilly Of A Daily

We had to laugh at the *Daily* of April 9 and the first installment of their article on prostitution. We did not laugh at the article itself, which was a good job done by Greg Breining (who incidently got his start writing for the *Technolog)* but at the thoughtless layout of that piece, especially when you turned to page 10.

On the right hand side of that page, the article continues with these words "was in bed with a morals squad officer. They were both naked." Directly opposite this article on prostitution is an eye-grabbing advertisement, in bold type, with the headline "10 Reasons Why You Should Increase Your Advertising". It was a *Daily* promotion ad and after reading such reasons as "Whether business is good or slow, you have to get your share of whatever business is around . . . In times of uncertainty, customers are careful and a little reluctant to spend . . . Remember how long it took you to get started? . . . You say your customers know you and for a while at least they'll keep coming in even if you don't promote? . . . One thing you control is your own promotion.", it is a little difficult to retain a sober attitude in returning to read a serious attempt to educate and inform the Minnesota student about a social phenomenon which is a major force in virtually every other urban area in the United States.

If I were the author of that piece I would be extremely angry at the *Daily* Art Directors for their lack of foresight and common sense in insuring a decent layout for the article. If the female *Daily* Art Director could have taken a few minutes away from posing for the pictures used to illustrate that piece, or had the male Art Director actually tried to comprehend what was going on, they would have been able to keep us from getting our laugh. That would have been all right with us. Our laugh was actually a sad one.

## Plumb Out

We guess that E-Week must be right around the corner. We can only assume this, as the hunt for tangible evidence that a 1974 E-Week actually exists is a difficult one.

At the time of this writing, April 16, the *Technolog* has been unable to find out from any source, including the I.T. Student Board, about exactly what events and contests are planned for E-Week. It has always been an intriguing notion that an anonymous group, Plumb Bob, is entrusted to run a public event. This year though, the anonymity is spreading to the event itself. You know that the situation is bad when you see a poster about the homemade car race which lists a place to register and a phone number to call for information, and you go to that place and find nothing there and call that number and there is no answer. That is exactly what happened to us.

E-Week over the last few years has become increasingly dull and stagnant. That is a real shame too because E-Week is a tremendous opportunity for all I.T. to give and share in some togetherness and real fun. The high point of last year's E-Week was the dropping of water-bombs and styrofoam confetti on the knighting of the Plumb Bob members. It was too bad that it was not a part of the planned program, as it was the most exciting event of the day.

E-Week is what the participants make of it. Rather than silently, passively hoping for entries into unknown contests, a massive publicity drive should have begun in March to make engineers aware of what their day was going to be all about. Plumb Bob should start offering some real prizes for winning contests as those prizes usually have a strangely effective way of attracting interested entrants. Some new contests, like Space War, Pong and Star Trek competitions, bicycle races, obstacle courses, to name a few, also seem to be in order.

We honestly wish E-Week our best and hope that as many engineers as possible participate and enjoy the week. But we cannot help but feel, deep down inside, that next year at this same time we will again feel the urge to write an editorial like this one.

With luck, you will prove us wrong. I certainly hope that is the case.

# STUDENT GOVERNMENT AT MINNESOTA:

# How to Become a Closet Fascist

by Laurence Yarosh

It is election time on campus. The *Daily* is overflowing with words about the candidates for Minnesota Student Association (MSA) President while hastily formed political parties distribute extensive platforms. All this is destined to be forgotten soon after election day as the parties will dissolve.

Yet the most important policies of student government are made, not by the MSA President, but by the unknown students who sit in the MSA Forum, the University Senate, and scores of committees and boards. In all of this activity, IT students have made a contribution far out of proportion to their numbers and, sometimes, beyond the scope of the election rules. Here is a look at student government over the past nine months:

**MSA Forum.** The Forum controls the Minnesota Student Association and its budget of $125,000 per year. Although IT is allotted three seats in the Forum, four people have assured us that they are regular IT representatives (see box). The past year has seen an endless series of confrontations between liberal MSA presidents and the more conservative Forum, beginning with a threat to censure then president Steve Carter and continuing with president Kathy Kelly's description of the Forum members as "closet fascists."

That famous remark came as Kelly, angered over the Forum's refusal to endorse a series of political causes, walked out of a February Forum meeting. In an interview, she maintained that the Forum has done little for MSA. "They spent a lot of time on internal haggling this year," she claimed, arguing that "not one single project has originated in the Forum." In her view, MSA's business has been carried out by its executives, including the president, with little help from the Forum.

Ron Ezuck, IT representative to the Forum, echoes many of Kelly's criticisms, accusing the Forum of "general apathy" and a great deal of petty quibbling." Greg Pelletier, IT representative and chairman of the Forum's budget committee, agrees. Deploring the lack of activity in the Forum, he told us that most committees are controlled by one or two people and "are not very effective." Yet he placed much of the blame on the MSA executives. Instead of leading the Forum, he said, they operate by themselves and merely ask the Forum to approve their monthly reports. If they were willing to work with the Forum, he suggested, they might gain more cooperation.

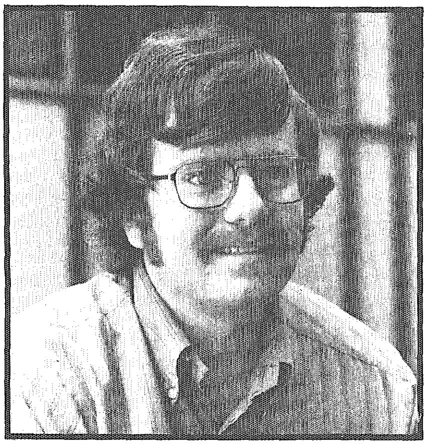
Mark English, another IT member, agrees that the Forum suffers from the iron law of oligarchy. There are "maybe four people who run the whole place " he told us. Yet English, who led the opposition to Steve Carter and authored the measures that curtailed Carter's spending power, argued that power comes only from having a knowledge of the issue and "being there" when a decision is reached.

Walt Lepisto, a fourth member of the IT delegation, emphasized that

# FACES: The I.T. Politicians

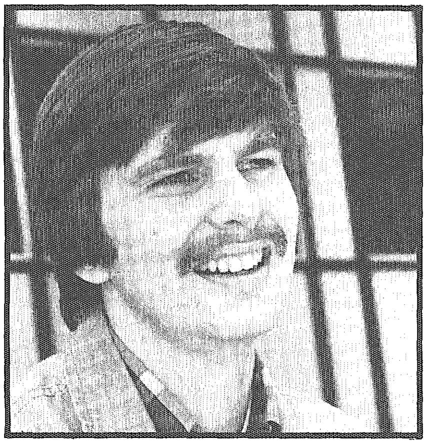
IT is allotted only three seats in the Forum and Student Assembly, but four people claim to be IT representatives. They are:

**Mark English.** English gained a wide reputation during two unsuccessful campaigns for Vice President of MSA. A Forum member for three years, he became involved in dormitory government as a freshman. Elected to the Forum in 1971, he served on the Student Assembly's Intramurals & Extramurals committee and its Small Grants & Budget committee. As a senior, he served on the Senate Committee on Educational Policy and the Student Assembly's Student Regent committee. In the past year, he was chairman of the Forum's Budget committee until January and is currently a student Regent, with the right to speak, but not vote, at meetings of the Board of Regents. English graduated in 1973 with a degree in Electrical Engineering and is now in Law School.



Mark English

**Greg Pelletier.** Pelletier, currently chairman of the Forum's Budget committee, was elected to the IT Board in 1971 and became its secretary in 1972. He was elected to the Forum in 1973. Pelletier is a senior in Chemical Engineering.



Greg Pelletier

**Walt Lepisto.** Lepisto has found his way into the Forum without ever running for election. Returning to school after an absence, he joined Kappa Eta Kappa fraternity and became their representative to the IT Board. When an elected Forum delegate resigned, he was appointed by the IT Board to fill the vacant seat. Lepisto is a senior in Electrical Engineering.

**Ron Ezuck.** Ezuck entered student government in his sophomore year as an appointed member of the Assembly Committee on Educational Services. In the same year he worked for the Tech Commission (predecessor of the IT Board) recruiting students for departmental governing committees. Eventually appointed to the Tech Commission, he was elected in 1972 and became the Commission's president. During his junior year, he also worked on the University College Governing Council and the Senate Committee on Resources and Planning. Ezuck ran unsuccessfully for the Forum in 1973, but assumed a seat when an elected delegate resigned. He is now a senior in Physics.

**Janice Tjebben.** While IT's entire Forum delegation is graduating or leaving this year, several members of the IT Board will run for reelection, including its president, Janice Tjebben. A board member for three years, she was board Treasurer as a freshman and Vice President as a sophomore before becoming President. She currently serves on Assembly committees on Planning, Registration & Orientation and Libraries besides holding membership in the Society of Women Engineers. Tjebben is a junior in Chemical Engineering.

Walt Lepisto

Ron Ezuck

Janice Tjebben

merely attending Forum meetings is not enough to participate in decisions – one must also join the Forum's committees and do the committee homework.

What of the organization itself? MSA has fallen under criticism from students who see little return from the $1.15 they pay each quarter to MSA in student fees. Pelletier sympathized with the complaints, noting that 37 percent of MSA's budget goes for salaries and stipends of its executives. Ezuck admitted that he was "hard pressed" to list any specific accomplishments.

Kathy Kelly, when asked, was not so hesitant. The MSA Telecommunications Corporation, she pointed out, provides access to audio-visual equipment for campus groups and is seeking a license for an FM radio station, providing a second news source as an alternative to the *Daily*. The MSA Housing Corporation has already purchased several buildings in Dinkytown for renovation and is planning to manage the Chateau apartment building in Dinkytown.

The MSA Services Corporation runs the MSA Bookstore and, although the bookstore has been operating in the red for two years in a row, it is in the midst of setting up a St. Paul bookstore.

Kelly has devoted considerable time to promoting child day care and it was MSA researchers who discovered a forgotten University Senate Task Force Report on daycare which has formed the basis for the proposal eventually presented to the Regents.

**Student Assembly, et al.** The Forum is not the limit of student government. The Forum sits, without the MSA executives, as the Twin Cities Student Assembly. The Assembly, in turn, combines with the faculty assembly to form the Twin Cities Campus assembly, which then combines with groups from the coordinate campuses to form the All-University Senate, spending a budget provided from University funds.

The Senate and its sub-groups control the MSA corporations (although MSA provides the money for its corporations) as well as exercising control over such University issues as daycare and long range planning. A Senate task force was the author of the daycare plan being considered by the University.

Ron Ezuck took part in the Senate's 1972 attempt to provide a long range plan for the University. Ezuck was a member of a student task force studying the faculty-dominated document, *Toward 1985 and Beyond*. The document recommended that the University concentrate on developing specialized programs at the expense of liberal arts and that it develop outstate campuses. The student task force recommended that money be spent instead to upgrade the quality of present programs, especially by reducing class size. The battle over the form of the final Senate recommendations was never resolved, and both documents were shelved.

**IT Board.** Organized separately from MSA and the Senate bodies, the IT board deals with college-level concerns. Smaller than the Forum, it manages to avoid the acrimony of campus wide politics.

The closest the Board has come to a bare-knuckles fight is their conflict with the CICS department over the basement of Main Engineering, due to be vacated by the bookstore. CICS had originally planned to request the entire space for offices, but agreed to submit a joint plan with the IT Board, dividing the space between offices and a student lounge. Board members warn that student pressure is still needed, lest CICS gobble up the entire space or the English department launch an invasion from their second floor offices.

This year's round of budget retrenchment presented a crisis for IT as a whole, and board president Janice Tjebben organized a series of meetings with University vice president Albert Linck to argue that IT was more vulnerable than other colleges to further budget cuts. When the budget cuts were announced, IT was cut the least of any college.

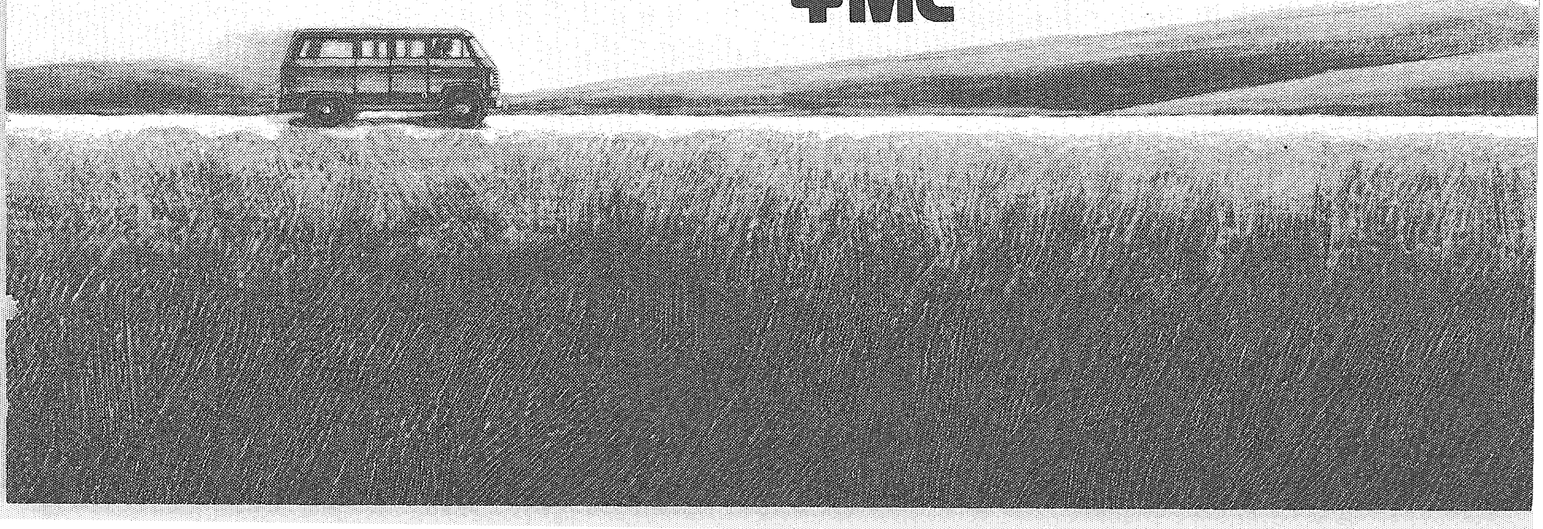
The new proposals for per-credit tuition have provoked the board's opposition. CLA students are currently allowed to take all courses offered by the Math, Physics, Chemistry and Architecture departments. Thus math majors, for example, may be tempted to pay the lower CLA tuition for three years, and transfer into IT only in the senior year and qualify for an IT diploma. The financial incentive, while significant now, would be even greater under a per-credit tuition plan.

**Participation in Student Government.** Student government is eventually a function of the people who make it up. CLA, which has six vacancies in its Forum delegation and a high absenteeism rate among the remainder, does not have as much influence for its size as IT, which has four delegates squeezing into its three seats. Kathy Kelly, bemoaning the Forum's lassitude, concluded, "It needs, more than anything, people who really care."

Those who care are drawn into an endless array of boards and committees, ranging from the University Senate to departmental grievance committees within IT. Most committees will accept members who have not been elected to the correspondent parent group. For the participants, the obstacles are significant, ranging from complicated parliamentary maneuvering to frustration with the administration's inertia. Walt Lepisto described the plight of students sent to fill vacant CLA seats in the Forum like replacements in the front lines of an army: "The old timers know how to manhandle people." he told us. New members are awed by the proceedings, become "lost in the fog" and finally quit attending. "You must be aggressive" to have a voice in the Forum, he warned.

Mark English described the setbacks and delays of campus politics and issued a warning: "People who take it seriously don't last – they resign out of frustration." The results of an effort may not be seen until several years after the project ends.

Yet there are rewards. "Student government is interesting," Lepisto told us. "You get to know what's going on." Pelletier was more positive. "I learned a hell of a lot," he said. "It helps in understanding other people's ideas." As chairman of the Forum's budget committee, he has been exposed to all the pressure and lobbying that surrounds the distribution of money. But the final rationale was given by Ezuck. "You have a feeling that at least you're in there trying." he said. "At least I'm trying."



# THE CURRENT JOB OUTLOOK FOR I.T. STUDENTS

by Robert Pirro

The present job market for engineers and scientists is dramatically improved over last year. This is the message received from such sources as the Engineers Joint Council's *Demand For Engineers Survey*, the College Placement Council's (CPC) *Salary Survey*, Dr. Norman Ceaglske, Director of the I.T. Placement Office and I. T. Assistant Dean, Paul Cartwright. All indicators point towards increased job offers and higher starting salaries for Institute of Technology graduates.

The Engineers Joint Council's survey reveals that in 1973 there was an average increase of six percent in the number of jobs available to college graduates. That figure is expected to rise during 1974. The CPC *Salary Survey* states that college recruiting activity is continuing to accelerate and that engineering majors are the most sought after graduates. According to the survey, "at the bachelors level, engineering disciplines showed improvement in volume of almost 50 percent." It goes on to say that "at the master's level, the number of offers in engineering rose 40 percent."

These findings were echoed by I. T. Placement Office Director, Dr. Norman Ceaglske. According to Dr. Ceaglske, twice the number of companies were interviewing candidates during the 1974 winter quarter than were interviewing in winter quarter 1973. "Generally, the offers average out to about two per student, starting at over $1,000 per month" said Ceaglske. He also pointed out that of the 60 fall I.T. graduates that worked through and kept in contact with the Placement Office, 49 landed jobs, seven went to graduate school and only four were unable to find employment.

Locally, all the engineering disciplines seem to be experiencing increased job demands and pay increases although Ceaglske points out that "civil's pay is a bit low." Ceaglske concludes that math, chemistry and geology are not in demand, but the other areas are reverting back to the early 1960s in terms of hiring.

Here is a capsulized progress report on some of the engineering and science fields. The figures stated here are from both the Engineer's Joint Council survey and the CPC's survey. The figures are based on national averages and trends.

**Aeronautical Engineering** finished relatively low in terms of monthly salary offers. The average monthly salary, $956 per month, was a 5.3 percent increase over last year. The Engineers Joint Council reports that aeros were the only engineering group to show a consistent pattern of retrenchment in industry jobs. There was a two percent net loss of jobs for aeronautical engineers over the last year. However, top dollar is still being paid in the aerospace and components industries, if you can get the work.

**Chemical Engineering** still commands the highest average starting salary for B.A. candidates with $1,021 per month, a 6.4 percent increase over last year. The masters degree also draws top starting salary among the engineering disciplines with their monthly average of $1,149. PhD candidates are pulling in a monthly average of $1,508, a salary which falls just behind that of electricals. The last 12 months show a seven percent overall rise in the number of chemical engineers employed. Average salaries of over $1,000 a month are usually found in areas of petroleum, merchandising services, chemicals & drugs, building materials, packaging, food & beverage processing, metals and electrical machinery.

**Civil Engineering** brings up the rear in terms of average starting salaries unless you work for the federal government or are in what is termed "Engineering technology." The B.A. average was $945 although the average salary raise was a respectable 6.2 percent and the job rate expanded seven percent over the past year. Salaries for civils on the masters and PhD levels are also lowest in the engineering fields, with $1,072 and $1,393 for the masters and PhD respectively.

On the B.A. level only petroleum and chemicals were areas in which a civil could be confident of making $1,000 a month. Fairly strong showings were in areas of tire & rubber, glass & paper packaging, banking & finance and merchandising services.

**Electrical Engineering** employs

more engineers than any other engineering major in the United States today. Electricals with a B.A. earn a starting average of $967 a month, a five percent increase over last year. This ranks them behind chemical, mechanical and metalurgical engineers in terms of starting salaries. On the masters level the average salary is $1,121, second only to chemical engineering and the PhDs outearn all other engineers with an average of $1,525. Despite already having the largest engineering work force in the country, the job market for electricals increased a healthy 6 percent last year. The most lucrative fields include merchandising, chemicals & drugs, food & beverage processing, automotive & mechanical equipment, building materials, petroleum and glass & paper packaging.

**Mechanical Engineering** is third highest in average starting salaries for B.A. degree candidates with a $981 a month average. This is a 6.4 percent raise over the last year with an increase in jobs of 9 percent, which is the highest rate of job increase for engineers. The post-graduate salary average was adequate but by no means outstanding. The masters candidate averaged $1,104 per month and the PhD averaged $1,456. In both levels, mechanicals trailed electrical and chemical engineering in average earnings.

The highest paying industry for mechanicals is petroleum, followed by glass & paper packaging and chemicals & drugs. A mechanical engineer should not have to starve if he or she enters merchandising, automotive & mechanical equipment, building materials, electrical machinery, metals or tire & rubber.

**Metalurgical Engineering** covers a wide field of engineering specialties. This group averaged $994 per month, second highest average salary in the B.A. level for engineers. This salary figure represents a 7.9 percent salary raise in the last 12 months. Masters candidates averaged earnings of $1,124 per month while the job market on the whole showed a six percent rise in jobs.

In reporting on the sciences no figures were available on many areas and no data was available to comprehensively treat the number of jobs gained or lost in some fields.

**Agricultural Sciences** had an average B.A. starting salary of $770 a month, a 6.1 percent increase over the last year. Masters degrees brought home an average of $985 a month. Only mathematics earned less at this level. Top dollar for agricultural engineers seems to lay in glass & paper packaging, local & state government, non-profit organizations (and schools) and electrical equipment & machinery.

**Biological Sciences** finished dead last in earnings among all the engineering and sciences mentioned here. They averaged only $723 per month for a B.A., which nevertheless was a 7.1 percent increase in salary over the past 12 months.

**Chemistry** finished third highest in science earnings with an average of $869 per month for a B.A. and $1,133 a month for the masters. This figure led the sciences in earnings. While chemists earned the most of any scientist on the masters level, a PhD placed second in earnings with a $1,417 per month average. The overall job rise was 5.2 percent.

The earnings range for chemists is remarkably consistent as most fields pay quite well. Petroleum, glass & paper packaging, building materials, aerospace & electronic instruments, chemicals & drugs, utilities, research & consulting all seem to pay fairly well for the chemist.

**Computer Science (CICS)** led the B.A. science field in earnings with a monthly average of $893, which is only a 3.5 percent increase from last year. A masters candidate averages $1,102 a month, which places third in that category.

A CICS major should choose a career carefully. He could live comfortably working in aerospace electronics & instruments, automotive & mechanical equipment, chemicals & drugs, electrical machinery, tires & rubber and metals. That same CICS major could starve working in banking or for the state or federal government.

**Health Sciences** showed relatively poorly in earnings. The B.A. averaged $763 per month with a mere 3.7 percent increase in salary during the last year. The only lower average starting salary was in biology and the only percentage of salary raise that was lower was in CICS.

**Mathematics** averaged $842 per month for the B.A. student, which is a four percent increase over last year. The average earnings for a masters degree was $964 per month. To earn this type of money the mathematician would have to take a job in automotive & mechanical equipment where the average starting wage is over $4,300 more per year than if that same person were to work for a local or state government. The mathematician could also live comfortably when employed in the areas of public utilities, electrical equipment, aerospace electronics & industries, and public accounting. The math major could get hungry quickly when employed in merchandising services or glass & paper products. He might make more money on welfare than working in banking or for the federal government.

**Other Physical & Earth Sciences** can expect an average starting salary of $884 per month, a 6.5 percent raise over last year. That is the second highest raise and salary total among the sciences listed here.

With the brighter salary and hiring pictures emerging for engineers and scientists, this question comes up; is the hiring boom due to greater industry demand or to the lower number of engineering majors graduating? Dr. Ceaglske feels that the increased job opportunities for engineers are due to a combination of both elements. Assistant Dean, Paul Cartwright, brought out the point that although the enrollment in I.T. has dipped for the last few years, this retrenchment will not be keenly felt until the next two or three years. I.T. enrollment figures show 988 freshmen enrolled in I.T. in the fall of 1970. That figure dropped to 615 freshmen in the fall of 1972. "Industry is aware of the long-term decline in engineering college enrollment around the country" says Cartwright, "and they are probably preparing for that decline by hiring right now." Cartwright adds that "since industry expects to grow and anticipates their needs in advance, they are beginning to hire right now to fill the quotas they will need two or three years from now."

So think twice before transfering to CLA. As an engineer or scientist you stand to be in demand again.

# The Highest Density of Life Anywhere; Antarctic Pack Ice

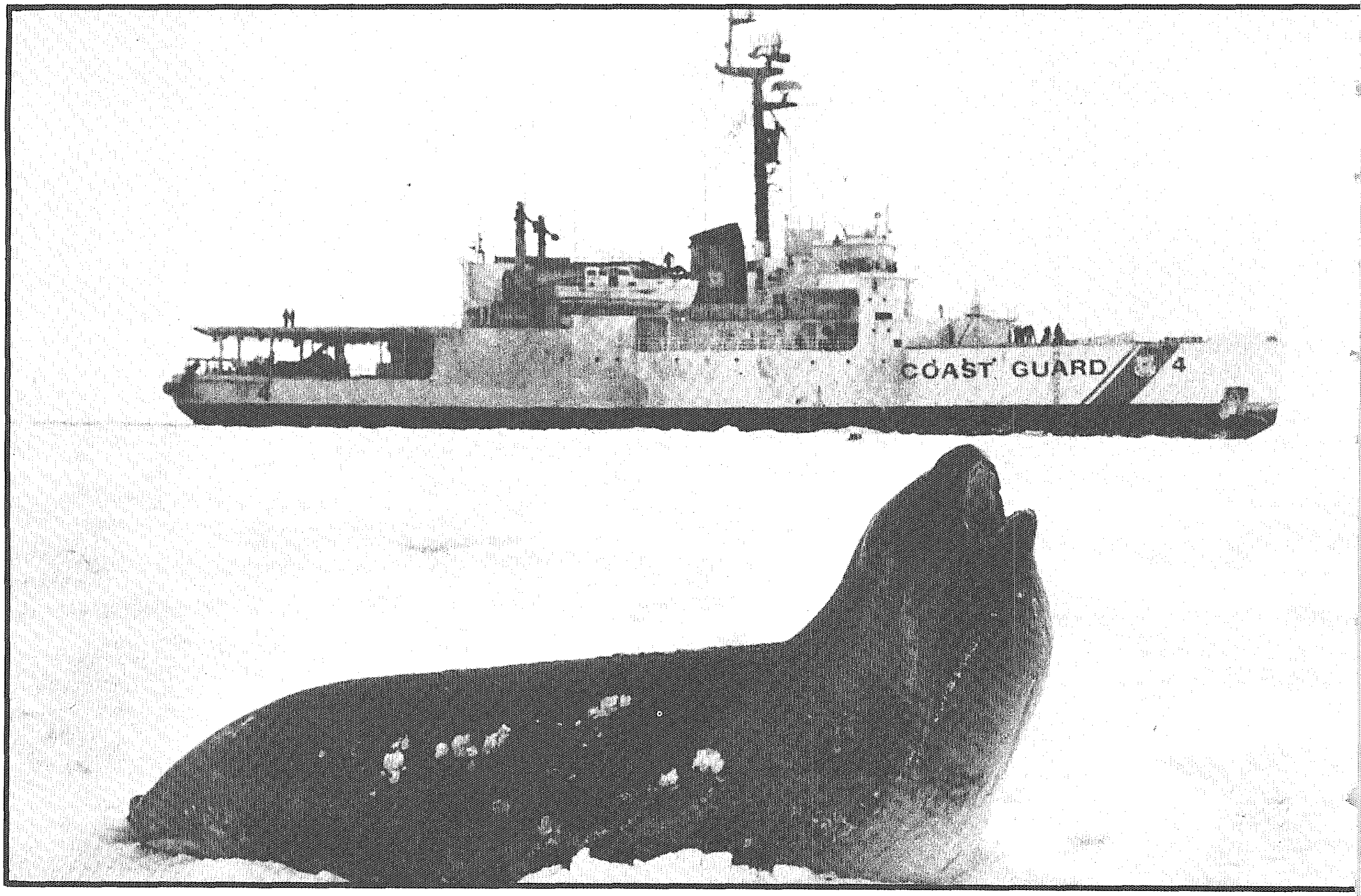
by Robert Pirro

An interview with Dr. Donald Siniff who is heading a research project studying Weddell seals. Most of the research is done in the seal's Antarctic habitat.

*Dr. Donald Siniff is an Associate Professor of Ecology & Behavioral Biology at the University. For the last six years he has spent a great deal of time in Antarctica engaged in research dealing with the Weddell seal. Here is a conversation with Dr. Siniff.*

**Q—How are studies like your Antarctic research funded and coordinated?**

A—The Antarctic studies for all scientific areas, for biology, glaciology, geology, upper atmospheric physics, are funded through a National Foundation of Science office called the Office of Polar Programs. Polar Programs contracts to the military for logistic support while we are down there. They also contract to a private con-



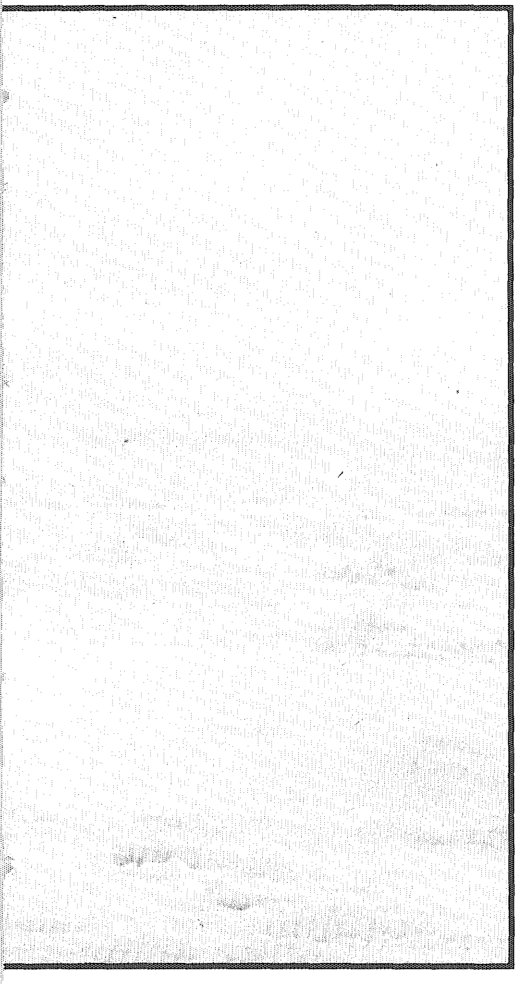
tractor.

NSF pays the total tab. In other words, they pay the navy, air force, and private contractor for our support down there. The money that is in our grant to the University of Minnesota takes care of some salaries and the equipment that we use at the University.

**Q—Are there any international agreements governing research in the Antarctic?**

A—The Antarctic comes under what is known as the Antarctic Treaty. This was ratified by the United States in 1961. Now there are 17 member nations. The Antarctic Treaty sets the Antarctic aside for scientific research. Period. It contains an open inspection clause, in other words, any nation can come at any time to a United States base and inspect any files, see anything we have there. Likewise, we can do the same to any other nation's base, providing you go through the appropriate diplomatic channels.

**Q—What sort of working atmosphere do you have with the Antarctic Treaty?**



A—It is very much an international atmosphere. This is the intent of the treaty. We work very closely with the United Kingdom scientists, Argentine and Chilean scientists in the area of marine mammals. We also have a scientific exchange program in which an American scientist spends winters at a Russian base every year, so it is an international type atmosphere.

**Q—Is your research on the Weddell seal the first source of information on this species or have there been previous studies?**

A—No, there has been quite a bit of work done with the Weddell. We have a pretty good basis of information available on this particular species. Seal census work had been started in 1962 and we picked up where the previous studies had left off by designing a more rigorous statistical design for getting seal density estimates. We have continued along that vein and now we have the techniques pretty well standardized. Using helicopter support we can obtain pretty reliable estimates of seal populations.

**Q—Which is the American base from which you center your operations in the Antarctic?**

A—McMurdo station, which is the largest United States base. In the summertime it holds up to 1,200 people. About 1,100 of those are logistic people supporting about 100 scientists in various areas.

**Q—Where specifically did you research the seals?**

A—Since late 1968 we started at a small spot about 12 miles from McMurdo station, called Hutton Cliffs. Here the seals haul out on the surface of the ice and have their pups. This happens every year around the end of October. We have been centered at this colony since 1968, pretty much detailing the social structure of the colony and trying to relate how the social structure and the physical characteristics of the environment, the ice cracks, may relate to the number of seals we see there.

Around the McMurdo station area there is one species of seal, the Weddell, which is an ice seal. It lives in very heavy pack ice.

**Q—What is pack ice?**

A—The Antarctic continent is a true continent. It is not like the Arctic in that the Arctic is an ocean surrounded by land. The reverse is true in the south. It is a continent the size of the United States and Mexico, covered by a great big sheet of ice. Occasionally little points of land stick out above the ice and that is where bases are built. McMurdo station is such a base. It is located on an island.

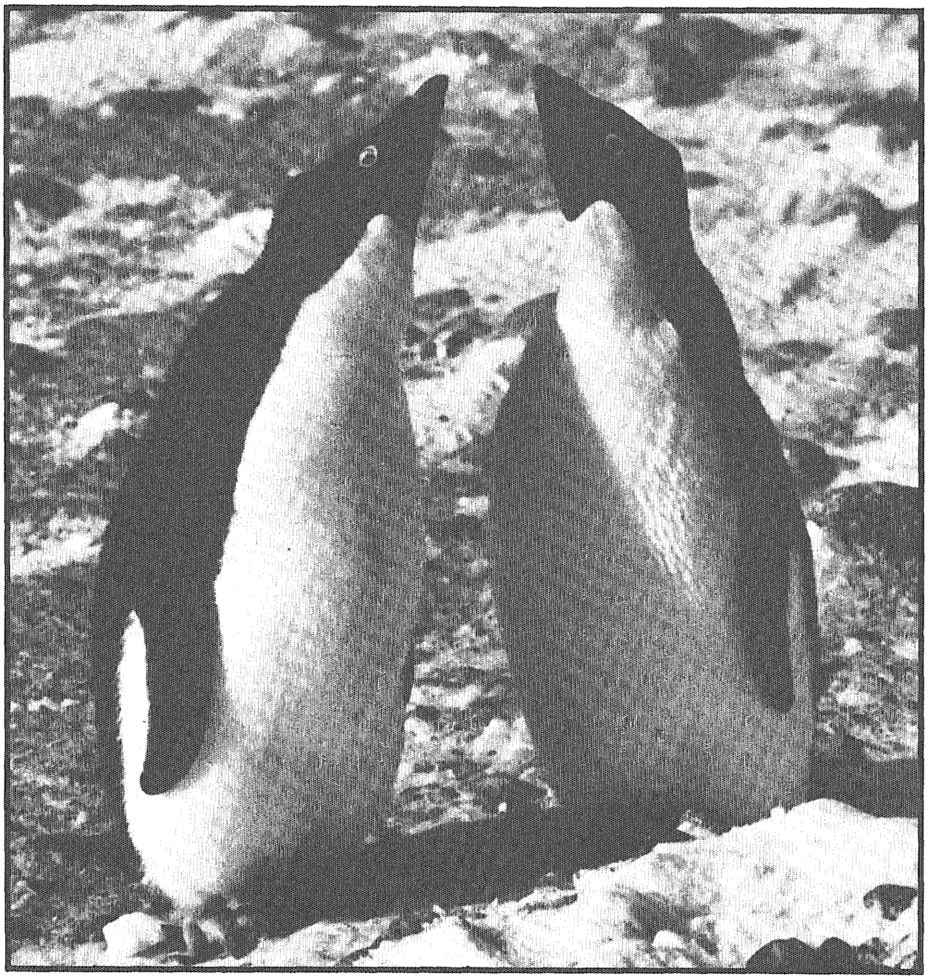
Now to explain pack ice. This big ice shelf, which covers the continent, streams off at the edges so you have an ice front around the continent which breaks off periodically. Large icebergs float out from the continent itself for up to a couple of hundred miles. Six hundred miles in the wintertime. This area is what we call the area of pack ice; sea ice which freezes annually, melts, receeds in the summer and re-freezes out in the winter.

**Q—What sort of biology exists in the pack ice region?**

A—The sea there is very rich because the nature of the ocean water causes upswelling of the sea, bringing nutrients up from the bottom. Since the waters are rich in nutrients you get, as a result, large growths of phitoplankton, mostly diatoms, which occur in the water in large blooms. The next species up the food chain is a little crustacean, the krill, which is about two inches long. It eats the diatoms. Then above it live many vertebrates. Crabeater seals, penguins, and some whales feed off the krill, so this area is extremely rich in life.

This system is unique in that it has a very short food chain consisting of nutrients, phitoplankton, krill and vertebrates. There is only one species of krill. Then you have many species of vertebrates living off'a very few species which are lower links on the food chain. Usually it is the other way around. And nowhere else in the world can you observe, as you do in the pack ice, the densities of life we observe.

There are no land animals, only some microorganisms in the fresh water lakes. In terms of plants there are very few species, mostly lichens. There is one species of grass in the entire continent. It is a pretty barren spot except for what we want to see.



Q—Where does the Weddell seal fit into this biology?

A—The Weddell seal occupies the habitat which is closest to the continent and the pack ice, or fast ice, does not melt until late January. When a crack occurs in the ice, and tide cracks often occur along a point of land, the seal will start working on this tide crack and makes the hole bigger so it can breathe. It holds the hole open by constantly chewing at it. So this is his habitat.

Q—Do the Weddells have any enemies?

A-Not this particular seal. The general enemy of seals in the Antarctic is the killer whale. Out in the pack ice he eats crabeaters, but the Weddell is so far inland that killers can only come in late in the season, if at all.

Q—How quickly does your research proceed and what sort of pace do you set for examining different areas?

A—We have a long term investment. We have a continuing grant from the NSF which is scheduled to continue through 1978 but there are many other areas which bear investigation. We proceed pretty deliberately. Every year we have certain objectives and we go down there with the intent of fulfilling just these objectives. For the last two years we have been concentrating on the size of the territory for males. For us this is a rather important factor. This year we will take a look at the female in relation to these underwater territories. We have pretty much measured what those territories are, now we will look at their movement as well as starting the experimental manipulation of density.

Q—Are just biologists employed in this research or are other disciplines applied?

A—Our program is very much a multi-disciplinary program. Every year we take an engineer down to Antarctica with us. This support comes from the Cedar Creek Bioelectronics Laboratory. We have two graduate engineers and a technician which not only help this program but all the other programs in terms of telemetry. They help us set up various electronic devices, implants for measuring heart rates for example, and they also assist in getting such things as underwater television to watch the seals under the ice. This is a very important part of the program because it allows us to collect data which we could not get any other way. Before we set up the television cameras down there we used scuba gear to dive under the ice and watch the seals. This is one way of researching but it has its limitations because the water is so cold that the divers could only stay down 30 to 45 minutes at a time and the seals were watching the divers instead of doing what seals normally do under the ice. So television allows us to truly study the seals and view firsthand such things as how the pups learn to swim. Under the ice is where all the seals interaction occurs, including the breeding. What goes on under water is quite different from what goes on when they are on the surface.

Q—Do you plan any experiments in your research?

A—We are now looking at some experimental procedures whereby we can manipulate density in relation to the number of holes in the ice. We will try and measure the effect of crowding on things like alternate year pupping and the female reproductive pattern.

Q—What other mechanical research techniques do you use?

A—We also use sonic tags to position the seals under the ice, so we can find out where they move in relation to the tide cracks. The type of information you get from tagging is long-term population data, demographic data which you can put into life tables. Three years ago we began tagging females in relation to our studies at Hutton Cliffs and the frequency of pupping among females has turned out to be a very interesting area. Weddell seals are physiologically capable of pupping every year but for some reason this particular population of seals has a great deal of alternate year pupping. Some pup every other year and some skip two years in a row. The question is why. This is one particular area in which we are looking right now.

Q—Do you have any idea why

**alternate year pupping occurs?**

**A**—Over the years we have worked there we are proceeding to understand some of the population phenomena that goes on. We still do not fully understand why some females have pups every other year. They may breed and the fertilized egg does not implant, or it implants but aborts. There is some physiological phenomena that goes on. The population we study is a closed population with three to four thousand animals in the region and very little exchange between this and other regions. Something, probably an interaction between the seals themselves and their environment, levels their population.

**Q—What do you feel is the overall significance of your work?**

**A**—I am not sure if you are familiar with the history of marine mammals in this country. Marine mammals in general have become very important in the minds of the environmentalists as well as other people within the last four years. In October, 1972, Congress passed the Marine Mammal Protection Act which set up a commission, a group of scientific advisors, which review applications from people who want to have anything to do with marine mammals. It has control over exports and imports, and over marine mammal products. There is a moratorium on these right now. It is set up so that if you want to work with marine mammals you have to go through quite a procedure to get a marine mammal protection permit.

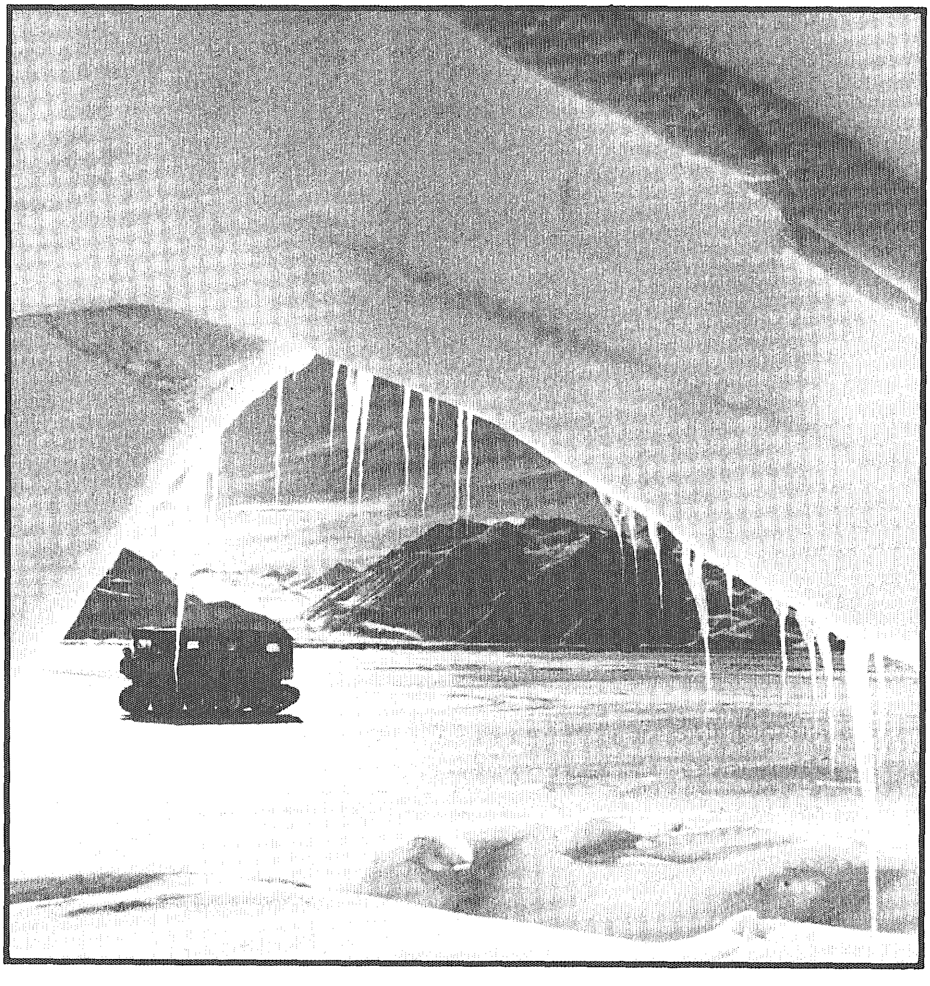
Prior to this in February of 1972, because of the concern for marine mammals in general and because nations are interested in harvesting Antarctic seals, a convention was convened in London which provided for a new treaty covering the exploitation of Antarctic seals. It is called the Convention For The Conservation of Antarctic Seals. Under this treaty guidelines were set up in the event anybody wanted to kill Antarctic seals for fat, skins or for meat. A scientific body was set up to review applications for those who wanted to kill, to collect biological information, establish quotas, establish procedures, to tell the nations when quotas were going to be exceeded and to tell the nations when to quit. At this convention, in order to set these regulations, much information was needed. Our work helped in this respect. There has been a great deal of public concern about Antarctic seals in general and hopefully our programs have contributed to setting guidelines for protecting these resources.

**Q—What is your view regarding the harvesting of seals?**

**A**—Sometimes we have a conflict between the conservationists on one hand and the scientists on the other. Some of them want a total ban on the killing of seals. Personally I have no strong feelings one way or the other. Take Norway for example, which has a history of sealing, and has been living off the northern fur seals and seal products for years and years, yet the seal stocks themselves are in pretty good shape. So there is some appreciation for this viewpoint. Essentially what the scientific view would allow would be to harvest these resources in a way that would not harm the ecosystem and allow a natural replacement for the mortality factors.

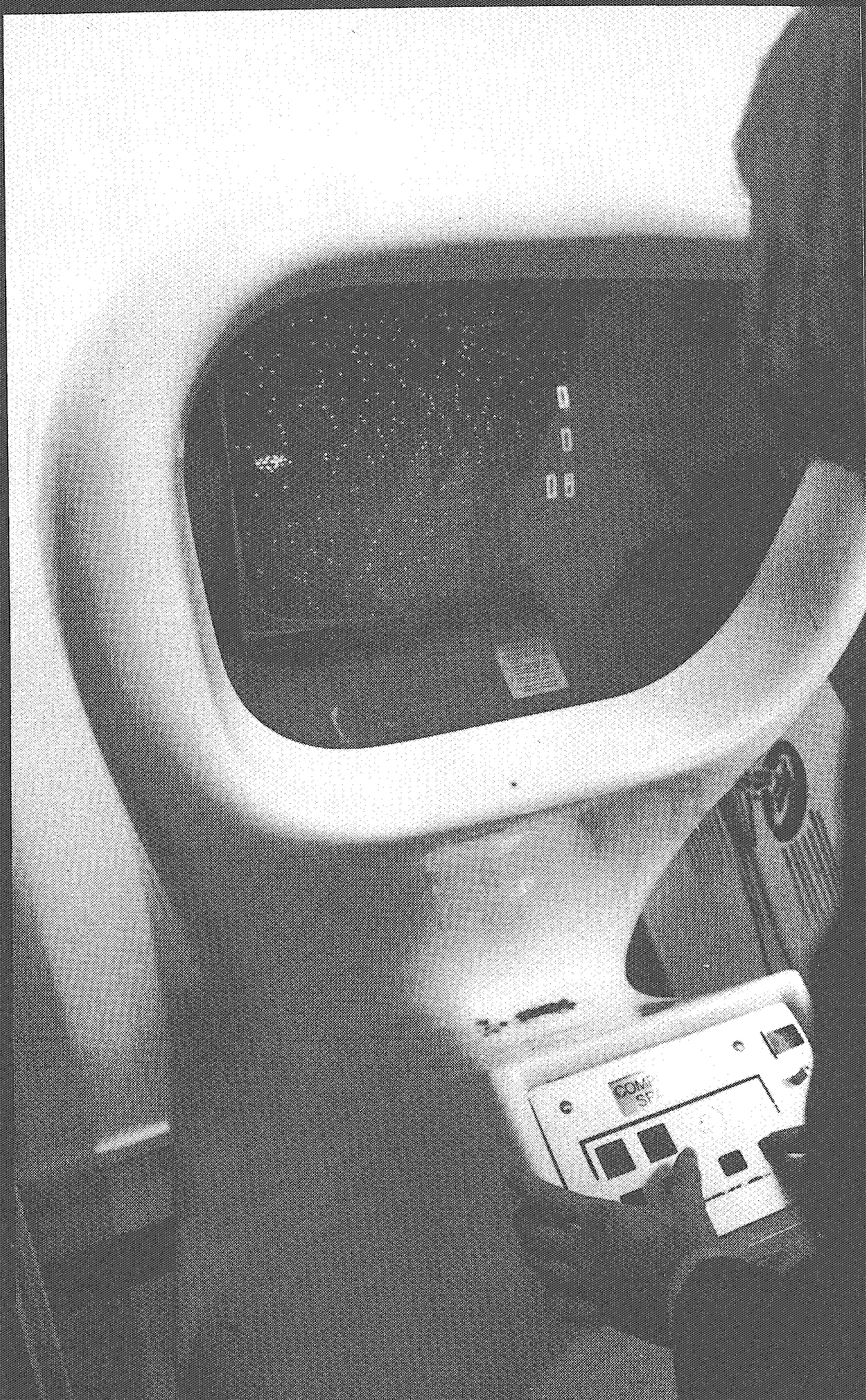
**Q—How successful have past treaties regarding resource regulation been?**

**A**—We have been somewhat successful and somewhat unsuccessful at these treaties. The fur seal treaty is an example of a good treaty. Early in the 1900s there were four nations working independently on the northern fur seals, Russia, Japan, Canada and the United States were harvesting these animals on the high seas. They drove the seals population to an extremely low level. Then the nations felt the need for a treaty and formed one at a fur seal convention. Now, populations are at a very high level. They have come back from near extinction to a point where they are doing all right. We can cite the whales as a bad example of a renewable resource treaty but in my view it is much better for us to have an international treaty, which allows a take on these resources, than to have 12 nations working independently on some resource with no controls at all.



# PAY TV

Strange TV screens have been popping up all around the campus. Blame it on a MIT technology freak who developed the first Space War.

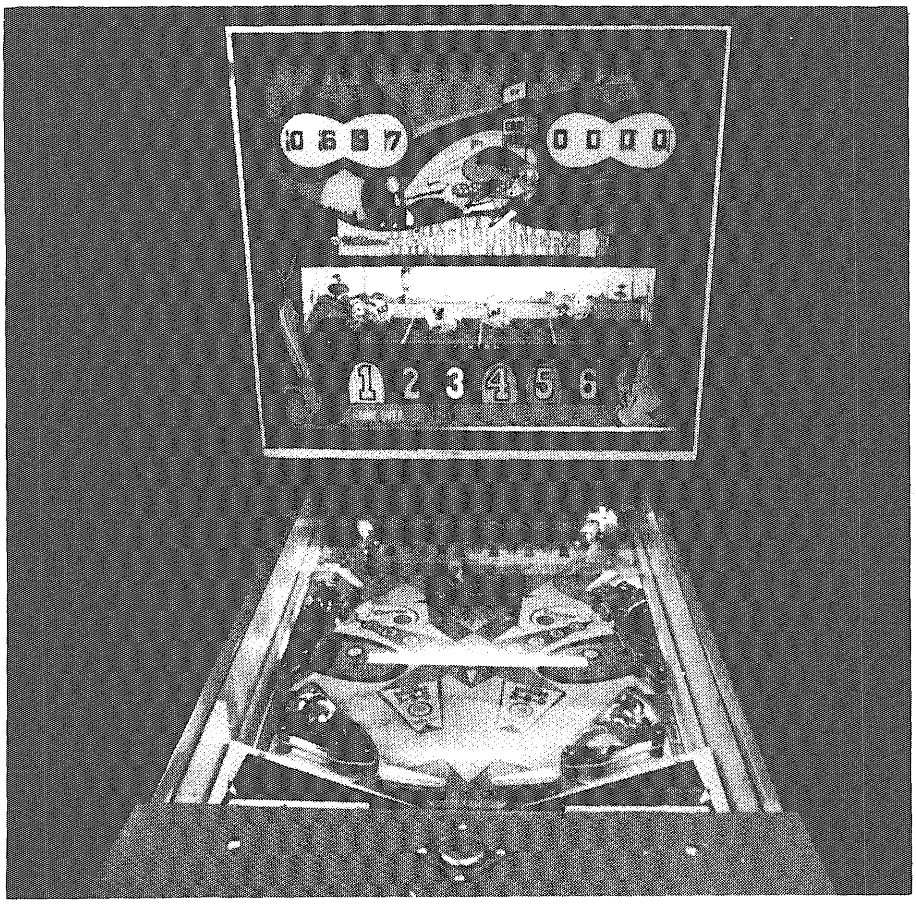


After months of self-restraint you finally yield to temptation. You take out your spare change and surrender it, enabling you to fondle, jostle and manipulate that box in front of you. Pinball machines always did give you a thrill.

But something is different. The familiar clicking of mechanical stepping relays has yielded to synthetic electronic pings. The cigarette-stained glass covering a pair of battered flippers has been replaced by inexpensive television screens.

The box you are playing with is


Below, a conventional pinball machine surface. Above, Playtime, a Pong-type electronic game.



one of a family of electronic pinball machines that have brought digital electronics to the astonishingly large coin-operated amusement industry. Pinball wizards will now have to adjust their game plans. Thanks to a handful of interested and isolated scientists, computer games have been forced on the multi-million dollar pinball industry.

Electronic games have given the industry the biggest shot in the arm since Harry Mabs invented the solenoid-activated flipper back in 1947. How did these industries get introduced to modern electronics? Around 1962 Steve Russell, an EE student at MIT, developed Space War, largely as an exercise to show off the graphic capabilities of the college's brand new PDP-1. In the original Space War two players, seated in front of a CRT display connected to the computer, used joysticks to control the heading and thrust of two rockets displayed on the screen. By pressing buttons they could fire torpedoes at one another. If one torpedo made a direct hit, the struck rocket would disappear with a flash.

Others quickly elaborated on the program by adding gravity and star fields, scorekeeping, space mines, and "hyperspace". CICS departments all over the country quickly developed versions, and Space War became so successful that **Rolling Stone** Magazine sponsored an Intergalatic Space War Olympics last year. Most universities have now banned the game because of the inordinate amount of computer time it eats up. The most popular version played at the University of Minnesota is Star Trek, although it is played on a teletype rather than a CRT.

During the early part of the Space War craze Nolan Bushnell was pursuing an EE degree at the University of Utah and was working summers as manager of the games department at an amusement park. He was familiar with Space War and with his amusement arcade background believed it would be a great arcade game. The only problem was the price; a computer, even a mini or microcomputer, would cost far more than any amusement arcade would spend for a game.

After he graduated and was

working for Ampex corporation on computer design and architecture of computers for television systems, Busnell devised a way of building a version of Space War that could be manufactured at a reasonable price. He converted a bedroom into a laboratory and developed a prototype game that was later sold as Computer Space. Ted Dabney, a co-worker from Ampex, developed the TV part of the system. The display is just a common TV with the i-f and r-f stages removed. The heart of the device was the special purpose "computer" they designed to manipulate information during retrace and blanking and store it for display during the active part of the raster scan.

Bushnell, the 29-year-old inventor of such games as Computer Space and Pong (a tennis type TV game), founded his own company in his garage about two years ago. His company, named Atari, now enjoys sales of three million dollars per year while employing 200 people in the U.S.A., England, and Australia. A dozen competing companies have recently entered the field and have sold 30,000 units of their assorted versions of Pong at roughly $1000/unit.

This represents a major penetration into a technologically conservative industry. Stepping relays and electromechanical logic has been used in pinball machines for over 30 years but printed circuits and IC's are virtually unknown. In fact, the relatively new manufacturers are the only ones who use plug in relays. The rest still use the rivet and solder variety.

Amusement manufacturers are not ignorant of the advantages of solid state logic and printed circuits but, like the auto industry, the oldest and most established manufacturers have a hefty investment in tooling. Consequently, they are reluctant to change proven production methods. Only Allied Leisure has recently been using IC's to synthesize sound effects for some of its games. Bally Corporation, one of the big three in pinball, (the others are Gottlieb and Williams) designed an electronic memory mainly for the functions on its pinball machines but never put it into production because they thought it would cost them more than the traditional

# SOME LOCAL COMPUTER GAMES

The computer department at this University never officially tells anyone what computer games are available. Most likely, this policy is done to keep the terminals free of game players. The required passwords and file numbers are often found scrawled on the teletype booths, but more often are discretely passed on from senior to freshman with the same solemnity as a puberity ritual. If you are fortunate enough to gain access to these treasures and are willing to take the trouble to scavenge the University's computer system, you will find enough games to keep you busy for a lifetime.

Perhaps the most impressive game programs are the various forms of chess. Every so often a national competition is held for the world computer chess title. So far, no computer has locked itself in it's room asking for more money.

In one version of chess you can set the difficulty level as high as you desire. At the highest level only a chess expert can easily defeat the computer. The program is hard to beat if you are not at least an advanced novice chess player. For the first few moves the computer responds quickly. At this time it does not perform the methodological searching of several steps ahead which it does do later on in the game. Most versions have master game examples in memory as a reference and will play the game like a master if the situation arises. Other programming methods are combined to allow the computer to maximize it's decision for a certain move. One program can even learn from it's mistakes and is being tutored by a chess expert. *(Scientific American, June, 1973)*

One of the first games to be programmed into a computer is the game of Black Jack, or Twenty One. It is common to assign it to beginning programming classes due to its simplicity although there are different levels of programming difficulty and elegance. In Black Jack the object of the game is to be dealt playing cards adding up to as close to 21 as possible. One program which uses only a few EXBASIC programming lines employs a clever algorithm to deal and to keep track of an exhaustible deck of shuffled cards. In contrast, the beginning programmer usually takes five times as many EXBASIC lines. Edward Thorp wrote a famous book in 1962 called *Beat the Dealer* that dealt with the probabilities of different playing strategies in Black Jack. One program at the University plugged Thorp's methods of playing Black Jack into the computer and had the computer play itself thousands of times, tabulating the results as it went along. The results matched Thorp's theoretical calculations as well as his results from actual play in Las Vegas.

Other computer games available at the University include such standards as normal tic-tac-toe and three dimensional tic-tac-toe. Perverted forms of baseball and golf are available on the teletype as well as nearly every possible game you can think of. The best version of golf is played on a CRT where you can control the hit and direction of your ball and even get caught in sandtraps.

Another fun CRT game is called follow the spot. A spot moves along a random curve and a second spot, controlled by your joystick, trys to keep up with the first. The more proficient players can elect to match the first or second time derivatives of the spot's velocity. The final negative score is an integral sum of the differences in position and velocity over the length of the game.

Computer experts are already talking about games they have not even devised yet. One is a biofeedback game where the players score by manipulating their brainwaves. Your move.

electromagnetic devices. Bally management has since made an official statement to the effect that they are not going to venture into digital electronics. Moreover, the industry's customers, those who operate and service coin machines, are proficient in repairing electromechanical devices but are inexperienced and uncomfortable at trouble shooting solid state devices.

But when confronted with the success of the Atari company, Bally and a number of other manufacturers turned out their own PONG games.

They are also developing video games of their own. Most of these manufacturers concede that there is a limit to the novelty of video games, but imaginations have been stimulated and many of them are starting to talk knowingly and enthusiastically about such things as CMOS, LSI, lasers, and interactive graphics.

Of the dozen or so companies manufacturing video ping-pong games, only two or three are doing so under license from Atari; most of the others claim that their "logic is different" or their "technology is superior" although most admit that they took their lead from the Atari game. Recently Atari did obtain a final patent on the method of character manipulation used in the Pong game. Bushnell indicated that he would like to come to some kind of "amicable licensing agreement" with the other manufacturers.

Ironically there may be a patent challenge to Atari from another quarter. About the same time that Atari introduced the first PONG games, Magnavox started marketing for home use an "electronic game simulator" called Odyssey, the rights to which they had purchased from a New Hampshire firm called Nashua Associates. The Odyssey game consists of two player control units, a set of transparent overlays and a master control unit connected to the antenna terminal of an ordinary home television set. This set-up converts any 17 inch or larger television screen into a game board.

The Odyssey game sold for about $100 and its Christmas time sales were much higher than Magnavox expected. Magnavox has been approached by several manufacturers who want to market the game in


the coin operated business. Magnavox claims that all the coin operated games currently violate some of their basic patents for Odyssey, and that Magnavox intends to start litigations. Bushnell can't believe Magnavox since Odyssey is an analog based computer where his is a digital based computer.

Virtually all the manufacturers who are now manufacturing video games hint at additional video games. Bushnell claims to have about a hundred ideas including some that use lasers and other recent technology.

There are also possibilities for spin offs that are not related to the coin games. Los Angeles International Airport uses an Odyssey type system to select prospective air traffic controllers, and one hospital is using a modification as a therapeutic trainer to help paraplegics improve their coordination.

And Bushnell is looking at another market — educational equipment. He feels that the ruggedness required of the coin-operated games would be an invaluable prerequisite for educational games.

# CHECK OUR SPECS BEFORE YOU BUY THEIR 4 CHANNEL RECEIVER.

| | Sylvania | Pioneer | Sansui | Fisher | Harman-Kardon | Marantz |
|---|---|---|---|---|---|---|
| **Model** | RQ 3748 | | | | | |
| **Continuous (RMS) Power**[1] | | | | | | |
| **4 channels** | 50W x 4 | | | | | |
| **Stereo Bridge** | 125W x 2 | | | | | |
| **THD at rated output** | <0.5% | | | | | |
| **IM Distortion at rated output** | <0.5% | | | | | |
| **FM IHF Sensitivity** | 1.9$\mu$v | | | | | |
| **50 db signal to noise ratio** | 2.8$\mu$v | | | | | |
| **Capture Ratio** | 1.5db | | | | | |
| **Price** | $549.95[2] | | | | | |

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

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

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

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

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

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

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

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

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

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

**GTE SYLVANIA**

Sylvania Entertainment Products Group, Batavia, N.Y.

# Sales and Service.
# 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.

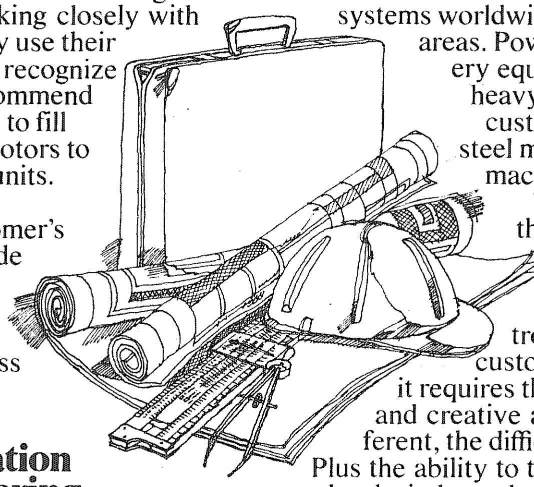
Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

This ad outlines the types of work found in the Sales and Service area of 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-3, 570 Lexington Ave., New York, New York 10022.

## Sales Engineering

Sales engineering is technical marketing. Sales engineers at GE are the important liaison between GE manufacturing facilities and utility, industrial, distributor and governmental customers. Working closely with assigned customers, they use their technical background to recognize customer needs and recommend GE products or systems to fill them. From small AC motors to huge turbine-generator units. Requires a thorough understanding of a customer's business, as well as a wide range of GE products. Plus the ability to work well with people and to recognize a good business opportunity.



## Application Engineering

Application engineers are technical experts who work closely with the sales engineer and the customers' engineers. Their job is to analyze special problems and equipment needs of customers, then determine the optimum GE products or systems to meet them. There are two kinds of application engineers. The first works out of a sales operation and is adept at applying a wide variety of products to create a "system" that meets the customers' needs. The second works in a product manufacturing department and is a specialist at applying the products of that one department. Both must have in-depth knowledge of the customers' technical needs. They often consult with product planners and other marketing personnel to suggest ideas for new or modified products.

## Field Engineering

Field engineers at GE plan and supervise the installation and service of large equipment systems worldwide in two main customer areas. Power generation and delivery equipment for utilities. And heavy apparatus for industrial customers such as paper and steel mills, chemical plants and machine tool manufacturers. They specialize in either the mechanical/nuclear or electrical/electronic areas. Since field engineers are often called to troubleshoot and correct a customer equipment problem, it requires the technical competence and creative ability to handle the different, the difficult and the unexpected. Plus the ability to take charge, lead people, and make independent, on-the-spot decisions.

## Product Planning

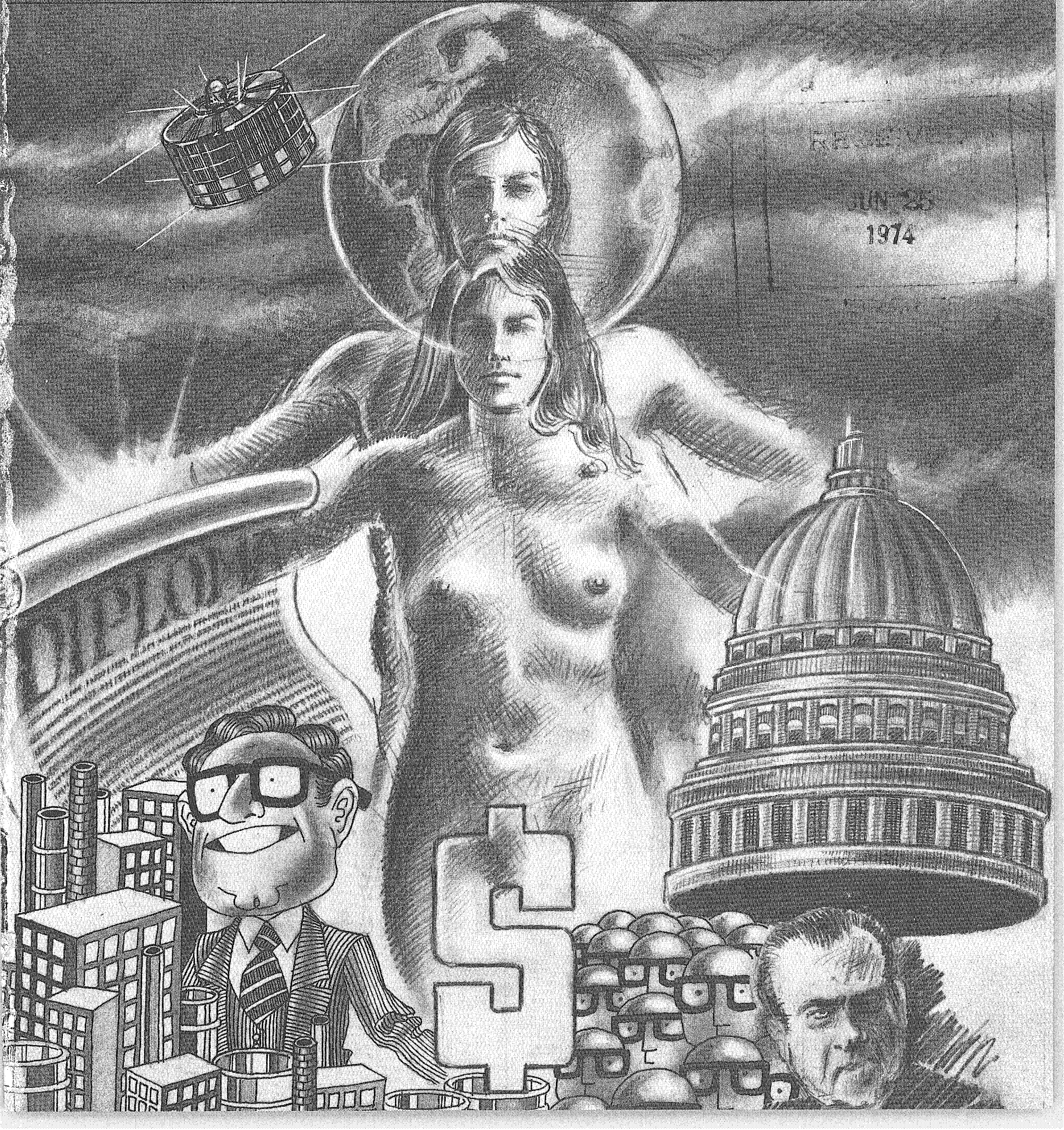
Product planning is a marketing function. Product planners make sure a product line offers what customers need at competitive prices. They determine the need for a new or modified product, product availability, market size, cost structure, profitability, specifications and distribution channels. To do this, they work with market researchers, application and sales engineers, finance experts, marketing management, plus design and manufacturing engineers. Their engineering background is a big plus. This work requires self-starters who can coordinate a project and sell their ideas to management.

GENERAL ELECTRIC

An Equal Opportunity Employer

minnesota **Technolog** may–june 1974

# JUST A FEW QUESTIONS ABOUT SCIENCE AND ENGINEERING



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# The Raps Are Off . . .

I have just played my worst round of golf this season, a 52 for nine holes, par 36. After that debacle I feel frustrated and disillusioned, having just spent my money and time on something which was supposed to be fun for me. The only good thing about this situation is that it puts me in the perfect frame of mind to discuss Plumb Bob, Blarneys Castle and E-Week in general. Students in I.T. have recently also spent time and money on something that was supposed to be fun for them, E-Week. But since most of the people I talked to did not expect much in the first place, they were not disappointed.

## . . . What E-Week? . . .

Our April *Plumb Out* editorial seemed to strike some nerves in I.T.. The main point of that piece, that E-Week should have been better publicized, is illustrated by this point.

On Friday, May 24, two weeks after the homemade car race was held, an I.T. sophomore, unclassified, walked into the *Technolog* office and asked us "when is E-Week this year?" When informed that he missed the festivities he noted "gee, it must have been really eventful."

He would have been justified in asking "why didn't anybody tell me?" The answer to that question lies in the hearts and the guts of the group responsible for insuring a successful E-Week, Plumb Bob.

## . . . Marked Men . . .

You can always tell a Plumb Bob member. They always have either their head up their ass or rusty zippers on their pants.

Plumb Bob members are not to be confused with foresters. Foresters are so stupid that they actually think that logarithms are trees practising birth control. Both foresters and Plumb Bob members do possess common traits. They operate with roughly the same level of intelligence, reach the same level of achievement, and also possess the quaint characteristic of never accomplishing anything constructive during E-Week.

Trusting a successful E-Week to Plumb Bob is like trusting a forester to handle a crate of eggs. In both cases, the groups are bound to fumble the ball, with the end result being a bust.

## . . .Repeat;What E-Week?. . .

The earlier statement, that E-Week should have been better publicized, is actually the understatement of the year. E-Week deserved publicity and it should have had plenty of it. The only notices it got this year were too little too late. While E-Week is what the participants and spectators make of it, at least they should have been given a break and let in on the secrets. The secrets being the information on when E-Week was and what it was going to consist of.

In realizing this obligation to provide information, Plumb Bob acted with about as much foresight and discretion as a goose with diarrhea.

As far as we can tell, the rumor that the head of Plumb Bob was Bozo the Clown is untrue. He just acted like it. We are still unsure of whether Plumb Bob was playing *I've Got A Secret, Who Do You Trust,* or *Lets Make A Deal* with the E-Week information. In any case, the end result of this publicity clamp is next year's E-Week being in *Jeopardy.*

## . . . What To Do . . .

What to do is simple. First of all, decide sometime in March that you actually are going to have an E-Week sometime in May. Then, start letting everybody know by appointing some people to drum up pulbicity. Sending one person around to notify the I.T. Student Board, Technolog Board and *Technolog* is not very difficult.

As for the general public, a hundred Insty-Print posters, written up by hand, cost as little as $3.19, and I have the receipts to prove it. Even drawing on a stencil, which could be run off in the I.T. Student

# editorial pages

Board office, 230 T.N.C.E., could be circulated early to alert the people to E-Week.

This year, the simple fact was that the average joe in engineering was not aware of the whens, wheres and whats of E-Week. And it was not his fault. It was totally the fault of the lazy, inept or just plain stupid group of clods who are supposed to be in charge of promoting E-Week, Plumb Bob.

## . . . The Candidate . . .

The time has come for Plumb Bob to be exposed for what it really is. The *Technolog* has been able to gain a copy of the actual entrance examination used to screen potential applicants for Plumb Bob membership.

Plumb Bob consists solely of male senior engineering students, and the exam questions read like this:

True or false;

$\sum F = mxt$

$\int E^x dx = e^y + c$

$s = \frac{1}{4} g_c t^2$

If the contestant answers true to all three equations, he then moves on to the next question;

"With an applied force of one lb. on the end of a one foot long wrench, compute the applied torque."

If the contestant answers with any answer but *one,* he moves on to the final question.

The final question is;

"By integrating, find the area of an ellipse."

If the contestant puts down any number at all, he is immediately initiated into Plumb Bobdom. As this test is given to all potential Plumb Bob members, they are able to keep their membership standards at the same constant level of quality year after year.

## . . . Knock Knock . . .

Blarneys Castle, the so-called publication of E-Week mysteriously appears each spring, like poison ivy.

This year it was the hit of E-Week. Among other things, this year they actually had two jokes that I had not heard before. Rumor has it that gnomes write the material for Blarneys Castle. We find that hard to believe, although we would certainly agree that their mentality is gnome-sized.

Blarneys Castle consists of nothing but humor. We thought the funniest piece of all was their editorial in number six. That was the editorial knocking the I.T. Student Board, the Technolog Board and the *Technolog* for their lack of co-operation concerning E-Week.

## . . . Serious or Delerious . . .

I hope they were not planning to be serious. It would be difficult to believe that any group, even Plumb Bob, would have the gall and the stupidity to blame other I.T. groups for their own failures.

The I.T. Student Board bent over backwards to give E-Week all the help they could. The *Technolog,* as was described in *Plumb Out,* searched high and low and came up empty handed trying to find out anything from anyone about E-Week. The Technolog Board or the *Technolog* was never approached by anyone about E-Week. If we were, we would have gladly done anything in our power to help make E-Week a success. All they had to do was ask or let themselves be known in some way. Apparently that was too difficult for Plumb Bob to figure out.

## . . .You Get The Bird

Plumb Bob had to have been facetious in their attack on us for a lack of communication and co-operation. Quoting from their "B.C. Editorial by M.J.R." the last "sentence" reads; "If these 'nattering nabobs of negativism' bickering for the sake of their own egos and more time supporting and working with each other, the spirit in the Insitute of Technology would be greatly inhanced."

Besides making no sense whatsoever, being misspelled, having atrocious wording, and not even being a sentence, that last "statement" has totally no basis in fact.

Wake up Plumb Bob. If you are really serious about giving "turkey" awards, try looking in the mirror. That is, if you can see past all those feathers.

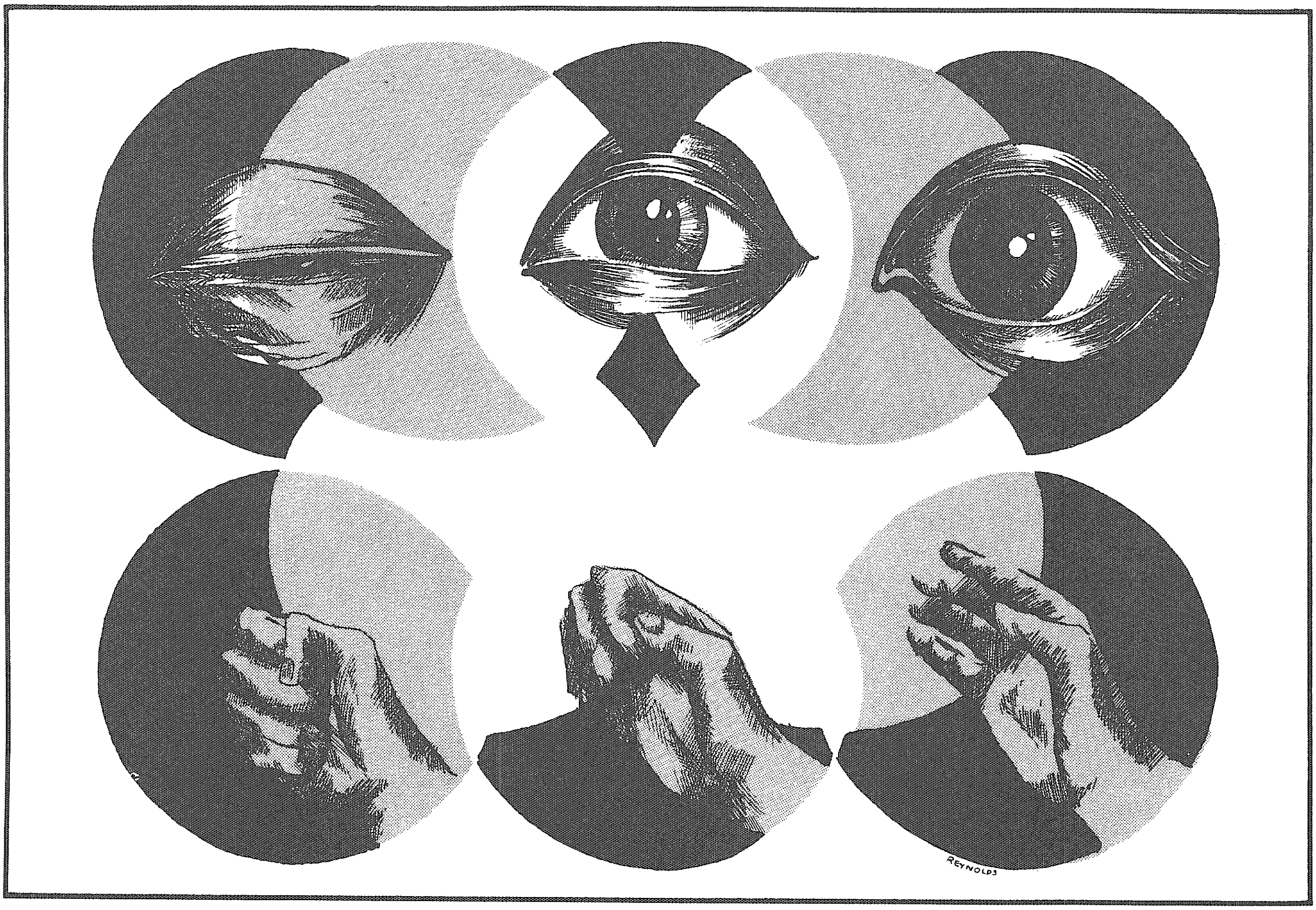
Robert Pirro

# WORKING TOWARDS BECOMING AN ENGINEER

## The Intern Program

by Robert Pirro

There is a valuable scholastic program in I.T. that most engineering students are not familiar with. The Intern, or Co-op, program seems to be truly advantageous for all who become involved in it. The I.T. faculty, the corporations and especially the engineering students are very happy with the results of the program. Those results are cooperation and interdependence between industry and the Institute of Technology, a steady flow of job prospects for individual corporations and money and engineering experience for the students themselves.



The Engineering Intern Program (EIP) began in 1950 and is now available in mechanical, civil, electrical and aeronautical engineering. According to the handouts describing the program, "the principal objectives of the program are to provide engineering training in industry during the last two years of a student's academic career and provide some financial support during the academic quarters." What that translates into is a combination between the functions of the student and the worker with many of the best aspects of both careers.

The entrance requirements are not difficult. All that is needed is a 2.0 overall average with at least a 2.0 average in your major fields. The students must register by January of their sophomore year as the program runs for the remaining two full years of their undergraduate careers. The program is run on a four quarter basis with the two summer sessions counting as one quarter. In the Intern program, full time work and full time study are rotated on a quarterly basis, you study for one quarter, work the next and so on. During the study quarters the student remains a full time undergraduate with a full schedule of courses, usually 16 to 18 credits. During the work quarters the student is on the job five days a week. Though considered a full time student, they take no University courses. The student is given two credits for each work quarter after the completion of a formal technical report concerning the work done during that quarter. This report is completed outside the formal working hours and is expected to be thorough and comprehensive.

So the junior and senior years are spent rotating between industry and the University with usually an additional two quarters of full time study needed after the fourth year to complete all the degree requirements.

There are between 20 to 30 companies who are involved with each department participating in the Intern program. Usually there are more than enough openings for the number of students who apply. This lack of student interest might ordinarily denote a lack of student satisfaction with the EIP program but this does not appear to be the case here. According to Clarence E. Lund, head of the Intern program in mechanical engineering, "99 per cent of the students we surveyed recently were very much enthused with the Co-op program." As Lund explained it, "the student stays in one company but works in different locations during the two years. In this way he is given a broad view of what applied engineering is all about." Lund refers to the Intern program as a "sort of a scholarship program." He points out that the average earnings for the two years of work range from $6,500 up to $9,500 with the higher salaries usually reserved for the out of town jobs.

The most important aspect of the engineering Intern program, according to Lund, is the training students get in applied engineering. "The student takes a greater interest in the engineering curriculum after he enters the Intern program. He is more mature, more diplomatic and behaves himself better."

Ladislav Cerne, head of the civil engineering Intern program agrees with this analysis. "The Intern program is the first step in the engineer's recognition of his profession" he said.

The process of matching each student to each company is done very slowly and carefully. In electrical engineering Dr. Keith Champlin, head of the Intern program there, was buried in paperwork for two weeks after the company interviews were completed, in attempting to match up students with companies. The student usually interviews with a good number of companies, which according to Cerne "is a beginning of an education in itself." Then the students and the company's preferences are matched up as closely as possible with the final authority and the greatest weight placed on the choice of the student.

The corporations have a great deal at stake by participating in the Intern programs. The companies are promoting themselves in a two-fold way. They have a company image to maintain at the University and an employee image to convey to the student they are recruiting. Consequently, the companies who participate in the EIP program are very helpful and very patient with the students. They often bend over backwards to give the interns the deepest and broadest possible experience in the most areas.

In this respect, Cerne feels the EIP program can be an essential part of a civil engineer's education. "The school of civil engineering is practically-oriented. Industry is also looking for those who are in professional programs. In this (EIP) program, the student draws exposure in his profession which cannot be replaced by classes. In industry he can solve hundreds of problems, instead of taking time off and wasting his time."

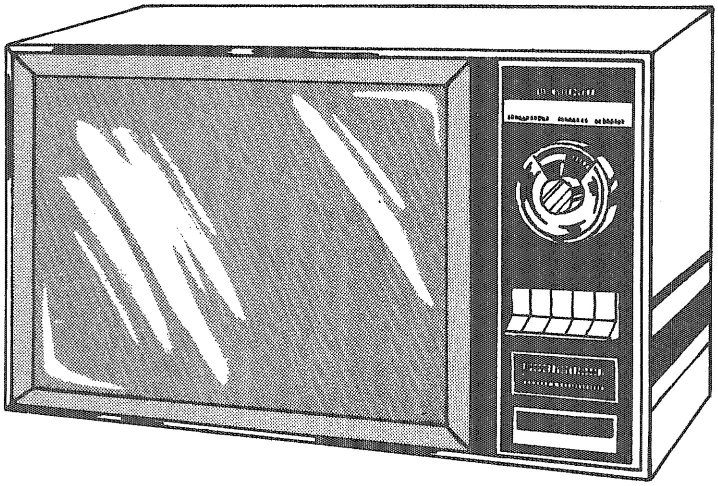
Like mechanical, civil engineering had about 30 industry openings this year, with a few more openings than students to fill them. The probable reason for this situation is that many students never hear about the program until it is too late. Others probably do not want to commit two years to full-time, year-round studies and work. Still others would like to graduate and be done with school as soon as possible.

The desire for graduating as soon as possible was expressed by Jeannette Schmidt, who recently graduated from industrial engineering. What prompted her to enter the program was the money as well as the work experience. Being married and the mother of two children accounts for the money need, but "I also wanted a chance to see what engineers are actually doing. The program was an education as it helped me to know more about what I did not want to do" said Schmidt. She added that "if you are not sure of which field in mechanical you want to get into, then the Intern program is great."

Doug Brosseau, a mechanical engineering sophomore about to enter the Intern program, first discovered the program when he was still in high school. At first, the money was the big incentive. Then, according to Brosseau, "the opportunity dawned on me. I saw it was a transition between being a student and being a real engineer. It also is a chance to land some good recommendations. So I guess it will be a two-fold, money and experience, education for me. I hope it works out."

According to all the indications, it ought to.

# THE MICROWAVE OVEN



# MOTHER'S LITTLE HELPER, PART 2

by Robert Pirro

The whole question of microwave oven safety revolves around the issue of radiation.

On hearing the work *radiation* many Americans have a reaction lying somewhere between paranoia and hysteria. Visions of A-bombs, fallout and radiation burns, the frightening signs of a new era which the common man does not understand or control, often predominate over rationality.

Against the backdrop of radiation poisoning, these facts should be noted. Microwave radiation is non-ionizing radiation; radiation which does not cause chemical change but causes a rise in temperature. Radio, light and infra-red rays are also non-ionizing and this form of radiation is emitted in many household appliances such as shavers, vacuum cleaners and all appliances with electric motors.

The issue with the microwave oven is that the non-ionizing radiation leaks out of the ovens at a disturbing rate. Regardless of the safety standards set up and maintained by the government and the microwave oven industry, many people do not feel safe around a microwave oven because of the radiation leakage. Is this feeling justified?

All microwave ovens leak some detectable radiation. There is no such thing as a "radiation tight" oven and the microwave oven industry does not foresee the possibility of such an oven in the near future. The culprit in leaking radiation is the oven door. It is impossible, given present technology, to construct an oven door that will not leak some radiation from inside the oven.

Given that all microwave ovens leak radiation, the question then becomes; how much radiation is safe for human consumption?

The federal Food and Drug Admin istration (FDA) branch, the Bureau of Radiological Health, has set up standards for microwave emissions in ovens. Previously the level had been as high as 10 mw/cm$^2$, then was reduced to 5 mw/cm$^2$. In 1971 the standard levels were reduced to no more than 1 mw/cm$^2$ for a new oven and 5 mw/cm$^2$ for a used microwave oven. An FDA aide, Dr. William M. Leach, commented on this standard saying "nobody has seen anything (deleterious) that 5 milliwatts can do."

The Russians, however, do not agree with these findings. Soviet standards for microwave absorption are far more demanding then the American levels. After discovering ill effects in workers who labored around microwaves, the Russians set a standard of no more than .001 mw/cm$^2$.

In considering microwave absorption there is also the fact that radiation diminishes by the square of the distance from the source. Thus, a microwave oven which leaks 10 mw/cm$^2$ two inches from the door actually leaks 0.1 mw/cm$^2$ at 20 inches. So any serious absorption of microwave radiation would have to occur at close range.

The FDA standard for microwave emissions is translated as 1 mw/cm$^2$ at five inches from the edge of the oven door. Now this appears to be a very low level but questions still persist. Can there be leakage of more than the 5 mw/cm$^2$ guaranteed by law? Has there been conclusive proof that microwave radiation is not cumulative and in low levels absolutely cannot harm the human body? Is the microwave oven guaranteed to be safe for anyone who wants to use it? The answers to these questions seem to be yes, no and maybe, in that order.

*Consumer Reports*, a magazine dedicated to testing and evaluating consumer products came out strongly against the purchase of any microwave oven. In its April, 1973 issue the magazine labeled "not recommended" all the microwave ovens it tested. The basis for this blanket rejection was on account of the radiation leakage. The magazine's arguments hinged on two major points. The first point was that all microwave ovens leak some detectable radiation. *Consumer Reports* felt that no radiation at all should be leaked. The second point the magazine stressed was that they were uncertain of what levels of microwave absorption, if any, are safe. As *Consumer Reports* stated "the popular models we tested leaked radiation at levels we can't be sure are harmless. We have been unable to uncover any data establishing to our satisfaction what level of microwave radiation emission can unequivocally be called safe."

This was far and away the most damaging criticism that the microwave oven industry had ever faced. Sensing that their rapidly expanding sales might be affected, the industry launched a counter attack. The war is still raging, with allies drawn to both sides.

The microwave oven industry began to stress the facts that microwave radiation is non-ionizing and does not cause chemical changes. They also began to stress the government safety standards for emissions and how their ovens easily met these standards.

*Consumer Reports* was not impressed on either of these points. They pointed out that microwave radiation does cause a change in temperature and claimed that it might be possible that the radiation might affect such sensitive organs as the human eye and the central nervous system.

According to data supplied by the microwave oven industry, microwave radiation is not cumulative. However, there is nothing said about the possibility that the effects of microwave radiation in raising the human body temperature might be cumulative. Dr. Milton Zaret, a New York ophthamologist, contends that irreversible eye cataracts may start forming years after the initial exposure to microwaves.

The ongoing battle between *Consumer Reports* and the microwave oven industry often gets very heated and personal, with definitely political overtones. Of all the counter-attacks, particularly fierce has been the stance of Amana, a Raytheon company. Recently, Amana went so far as to entice a disgruntled associate director of *Consumer Reports* to give an address. The publicity release on that address stated that *Consumer Reports* was guilty of "an editorial slant made to increase sales of the magazine". *Consumer Reports* hotly replied, in a well-publicized letter, that their former employee "had nothing whatsoever to do with preparation of the *Consumer Reports* article on microwave ovens or their testing". This statement was made in reply to their former employee, Channing H. Lushbough, who also noted to Amana, "I just don't see how *Consumer Reports* can hold itself out as being objective, when they also try to be advocates for consumers."

The microwave manufacturers also challenged *Consumer Reports*, and subsequent groups, on the validity of their tests. The oven makers felt that particularly *Consumer Reports* was making "unreasonable demands on the oven and the conditions it would have to normally undergo."

*Consumer Reports* claimed that their tests were valid because they subjected the oven to very possible demands and conditions that the oven would have to face.

One particular example was sticking a piece of plastic wrap or aluminum foil through the door seal, causing microwaves to leak outside the oven. Using this test, levels of 20-200 mw/cm$^2$ were recorded in various tests. The microwave industry is very proud of the double safety interlocks on its oven doors and warns that "tampering with the interlocks on a microwave oven is as dangerous as tampering with the brakes on an automobile". The oven doors are set up so that the oven automatically shuts off when the oven door is open. However, the plastic wrap tests proved that the ovens still cook when something thin is inserted through the door seal.

To find out how farfetched this situation actually was, I went to Coffman Union (before the lettuce boycott) and tried to duplicate the *Consumer Reports* tests on the microwave ovens there. I found out that the plastic wrap on a cheesburger or chuckwagon fits easily through the door openings on either side and the bottom of the door. In fact, something as broad as one of the wooden sticks used to stir coffee, or a packet of salt also fits through the door opening while the oven cooked.

The "extreme" tests performed by *Consmers Research* and others were based on ignoring some of the basic instructions governing microwave oven use. Among these instructions are "(1) Make certain that objects are never inserted through the door grill or around the seal; (2) that the seal is frequently cleaned with water and mild detergent; (3) that the safety interlocks are not made inactive by tampering; (4) that the oven is never operated while empty; and (5) that the oven is inspected regularly by a qualified service man for signs of wear, damage or tampering."

These guidelines describe what every microwave oven owner should do. Common sense, however, tells us that a majority of owners will not follow all of these procedures and a sizeable number of users will follow none of the guidelines at all. Many people will also, deliberately or unintentionally, subject their ovens to abuse. Despite all safety precautions, a sizeable number of defective ovens will also be sold. So when concluding about the types of situations microwave ovens will be used for, you must take into account the factors of human ignorance, stupidity, carelessness and

## DO'S & DON'TS

If a microwave oven is in your future plans or is presently in your kitchen, here is an abbreviated checklist of things to do and no-nos you might not find out from your dealer.

Do follow all the manufacturers specifications to the letter. Always keep your oven clean. Dirt and food left for long in a microwave oven can result in beautiful cultures of bacteria. Arrange your food "in a ring" in the center of the oven. When cooking two or more items keep them spread apart. The forte of the microwave oven is in reheating foods—it is terrific.

Do not cook using wood or metal utensils and only use straw and strong plastic utensils for very short spans of time. Paper is your best bet. Do not cook eggs or bake any bread or pastry in a microwave oven. Try to avoid broiling steaks, hamburgers, and other meats that take a short span of cooking time—a conventional range does a much better job. Most importantly, do not tamper with the door seals and do not repair, tamper or modify this machine. It is not a toy.

the ingenious ability of man for foiling the most carefully constructed and conceived devices designed for his own protection.

Litton Industries, in their "Facts About Microwaves" booklet says, among other things, "There has never been an injury due to emissions from a microwave oven with more than 700,000 microwaves in use."

This statement is made despite sensational stories which have appeared in the media about dramatic microwave burnings. A Honolulu woman supposedly was blinded by microwaves from her oven last year. A Scarsdale, New York housewife also supposedly was blinded and received severe burns from her microwave oven. A Dallas, Texas restaurant worker supposedly fried one of his hands in a microwave oven. A Maryland doctor claims that microwaves leaking out of an oven have made one of his patients sterile.

It is difficult to give these stories full credence, just as it is difficult to regard the Litton statement as gospel. Apparently the truth lies somewhere in the middle. It appears that there indeed have been no reported injuries due to microwave oven emissions, but only from ovens which were operated and maintained under ideal conditions. If we maintained our automobiles under "ideal conditions" and followed all the guidelines set down for their use, then there would not be any road accidents, no major repairs would be necessary, and you could get 15.8 miles to the gallon with your Cadillac (so the advertisement goes). However, because people do not always follow advice, there were 50,000 people killed last year in accidents, automotive repair is a billion dollar business, and you are lucky if you can drive that Cadillac once around the block without running out of gas. One of the winning entries for human stupidity with microwave ovens goes to the housewife who started a fire while trying to dry her towels in her microwave oven. So far, the grand prize goes to the student who was clever enough to take off the interlocks on his microwave oven, so the oven would work while the door was still open, and then tried to dry his shampooed hair in the oven. He nearly electrocuted himself while giving a marvelous impression of a burning torch.

To the credit of the microwave oven manufacturers they have done virtually everything economically possible to make their product safe. One of the interlocks, for example, is hidden in order to foil tampering. In assesing the situation, Dr. Robert Elder, Associate Director of the Bureau of Radiological Health of HEW, stated "Remember that the published newspaper and television accounts did not report actual evidence of hazard. There were only surmises that some hazard might exist. A change in the accepted leakage limits would be warranted only if studies by someone of proper scientific qualifications should reveal solid evidence that present officially established leakage limits were not properly set for the safety of users."

Unfortunately for the microwave oven industry, those types of remarks are proving to be less and less reassuring. Locally, the Reserve Mining trial is a current example of an industry saying in effect "show us some dead bodies" in order to prove there is a health hazard. The quote "only if studies by someone of proper scientific qualifications . . . reveal solid evidence . . ." is also a direct quote from an American Tobacco Company publicity sheet, which discussed the link between cigarette smoking and lung cancer, in 1961. Visions of cyclamates, hexachlorophene, thalidomide and other health hazards also come to mind when the call for "actual evidence" is made.

A frightening example was reported recently in *Science News*, where fluorescent lights, emitting X-rays and radio waves, were found to have a definitely harmful effect on hyperactive children. In an experiment where the fluorescent lights were replaced by lighting which gave off no X-rays or radio waves, the hyperactivity in the children decreased dramatically.

If a slight dose of X-rays and radio waves can have that type of effect on children, is it difficult to wonder why some people fear that one day microwaves might also be discovered to have a harmful effect on humans? However, whether this fear is strong enough or valid enough to keep potential buyers away from purchasing microwave ovens remains to be seen.

All the sides in the microwave oven controversy are currently acting in a self-constructed vacuum. Frankly, there are no fully accepted standards for knowing exactly how much microwave radiation can safely be absorbed by human beings. The notion that microwave radiation is not cumulative may be valid, but there is no substantial proof that effects from any microwave radiation are not cumulative. The amount of radiation leakage from any given microwave oven depends on the quality of that oven and the care and maintenance of it by the owner. There are certainly no guarantees that your microwave oven will not exceed the 5 $mw/cm^2$ level set by law, given enough time and enough use.

What the issue seems to boil down to is a tradeoff. If you believe the claims of the microwave oven manufacturers, if you trust the microwave emissions levels to be safe for human consumption and if you do not feel that subsequent harmful evidence will be uncovered about microwave radiation levels, then the microwave oven is safe for you to use. There is strong evidence to support this position.

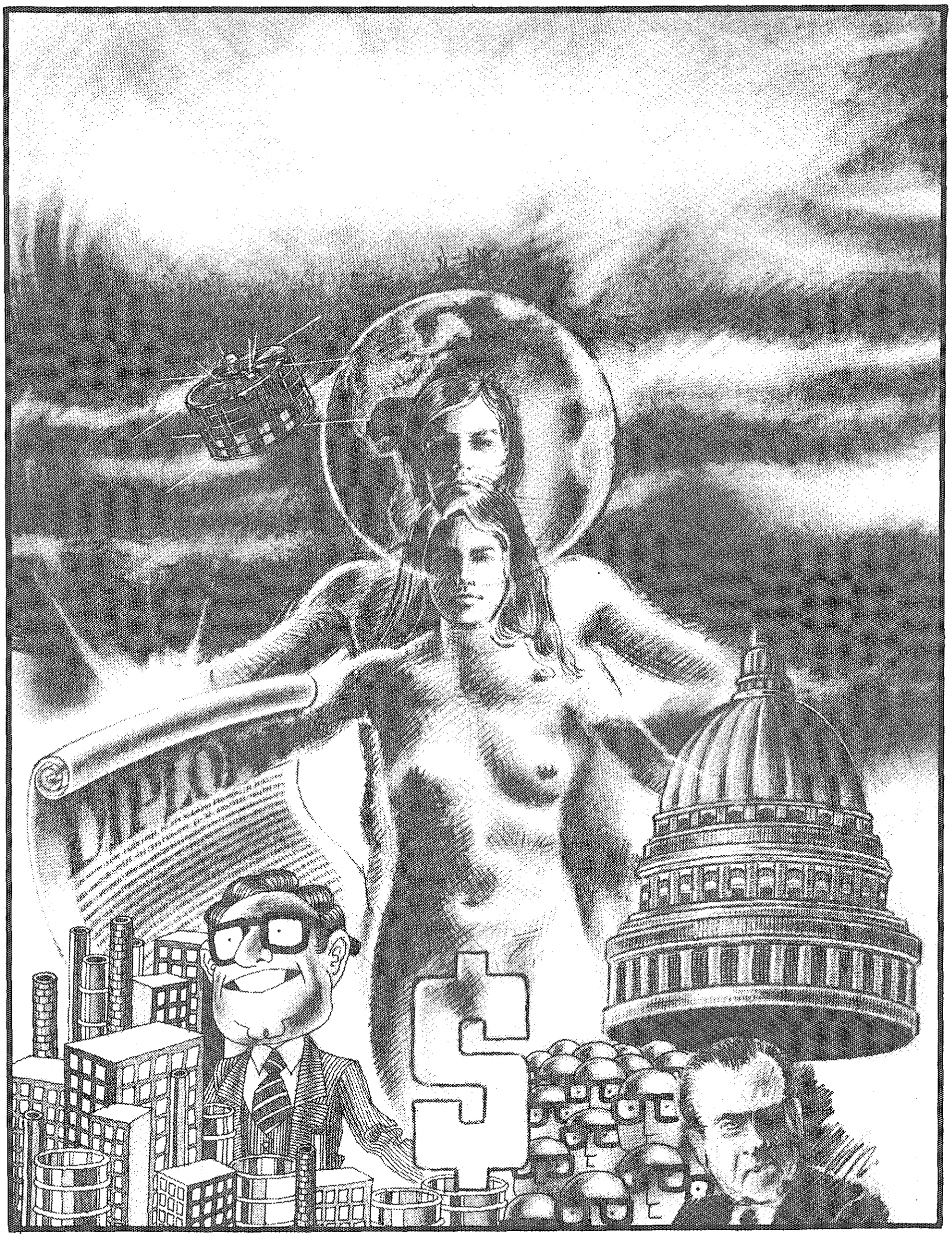
If you do not trust microwave emission levels, if you do not trust the infallibility of the safety features on microwave ovens and if you do believe that subsequent evidence may be uncovered proving that minimal microwave radiation exposure may be harmful, then the microwave oven is not safe for you to use. There is also strong evidence to support this position.

The only plain and simple fact uncovered in the whole muddled area of microwave oven safety is that despite all the assurances in the world, nobody is talking about microwave radiation from an impregnible position. All the facts are simply not in yet.

If you do decide to buy a microwave oven, here is a piece of advice. When you are cooking with it, stand to one side, about five feet or more away from it. You might as well be on the safe side.

# Special Section

*compiled by Paul Burtness, Robert Pirro & Laurence Yarosh*



# JUST A FEW QUESTIONS...

If you are truly a student, then you will always ask questions. At the close of another school year, the *Technolog* has decided to ask just a few pertinent questions that should be on the minds of most engineering and science students.

Because of our limited resources, the answers are not as complete as we would like them to be. Clear-cut, simple answers to questions like these are rarely apparent and when available, they usually prove inadequate.

We have tried not to be a mile wide and an inch deep. We have also tried not to preach, dictate or lecture. What we have tried to do is provide you, the reader, with some alternatives, perhaps a fresh insight or a view you may not have heard expressed before. We think that providing alternatives is what education is all about . . .

# What Is The Future Of I.T. Undergraduate Education?

**Many I.T. students feel that the undergraduate student is discriminated against. They feel that certain departments and faculty are more concerned with educating graduate students and turning out professionals in specific fields than with training students on an undergraduate level. Most faculty members we spoke with, disagreed.**

compiled by Paul Burtness & Robert Pirro

Science and engineering students must not only be familiar with knowledge in their own fields, but they must also be aware of how science and technology function in society, K. S. Kumar, an electrical engineering professor, says.

"It is easy to design and build utopias, but what do you do if nobody wants to live in them? Do you want real or plastic people to live in them?

"A complete solution to problems is not necessarily supplied by technology alone.

"Science and engineering students should know something about social institutions. They should know who they are and how to approach them. Students should also learn that they can't just shove any technology down the throats of the public.

"But I'm not too crazy about setting up courses just for engineering students. They have to learn how to interact with other professionals by taking the types of courses they take.

"Also, I don't like to see every course that way. Science and engineering students still have to know their bread and butter. The primary concern is still to be a good engineer because the time has not come yet that an engineer is hired because he's a fair engineer but has good social awareness."

The structure of IT classes will play a role in this. "Ideally you would have fifteen to twenty completely prepared students in a class. Then you could spend most of the time in discussion.

"But the present mixture of large lecture and small recitation classes, which has been in effect for five years or so, is an excellent compromise. It has really made a difference in terms of student understanding. Many departments are doing it and it seems to be the trend of the future."

Moves to make the social sciences a more integral part of a science and engineering education may be desirable but they may not be fulfilling the original intent of liberal education requirements for all University students, William Shepherd, former vice president for academic administration and an electrical engineering professor, says.

"The present liberal education requirements were a consequence of a question posed by University president O. Meredith Wilson around 1961.

"He asked, what ought to be the hallmark which the University of Minnesota imprints on all of its graduates, regardless of what their field was going to be.

"The upshot of this was that a background knowledge of society and the world was something that everyone ought to have.

"I can understand the desirability of social science courses like that to help the engineer understand the impact of his work. But I hope the intent isn't simply to make an engineer technically competent rather than keeping in mind that an engineer should be an educated citizen."

Pertaining to graduate and undergraduate education, "there is a lack of understanding of the relationship between graduate and undergraduate. Somehow there is the feeling that everything that is taught at the undergraduate level is somehow just there. But where does that knowledge come from? Research at the graduate level is developing today what will eventually be taught to undergraduates.

"Also, I think you'll find that the teacher who is still a student himself is going to be a far more stimulating teacher than the individual who has learned all he is going to learn.

"I don't feel the undergraduate is slighted over graduates in civil engineering" said Ladislav Cerne, associate professor of civil and mineral engineering. "Here, the undergraduate is the center of attention. People go directly from being undergraduates here to the firms and if there is a poor performance, by him we get immediate feedback from the company.

"A four year program is the miserable minimum for a bachelor of civil engineering. I would stress that everybody take a fifth year of study so that you go out into the world not as an embryo but to be a more mature civil engineer. This is the European program and a fifth year there is common.

"Undergraduate education must be improved by being extended for a fifth year. They should also stop mixing professional training with general education."

Commenting on the functions of the University, Cerne said, "the student should be trained in other areas by the time he reaches the University, and he should take only his professional training at the University. The student now is being loaded down with CLA courses. He should take these courses, if he feels he should, outside his professional training, on his own time. To take eight credits for freshman English out of the engineering program is a bad mistake. He should be taking valuable professional courses. He ought to build a professional career here, there shouldn't be any compromise."

Science and engineering students might be facing larger classes in the future and they might have to stay in school longer to finish up all their required classes if the decline in instructional funds for the Institute of Technology continues, Paul Cartwright, assistant dean of IT, says.

"It's something we can't do much about. We're in a real bind in some of our departments. The only solution is to hope that the legislature gives us the money we need.

"The result of the decline in funds could be larger classes but the place it really hits home is in the laboratories.

"We're going to have to limit the number of sections and the number of students in those sections.

"Our enrollment is now increasing again. We somehow have to take care of those students in face of cuts in funds."

As far as the changing nature of an IT student's education goes, "there's more emphasis on the type of courses that tie together the social sciences and engineering fields. There are more and more of those things being set up. There are courses in the history of science and engineering, interdisciplinary programs, and so on.

"Soon there will be twice as many women engineers as there are now. And they have a slightly different slant on their interests than men.

"As scientific knowledge grows, there's always pressure to add more technical material at the expense of something else.

"We have to have twenty percent of our work in the liberal education area, though.

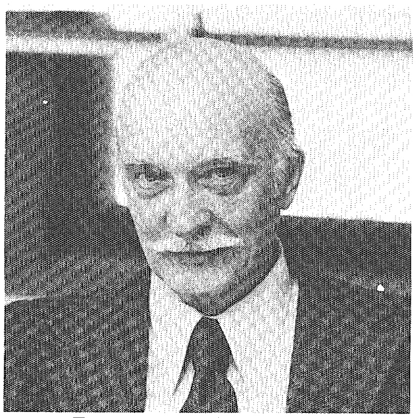
"The quality of teaching in IT is as good or better than most other departments of the University. But students are more inclined to speak up these days. And the administration of IT is more than willing to move on student suggestions.

"There's no question about it, excellence has to start at the undergraduate level."


**Prof. K.S. Kumar**


**Prof. William Shepherd**


**Prof. Ladislav Cerne**


**Dean Paul Cartwright**

# What Is The Relationship Between The Government And The Scientist?

compiled by Robert Pirro

**Remarks by Vice President Gerald R. Ford, Chattanooga Area Engineer's Week, Chattanooga Choo Choo Restaurant, February 18, 1974.**

I am honored to have the opportunity to address your 1974 Engineers' Week here in this vital electrical and energy center know as "the dynamo of Dixie".

There is a growing awareness that the engineer and the skills that he commands are among our greatest resources. Today as never before this great resource must be used wisely and well . . .

In the Fifties our engineers forged ahead with new weapons for our defense.

In the Sixties American engineering put Americans on the moon in a single decade.

Now, in the Seventies we turn to the engineer to help solve the energy crisis.

The American engineer has the talent and the ability to solve the energy problem. What we lack is the time required to bring our skills into effective action. Fortunately, in this crisis as in similar situations in the past, ingenuity can be a substitute for time . . .

We have 1.8 trillion barrels of oil which can be unlocked from the shale formations in Colorado, Wyoming and Utah, with the proper technology. This is more than the proven reserves of the largest Arab oil producers in the Middle East.

We have half the free world's proven coal reserves, enough to last for centuries. It awaits the technologies for effective conversion to clean gas and liquid forms, and the technologies which will permit us to mine these vast reserves without despoiling the land.

Forty per cent of our potential oil and natural gas reserve lies untapped on the Outer Continental Shelf. Not a single exploratory well has been drilled on the Atlantic Outer Continental Shelf. There must be strong assurances that the ocean drilling can be done without the risk of serious environmental damage.

Once the Alaskan pipeline starts flowing, we can start developing the huge resources in our largest state. No one really knows the extent of those reserves.

There are millions of acres of proven and potential geothermal areas in the western states. Technology is needed to make them economically useful.

Research—much research—is needed to perfect the use of solar energy, perhaps our greatest untapped energy source.

There are more—but those are some of the challenges American engineers have to meet and conquer.

There is still a greater—even more vital—challenge in which your help is of the greatest importance.

I predict that project Independence—President Nixon's program for making the United States self-sufficient in energy needs—will be supplemented by Project Interdependence. That is the worldwide cooperation of mankind to solve the dilemma of constantly growing populations and energy needs, against a finite supply of mineral resources. This goal of worldwide cooperation is being brought within reach by this Administration. Project Interdependence can flourish in the climate of peace created by President Nixon's world policies.

We are fostering a new spirit in the world—a spirit that will transcend temporary differences.

Dr. Kissinger, our Secretary of State, summed it up recently when he said: "We know that the energy crisis indicates the birth pangs of global interdependence. Our response could well determine our capacity to deal with the international agenda of the future."

Your work as engineers will be part of our response.

You are hastening the day when mankind will share its collective genius to bring about an era of worldwide peace, well-being and understanding. But the work has only just begun.

We must all take part. It will require greater effort, greater thought, greater ingenuity, greater concern from each one of us.

The challenge is huge.

But the goal is the dream of every thinking person. And the goal is within our reach. Let us grasp the opportunity.

I thank you.

**Remarks by Richard Nixon, Sept. 21, 1972.**

"Don't ask me what a breeder reactor is; ask Dr. Schlesinger. But tell him not to tell you, because unless you are one of these Ph.D.'s you wouldn't understand it either, but I do know that here we have the potentiality of a whole new breakthrough in the development of power for peace. That means jobs – jobs for this area, and jobs and power for hundreds of millions of people all over the world . . .

All of this business about breeder reactors and nuclear energy is over my head. That was one of my poorest subjects, science. I got through it, but I had to work too hard. I gave it up when I was a sophomore.

But it has always been fascinating to me because it seems to me that if a people are to be a great people, we must always explore the unknown. We must never be afraid of it . . .

I live, as you know, in California, down in San Clemente. Right next to us, within a couple of miles, is one of the new nuclear power plants.

Many are afraid to live there because they fear what could happen with regard to that peaceful nuclear power plant. I am not afraid to live there. I am not afraid, not because I know much about it, but because what I do know tells me that here we have a new source of energy . . . that is absolutely important to the future of the world.

## Commentary

These two addresses demonstrate the current administrations feeling towards the engineer and the scientist. The two highest political figures in our country take a position which has been consistent governmental policy since the first world war. This policy regards the engineer as a natural resource. Applied science, and the scientists themselves, are to be manipulated by the government to produce what the federal bureaucracies want. Period.

The primary bureaucracy pressing demands on the scientist is the Pentagon. Other related bureaucracies include the Atomic Energy Commission (AEC). Both of these bureaucracies are inter-related and, to some degree, interdependent. As true bureaucracies, they are interested primarily in their own survival, even at the expense of individual members and those individuals affected by their policy decisions.

The history of the AEC, for example, is a shabby collection of situation after situation where the needs of the government are their only consideration. They assume liscense in callously disregarding the safety of the individual citizen.

The Nixon remarks on reactor safety are quite meaningful on this point. They show a man who values jobs, heavy industry, defense and the necessity of maintaining the status quo. This stance is maintained in the face of serious and widespread concern over the safety of breeder reactors, to say nothing of their overall efficiency. As far as Nixon is concerned, it is "full speed ahead" without knowing what lies around the next corner. This is the typical attitude of the politician, especially the politician who knows nothing about science.

The Ford speech is particularly meaningful in that he addresses himself directly to engineers and pats them on their collective backs for being great resources. Again, in solving the energy crisis, the engineer is to be a tool used to achieve goals set by the government, not by the individual himself. Ends, not means, are important to the government.

Particularly interesting is the rundown of potential energy sources which Ford hammers on. In typical political jargon, Ford paints a rosy picture of unlimited potentials for American energy production, while ignoring serious shortcomings in each area.

For example, Ford conveniently neglects to mention that the oil extracted from shale is so costly at this time that major oil companys are hesitant to even begin exploration without generous government assistence.

The vast majority of coal reserves in this country will have to be mined using strip mining, which under the present technologies, totally wastes the land.

The Outer Continental Shelf, is too far out at sea for conventional drilling. It would also be ecological suicide if oil companys began indiscriminate drilling there.

The Alaskan pipeline is years away in construction, let alone pumping the production of oil wells.

Potential geothermal areas in the western states are a fancy term for deserts. Like solar energy, the potential is indeed there and research and technology, which means money, is needed if they are to be exploited. However, Ford omits the fact that there is little money coming from the government in these areas. They are concentrating on the nuclear reactors.

Project Independence, a slick political idea designed to win votes and support from the general public, is already being dismissed by the responsible scientific community as being unfeasible.

The government "War on Cancer" spotlighted recently in an NBC television news special report, points out the typical governmental approach to science—give us results. In the cancer war, money is being diverted from basic research and funded directly to cancer studies. This has many medical people up in arms because while the short term effects may be beneficial in the fight against cancer, the long term effects may be disasterous to medical science as a whole.

This is the way of the politician. Treat the effects not the causes. Worry about ends, not means. Manipulate all your resources to achieve those ends.

Engineers, scientists, you are the means. Beware.

# What Are The Ethics Of Engineering?

**One chemical engineering professor, when asked to respond to this question, replied that he "did not want to be quoted on this subject (ethics) because I haven't given it a great deal of thought." Fortunately, some other professors were not so reluctant to speak on this subject.**

compiled by Robert Pirro

"Ethics is a personal matter" said J. E. Holte, electrical engineering professor. "Ethics can be equated to personal responsibility, where you refrain from doing certain things. It is not so much ethics as it is personal behavior.

"Ethical responsibility is a willingness to assume individual responsibility. The important question seems to be: would you be willing to stand behind what comes of your work?

"If the answer is yes, then you are acting ethically. If the answer is no, then you are acting from a questionable moral base. This is frightening in a complicated technology where in most cases you do not have control over the results of your work. The situation ethics person cannot anticipate every possible case."

In discussing the field of engineering, Holte said "I don't think engineering is different from other activities. You are working in the public interest.

"In knowing how your knowledge will be used there is the question of reasonable likelihood. You ask; does it feel right to me? In other words, it is conscience. There are a certain large area of decisions we make because they feel right or wrong to us."

On the nature of ethics, Holte felt that "ethics are not just passive. They are powerful. They include not letting potentially bad consequences from the bad acts of other's come to pass. This is where the tougher decisions come.

"The lack of professional responsibility and ethical behavior tend to divide us into *us* and *they* camps. We feel that things and people outside of us are different and these are the seeds of unethical behavior, which is often performed in a very sincere way.

"When you take individual responsibility, you realize that others are not different from you. Collectively or individually, they are just like us. If you operate out of this basis you will decide on the greater good for the greater number of people.

"There is an ethics rule. It's not as strong as the doctors code of ethics, but then again, many of them don't follow theirs either."

Professor Fulton Holtbe, mechanical engineering, feels that in ethics "the most important thing is to stick to the facts. Stick to the facts, use good engineering principles in design, processing and materials selection.

"Ethical conduct is also using the latest technological information thats been proven. That is keeping up with the state of the art."

Since Professor Holtbe is frequently called on to testify in court cases, most of his ethical examples referred to legal situations. "There is very poor ethics in the courtroom. Some engineers try to become lawyers and try to win the case. That is absolutely against professional ethics. An engineer deals with facts.

"Some people try to snow you. Perhaps defining terms is a part of ethics. Some professors and engineers use a lot of fancy terms and nobody knows what the devil they said. They are not being ethical because they are not dealing with the facts. They are playing games.

"What often happens in court is that an engineer's original design is valid, then advertising or somebody else comes along and perverts it. They spoil the engineering ethic.

On getting involved in cases Holtbe advises "never ambulance chase. Don't look for jobs like some engineers do. Its bad ethics. I wait for them to call me and then go with whoever calls me first. Whoever wants my services first, gets my services, regardless of who contacts me afterwards. And I stick to the facts, whether they have a case or not.

"What I do and say, nobody controls. Thats why I like to be on my own."

In all cases, Holtbe feels that "the engineer should follow the definition of engineering in Websters dictionary. And you should always base your opinions on the facts as you know them."

In discussing personal responsibility in engineering, professor Perry Blackshear, mechanical engineering, agreed with the belief that the engineer is responsible to himself, his employer and the people who will be affected by his work, usually in that order. "You can always justify what you do as an engineer. Since you are one of the good guys and they are the bad guys, any engineer can rationalize and justify what he is doing as being work done for the overall benefit of mankind.

"Of course, the engineer can also ask himself whether this work is the best thing he could do with his time and effort."

Blackshear explained that "in the past decade, engineers have realized environmental and social constraints that did not exist previously. It is the job of the engineer to give the hows and whys to society when they need a given problem solved – to work out the technology and tell others how and what to do.

"Now there is tremendous interest in the engineer's role in the environment. It seems to be discussed at every engineers meeting."

Discussing what motivates engineers, Blackshear noted "a strong influence on the engineer is the public's willingness to spend money on what the engineers will produce. This influence is felt directly through the large corporations.

"My feelings toward technology here is that engineers are primarily employed by the big corporations in the United States and all their engineering developments are aimed at improving the performance of those large corporations. This is engineering in the large.

"There are few institutions designed to encourage engineering in the small – the types of things that would benefit independent men, like the small farmers.

"Engineering in the large is designed to make man dependent on mass production. Engineering talent should also be rewarded for developing technologies for engineering in the small."

**Response By Freshmen Engineering Students To A Lecture In EE 1-000, Introduction To Electrical Engineering, Entitled** ***Professionalism, Ethics and Your Engineering Societies.***

I thought it was rather boring but it did bring up many things I never thought of.

* * *

Not reall bad, but I did like what we where doing before better. (This was the spelling the author used.)

* * *

I didn't realize that there were so many types of engineers. However, it seemed to go in one ear and out the other. I'm sure that I will forget virtually everything about this particular lecture by the end of the quarter.

* * *

The ethics of engineers is an idea I would like discussed by an engineer and employer of engineers to get both sides of statements.

* * *

It got me to think about the ethics part seriously.

* * *

I hadn't thought too much about the ethics problems involved in engineering. I didn't realize that it was a big enough problem for a national society to pay attention to.

* * *

Ethics was okay but rather vague.

* * *

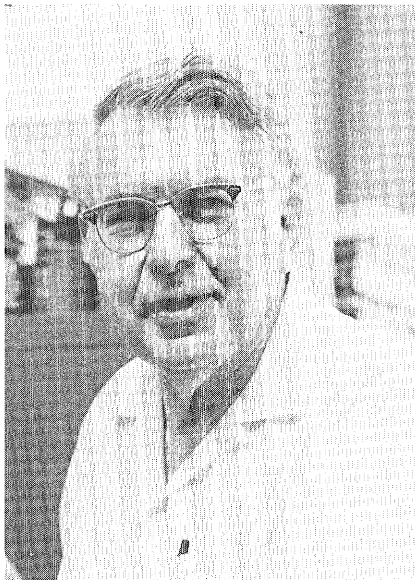
I am really interested in the ethics that guide the career of any professional. If there was more internal contact in the engineering field as there is in the medical or law fields; then as professionals we could control our own ranks. It should be up to professional engineers to decide a code of ethics for all engineers to follow, and to handle infractions of the code within the profession.

* * *

An interesting speaker. He made a good point on how much we all don't know about engineering rules and the laws about engineering.

* * *

Prof. J.E. Holte



Prof. Fulton Holtbe

Prof. Perry Blackshear

# Does The Corporation Control Technology?

**The corporation is the largest and most powerful institution, short of some governments, in the world. It directly affects and regulates our lives.**

**In the United States we have control over our most powerful institution, our government. But what sort of controls could we have over our second most powerful institution, the corporation?**

compiled by Laurence Yarosh

*The strongest control over scientific development is exercised by the companies that provide the engineer's paycheck. Ralph Nader, the "public citizen" whose campaign in support of consumers has commanded national attention for over eight years, claims that their power is too great – the great corporations stifle technical developments that do not profit them and hide the harmful side effects of their operations.*

*Nowhere has this issue been more important than in the Reserve Mining trial. Nader was in Minneapolis in late April, days after a federal judge ordered the closing of Reserve's plant for contaminating Lake Superior with asbestos fibers. Besides criticizing Reserve, Nader suggested a unique control on corporate power: A government takeover of irresponsible companies through a declaration of "environmental bankruptcy."*

*Yet the government alone cannot control "crime in the suites." From the beginning, Nader has campaigned for increased responsibility among the professionals who work for corporations – in particular the scientists and engineers who design the factories and products, and must defend them in public.*

*We present, first, excerpts from Nader's April 23 press conference in Minneapolis. Then, Nader's thoughts on professional responsibility;*

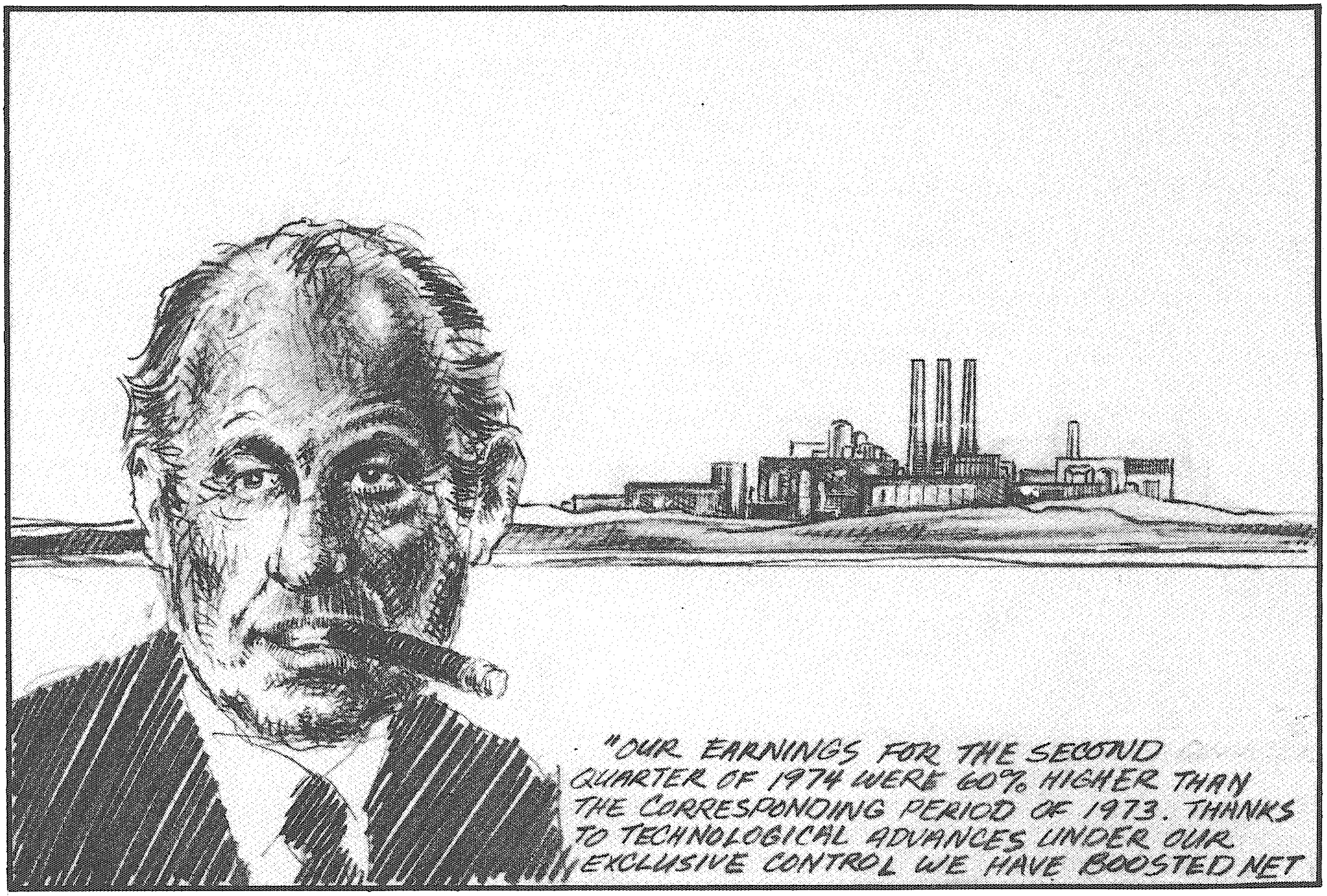
Ralph Nader

## COMMENT

"The Reserve Mining issue is now a matter of national attention. The issues in this trial are not being given sufficient prominence in other contexts, namely, that the issue is one of corporate criminality. Here you have a corporation owned by two other corporations based in Ohio, Armco and Republic steel, who, for years, refused to analyze the nature of its dumpings into the air and into Lake Superior, thus displaying acute criminal negligence in its operations. And after it was pointed out to them the nature of the asbestos prevalence, they fought to delay, to obfuscate and to cover up. This is a performance which can only be characterized as criminal. You have a corporation confronting a major health hazard with the financial resources to overcome it and with the alternative technology to implement it.

"Because of the seriousness of this type of criminality, it is quite clear that our laws are far too permissive for such corporate behavior. We need a strengthening of our laws, particularly to transform such corporate criminality into a form of environmental bankruptcy, where the courts appoint public trusteeships to manage the company until it can treat its workers and its neighbors with elementary concern about their public health.

"For instance, if the creditors of Reserve Mining were not getting their bills paid, they would have legal rights to throw that company into bankruptcy. The judge will appoint trustees and he will distribute the assets or see that the creditors are paid off, as they are entitled to be. On the other hand, you have companies that are poisoning systems in the environment and exposing workers and neighbors to these serious hazards, and the law does not have a provision to throw this company into environmental bankruptcy which will still permit it to be operated, but only if the public's health is re-




cognized by a team of trustees appointed under due process by the courts. If we've got creditor-induced bankruptcy laws in this country, we ought to have environmentally-induced bankruptcy laws. Because what is occurring is that the managers of these companies and their masters in Ohio are absolutely invulnerable to the legal process. They are not going to jail, they are not going to be fined, and they are not going to be removed. And because they have such an established tenure of position, they are acting irresponsibly."

## ANALYSIS

"Scientists have not displayed much commitment to giving a broader significance to their work," Ralph Nader told his biographer, Charles McCarry. "They have been in possession of information that is relevant to the elimination of millions of casualties, and the expertise to utilize that information, (but) they have shown only a slight appreciation that their special roles should require them to state forcefully in public forums the issues for discussion and resolution."

Ignorance by scientists of their "special role" has allowed manufacturers to ignore 20 years of safety technology in building automobiles — the auto engineers "did not have the professional stamina to defend their engineering principles from the predatory clutches of the cost cutters and the stylists." It has also produced supermarkets full of food of doubtful safety and nutritive value. "These putrid foods taste good", Nader told a Minnesota audience, "because of the misdirected genius of modern chemistry."

Nader's answer to the submissive scientist is two-fold. One is to encourage the professional employee to speak out. His book, *Whistle Blowing: The Report of the Conference on Professional Responsibility* gives numerous examples of professionals who exposed institutional crime, from the cost analyst who discovered the cost overrun on the Air Force's C5A aircraft to the Japanese engineer who was jailed for criticizing the Japanese automakers. The Clearinghouse for Professional Responsibility provides confidential advice and help for professionals who want to "blow the whistle" on their employers with minimum risk to themselves.

His second answer is to create scientific organizations free of commercial obligations. In contrast to the professional societies who, Nader says, are "indentured to the companies they are serving in the first place", the Center for Science and the Public Interest is a scientific equivalent of Nader's Raiders, employing five full-time scientists on an annual budget of only $20,000. "Beneath all aspirations and all changes," Nader says, "must be a commitment to solve the problem of deployment of scientific manpower into new careers that rest . . . on the conscience of the scientist and not the organizational dictates of the employer."

# Can Man Be Free From Science?

**What are the extent and scope of freedom that science and technology give man? Science and technology have always been lauded for freeing man from want. But the way that science and technology do this puts other constrictions on man's freedom. What are these constrictions and are they caused by how we use science and technology or by how they use us?**

by Paul Burtness

A modern automobile assembly line is a marvelous thing to behold. On it, thousands of individual parts are efficiently and uniformly mated into a bewildering diversity of products. We may be amazed that no two snowflakes are alike; we may be awed that nature has made each human fingerprint unique. But on one assembly line producing only one model of car, a single assembly line worker, or his robotic equivalent, could work steadily for a hundred years before seeing a car that was identical to an earlier one. Engine sizes, drive trains, paint jobs, upholstery and other options; the permutations and combinations accumulate.

Multiply this tremendous capacity for diversity by dozens for the different models of cars. Multiply it again by another dozen for the number of worldwide auto manufacturers. Imagine all this at the command of the individual car buyer, who can take delivery of any of the majority of these vehicles at almost any location in the United States. Then you will have an indication of human choice.

Yet, in many places, it is virtually impossible for an individual to choose to travel a significant distance without an automobile. And, in many places at certain times, the congestion of these vehicles make it almost impossible for an individual to travel with an automobile. These vehicles inflict more casualties than armed conflict. Their fuel requirements aggravate international tensions. Their pollutants shorten life spans. And yet, an individual cannot choose to be a legitimate citizen of many societies without owning one of these vehicles.

Imagine the difficult position of an individual who wishes not to be part of this transportation system. Then you will have an indication of human choice.

Most discussions of human freedom lead eventually to human choice and action on those choices. To the extent that those choices or actions are limited, human freedom is limited. Limitations on human freedom can be either internal or external. One external limitation to human choice is material conditions. Freedom from want of food, clothing and shelter is basic to all other freedoms. If some material need is not met, other choices and actions must be sacrificed to meet material needs.

It is at this point that science enters its role in determining the extent of human freedom. Science is the systematic accumulation of knowledge about the physical universe. Knowledge of the physical universe is only part of the knowledge that human beings have access to; science is only one means of accumulating knowledge. Those who would make science the superior means of accumulating knowledge are not only expecting more from science than it is capable of giving, but also ignoring the potential of other ways of accumulating knowledge.

Knowledge of the physical universe implies manipulation of material conditions. That is science's relation with technology. Technology is the expression of science through human choice. Since science cannot accumulate knowledge of the universe without manipulating material conditions, science cannot exist without technology. Science and technology together make up one way of knowing and doing; they can be referred to collectively as technique.

If the extent of human freedom depends partially on material conditions and technique is the means of manipulating material conditions, the extent of human freedom depends partially on technique. If human freedom consists of choices and some choices are governed by material conditions, the sorts of techniques available to humans will determine the choices that can be made.

We can safely say, then, that technique establishes the material limits of human freedom at any particular time. We can also say that technique, to a large extent, determines how human freedom will be exercised at any particular time.

To show this, look at that example of automobile manufacturing again. The techniques of manufacturing and labor management, among others, establish the extent of choice we have in selecting an automobile. The techniques of marketing and advertising, among others, determine to a large extent that we will exercise our choice to buy a car.

So far this argument has been an analysis. Its propositions and conclusions are subject to the same critical evaluation as any other analysis. No values have been expressed.

Values are another sort of knowledge that humans have access to. Value knowledge also derives from experience in the physical universe. But it is not universal and cannot be arrived at scientifically. Value knowledge is another basis of human choice; this is the choice between what is right and what is wrong.

If you have ever been a student at a large university, you have been part of a bureaucracy. Doing business with a firm that employs a hundred people or more puts you in contact with a bureaucracy. When you drive on a freeway, you use a service provided by a bureaucracy. Entering a large hospital brings you within the physical domain of a bureaucracy.

The common denominator of all these examples is size; they are all large organizations. These large organizations could not exist without bureaucracies. Without large organizations, there would be no need for bureaucracies.

Any organization is a collective of individuals whose actions converge on some purpose. A bureaucracy accomplishes this with a system of positions and relations between those positions. The behavior of each position is defined in terms of that position's relations with other positions. Most positions within the bureaucracy have required behaviors that are several levels above what machines are capable of. That is the reason why people fill most positions within a bureaucracy. That fact does not necessarily make the bureaucracy a human organization. The survival of a bureaucracy is dependent, not on the importance of individuals, but on their replaceability.

There are two important characteristics of the bureaucracy. The first is its consciousness of purpose. It is designed for a specific end. Its goal may be to accredit students, produce goods, provide transportation, or treat sick people. It has one measure of its success in achieving that goal and that is efficiency. This does not mean that bureaucracies are the most efficient way of getting things done. Rather, it means that bureaucracies measure their success in terms of how much of one particular resource, usually money, is expended to accomplish their goals and, more importantly, to keep the bureaucracy running.

**The first reaction of the bureaucracy is resistance.**

The second important characteristic of the bureaucracy is its unconsciousness of purpose. Individuals within the bureaucracy tend to forget that it is not their personal decisions that make up the behavior of the bureaucracy, but the defined set of relations between the positions of the bureaucracy. This set of relations usually tend to direct the behavior of the bureaucracy in one general direction. The bureaucracy may have one or more conscious goals; but an unconscious goal of the bureaucracy is survival. Its first reaction to a hostile, changing environment is one of resistance; if it has enough power, it will begin to manipulate the environment to guarantee its survival.

Bureaucracies themselves are techniques and, by definition, techniques cannot be bureaucracies. But techniques can be bureaucratized. In fact most of our current techniques, or ways of doing things, are bureaucratized.

A technique becomes bureaucratized when it is administered by a bureaucracy, when new features of that technique are generated by a bureaucracy, and when it acquires some of the unconscious characteristics of a bureaucracy. The other characteristic of the bureaucracy, consciousness of purpose, is an inherent aspect of any technique.

Transportation in the United States, for example, has been bureaucratized. The companies that build the transportation vehicles are bureaucracies, some of the largest ones in the world. Fuel is supplied by bureaucracies and bureaucracies supply the rules and regulations of transportation. Innovations in transportation are produced, by and large, by bureaucracies. The tremendous resistance of the auto industry to safety and pollution standards is not so much evidence that irresponsible people fill the positions in the industry. Rather, that resistance is the survival aspect of the bureaucracy's unconscious characteristics.

Energy production, food production and health care have also been bureaucratized to a large extent in the United States.

All bureaucracies are techniques and most current techniques have been bureaucratized. But not all techniques have been bureaucratized. This analysis of bureaucracy would be a waste of time unless there were alternatives within the realm of human choice.

Dig up a piece of ground with a spade some time and notice how you really have to work to get a lump of earth turned over. The roots of the grasses and other plants intertwine tenaciously to hold the soil together. From a distance, the patch of ground you just overturned looks uniformly green, undifferentiated and constant over time. Closer examination reveals all colors of the spectrum and a splendid diversity of plants. Examination over time shows the dynamic property of that patch of ground as different species predominate and then die out.

Every vacant lot, unless it is continually trod upon or blasted to death with salt or other chemicals, will eventually become green again. Concrete crumbles as moss grows and grass roots force their way into the cracks. A cultivated field will become wild again in one season or less.

Human organizations have often been described in ecological terms. "Grass roots" is a term referring to popular movements that have no centralized organization, but spring up independently around a common idea. In politics as in sod, grass roots come in many different varieties but are woven together into a durable and evolving fabric.

Grass roots are the absence of bureaucracy. When the uniformity of bureaucracy is absent, a multitude of grass roots can appear.

Individuals replace positions and responsibilities replace required behavior. The survival of a grass roots organization depends on the durability of individuals, not on their replaceability.

Just as there are bureaucratic techniques, there can be grass roots techniques. A grass roots technique, rather than being an integral part of a bureaucracy, would be used by those individuals in a small organization. Rather than being generated by the positions and relations within a bureaucracy, a grass roots technique would be created by member or groups within the grass roots organization. Grass roots techniques would be more limited in scope than bureaucratic techniques. They would not acquire the power that tends to make bureaucratic techniques dominate the individuals that use them. The idea of a grass roots organization itself, however, is not a technique. It cannot be designed and administered like a bureaucracy.

What are some grass roots techniques and how do they compare with bureaucratic techniques? In energy production, small solar collectors for space conditioning in homes are grass roots techniques; square mile collectors for generating electricity on the ground or in space are bureaucratic techniques. In food production, smaller more intensively worked farms with cooperative markets distributing food are grass roots techniques; corporate farming with many layers of corporate food processing and distribution are bureaucratic techniques. In health care, good nutrition, individual preventive medicine and community clinics are grass roots techniques; huge hospitals and federal health care insurance are bureaucratic techniques. In all examples, the scope of organization in the grass roots is small, in the bureaucratic organization large. The potential for diversity in the grass roots is great, in the bureaucracy small. The importance of the individual is great in grass roots, but secondary in the bureaucracy.

All of these grass roots techniques, plus many more, are within the realm of the possible, here and now. The fact that bureaucratic techniques now dominate overwhelmingly means far more than that human choice dictated bureaucracy over grass roots. The reason behind that fact lies in the nature of bureaucratic techniques.

Small children learn about the world in a seemingly arbitrary manner. They probe around them, asking embarassing questions that do not come in any logical order. This way they gradually accumulate knowledge of how the world works, and what can or cannot be done. They learn the extent and scope of their freedom.

We too can learn the extent and scope of our freedom by asking embarrassing and childlike questions. We can ask questions like: Why must the productive capabilities of the United States be concentrated in a few huge, key firms? Why must energy be produced centrally and by only a few major technologies? Why must food be grown at a temendous cost in energy and then be marketed through many layers of processing to be sold at high prices? Why must health care be a mysterious matter that only doctors and medical care centers can handle?

Asking these questions will get you one common answer: efficiency.

But consider the fact that centralized energy production involves transmission losses. Consider the fact that food production is taking more and more energy to produce a calorie of food energy or a gram of useful protein. Consider the fact that in most cases, health care has become extraordinarily expensive but remains frightening and inhuman. Consider the fact that concentration of wealth in a few industries does not lead to the most efficient distribution of resources. Then what does the answer that these techniques are more efficient mean? What does it indicate?

**We find ourselves with a limited scope of choices.**

In a bureaucratic technique, efficiency does not mean the relation between useful energy consumed to produce products, services or some other sort of usable output. It means the degree to which a technique can be brought under the control of the bureaucracy; it means the degree to which improvements in that technique can be generated by the bureaucracy; it means the degree to which that technique will help insure the survival of the bureaucracy.

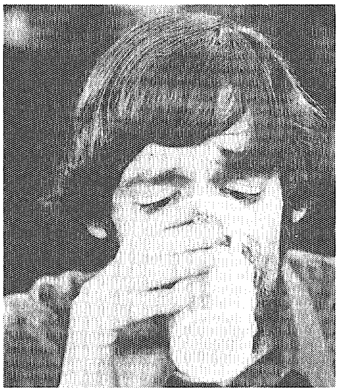
The bureaucratic meaning of efficiency indicates the fundamental limitation of human choice in the industrialized, technical world. We are limited to bureaucracy by bureaucracy. We may have our choice of bureaucratic products; we may have our choice of bureaucratic styles; we may have our choice of bureaucracies. But we cannot choose anything other than bureaucracies.

Because of this bureaucratization of choice, we find ourselves in a situation where we have a great extent of choices but a limited scope of choices. Furthermore, our scope of choices are continually being constricted in the direction of bureaucracy. That this is the trend of the future is indicated in two major schools of thought. One variation of the "limits to growth" theory calls for intensive bureaucratic management of resources on a global scale. The counter argument to the "limits" theory calls for intensive technical development to constantly expand the limits of the possible. In both cases, the boundaries of necessity always push up against and sometimes exceed the limits of ability.

The absence of bureaucracy is one choice that should be open to the human race. Grass roots techniques should be a viable alternative to bureaucracy. The term grass roots may evoke a sort of rural, primitive setting. Most rustic settings are grass roots and many people will find them desirable. But if we cannot imagine any other sort of grass roots setting, that is only an indication of how far bureaucracy has swallowed our imagination.

Grass roots must be seen as a conservation of human potential and diversity. In our mad dash to accomplish the technically possible, we have lost sight of the humanly possible. We must change the way we do things in order that we may more clearly see what can be done.

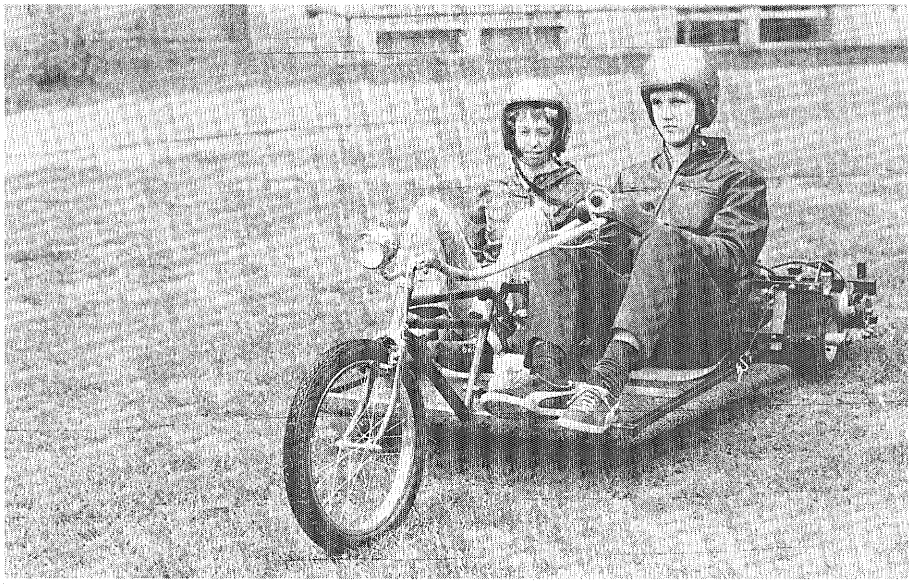
# E-WEEK 1974



by Laurence Yarosh

From the hidden garages and underground workshops come the machines, made from old airplanes, motorcycles and industrial lathes. They are the result of weeks of planning, experimenting and frenzied negotiation with factory managers. This year, six machines challenged Plumb Bob's 500 ft. track, and miraculously, they all finished. This is their story.

**Dennis Parvey.** Parvey, the grand old man of Minnesota autobuilding, has won three first place awards and a second place award in four previous E-day races. His fifth effort, a three-wheeler, features two independent auto starter motors for the rear wheels, driven by a single lead-acid battery. The current is controlled by a series of steel resistors, selected by a solenoid activated switch. He placed second in both speed and design. Last year, his electric "bathtub mobile" reached speeds of 30 mph. Why build electrics? "They are close to being practical," he says. "They provide a touch of realism – you could go to the grocery store in one."


*Dennis Parvey's mortorized surfboard.*

**Pat Ferrin.** Ferrin helped to build Dennis Parvey's 1972 homemade car. In 1973, he modified the car and ran it once again as Parvey concentrated on the mysteries of bathtub propulsion. That effort won him two trophies. This year, Ferrin won the trophy for best speed, 19 seconds, in beating his mentor, Parvey. The winning margin was one second.

His racing machine features a two-speed transmission that he designed himself for a ME design class and hydraulic disk brakes. The compound-wound motor was once used to raise and lower airplane flaps. The brake components were salvaged from a Ford Falcon and parts for the transmission were machined at a Whirlpool plant.

Did he consider any alternative to electric power? "Steam power was thought of," he said, but legal restrictions on design and the requirement of a licensed operator for any system over 200 psi in pressure interfered. "The cost would have been phenomenal," he said.


*Pat Ferrin surveying his updated version of the Apollo Lunar Rover*

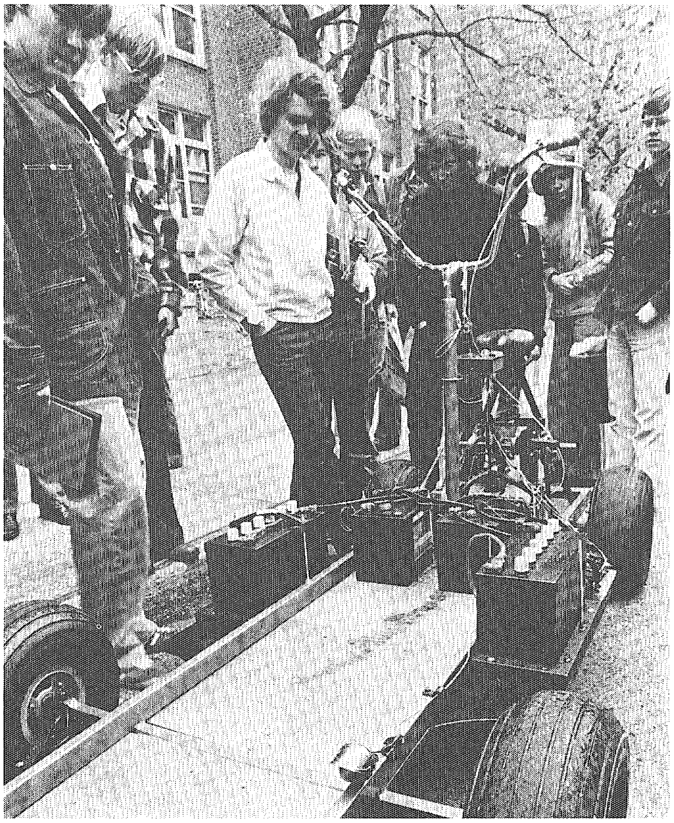
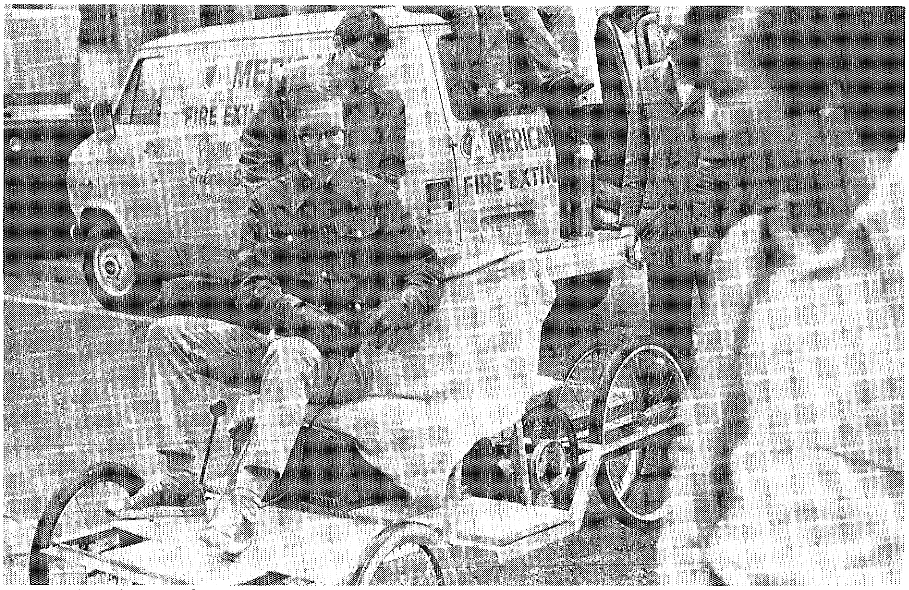


*photo of Pat Ferrin and cluttered end of his car*

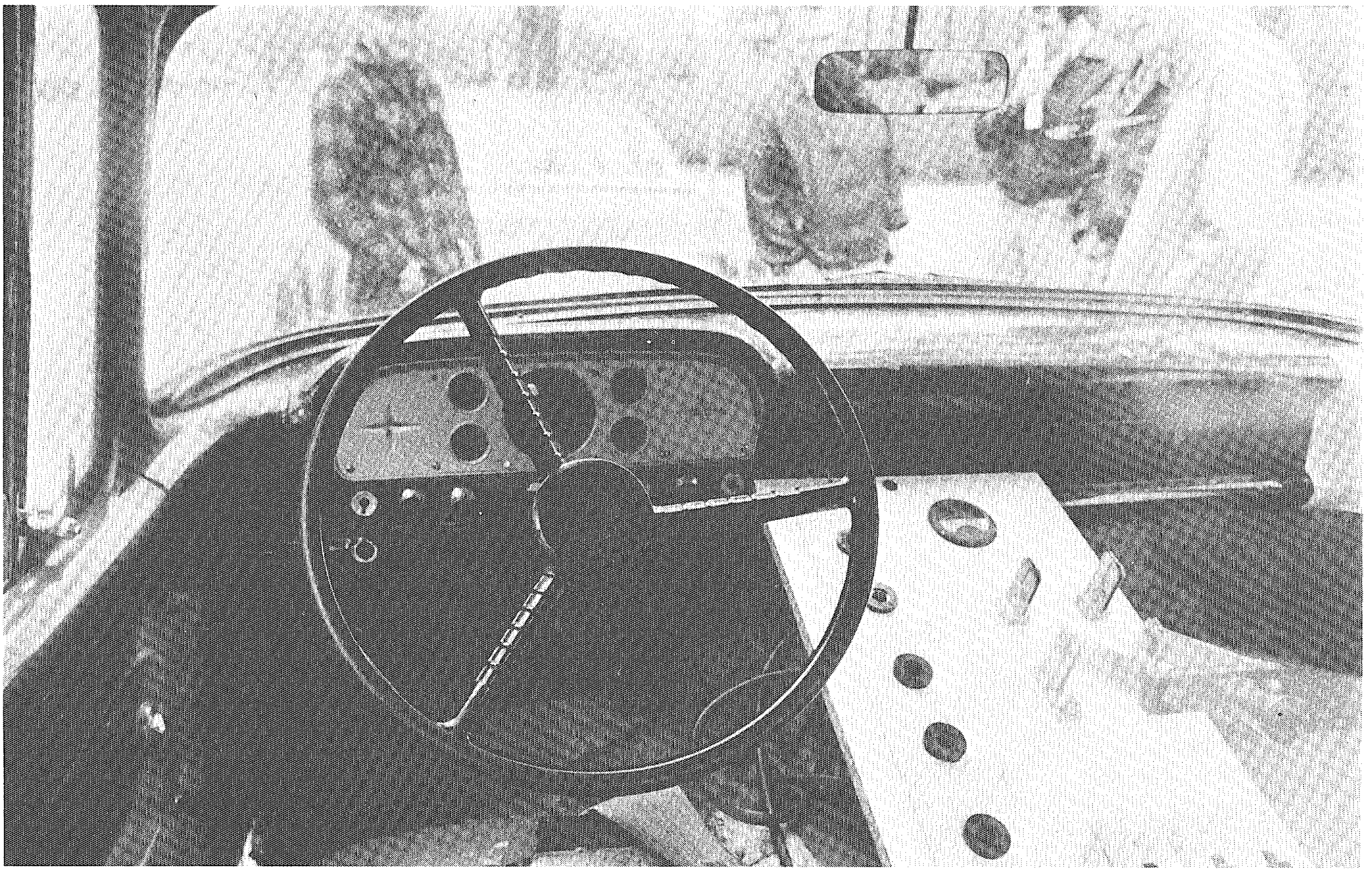

*KHK's handy runabout.*

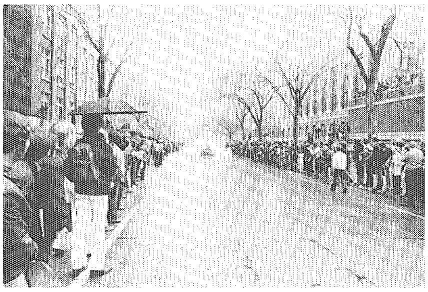
**Kappa Eta Kappa.** The KHK skonk works came up with the only car made from bicycle parts. The roadster, KHK's fourth homemade car, is driven by two automotive starter motors connected by a 10-speed deraileur to the rear bicycle tires. Project supervisor Mike Anderson explained that last year's car, also an electric, was hampered by numerous problems, including a drive train that was set up backwards. This year, all parts faced in the same direction and the car finished the course in 26 seconds. What about next year? "A flywheel driven car", Anderson speculated. But their capability so far is all in electrics.

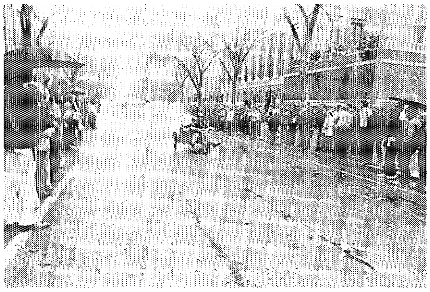
**Bill Kinghorn.** Kinghorn, a graduate student in EE, drove a monster electric car, a 1958 Ford pickup truck fitted with a 10 kilowatt generator and a hundred pounds of auto batteries. Capable of speeds up to 50 mph, it covered the course in 20.5 seconds.

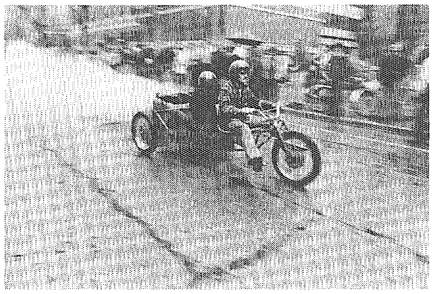
The truck's motor is connected directly to the differential without a power-gulping transmission. "The DC motor is capable of such tremendous overload," said Kinghorn, that the truck "has good acceleration" without using a low gear. In practice, the motor produces five times its rated torque without damage.

As an additional feature, the motor is electrically reversible, allowing it to act as a generator and charge the batteries. This "regenerative braking" slows the truck almost to a stop without the use of normal brakes and converts its kinetic energy into electric current.


*View from the cockpit of the F-100 electric monster.*







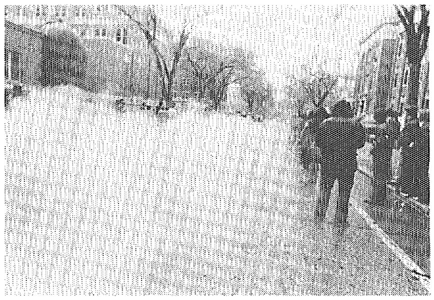
**Triangle.** The only challenge to electricity this year came from Triangle fraternity's Mobile Obfuscator. Their handy machine makes a quick getaway and lays down a smokescreen at the same time using the thrust of six Onan fire extinguishers. The six units, filled with carbon dioxide at nearly 2000 psi, generate 30 lbs of thrust each. Fired two at a time, they lasted long enough to propel the three-wheeler to a time of 29.2 seconds and a first place trophy for design.

Besides its novel propulsion system, the Obfuscator features three motorcycle tires and internal drum brakes.

One of the earliest compressed air cars ran in 1969, when demonstrations over the invasion of Cambodia forced the racers into the obscurity of the river flats. The car used a stream of water driven by compressed air (similar to some toy rockets) and gave an impressive performance (there wasn't a dry eye in the crowd).

The next year ASME ran a similar device, described by the *Technolog* as a "water-spitting bomb."

Mark Lent, Triangle's chief inventor, planned to copy ASME's car. They obtained a fire extinguisher nozzle from Honeywell, connecting it to a welding gas tank. But safety problems intervened; the pipes and tank, although safe for compressed air, were not designed to handle water under pressure. No firm in the Twin Cities would accept responsibility for pressurizing the tank. Left without any compressed air, Lent switched at the last minute to $CO_2$ fire extinguishers.



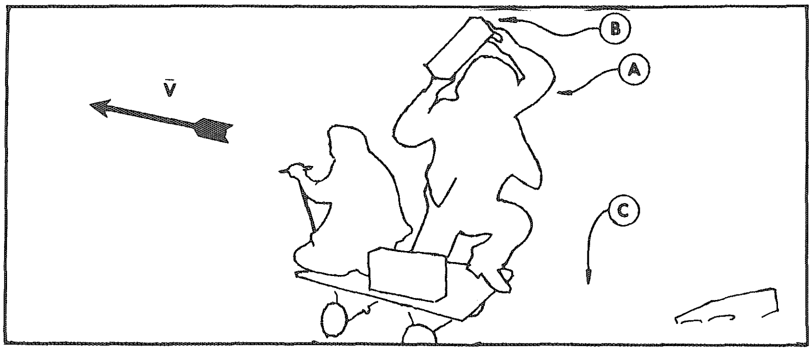
*Sequence of photos of $CO_2$ car*


*Triangle fraternity's Mobile Pneumatic Obfuscator (MPO) in action. Built under a contract from the White House, it can sneak away while simultaneously laying down a smoke screen.*

**Eta Kappa Nu.** The only commercially manufactured entry was driven by Eta Kappa Nu fraternity. The EE Department's Henney Kilowatt Electric Car, entered under an agreement that made it ineligible for trophies, limped in at 30.5 seconds, placing last in both speed and design.

The car's 7.2 horsepower motor is connected to the rear axle through reduction gears. It has a top speed of 35 mph and a range of 60 miles per charging with its 12 six-volt batteries. Power is regulated by a continuous voltage control. The car has been rendered obsolete by modern vehicles developing up to 20 horsepower.

**Forestermobile.** The School of Forestry's entry arrived too late to enter the race, but is nonetheless a significant improvement over earlier efforts. The device consists of a modified railroad handcar, two foresters and a supply of cinder blocks. The propulsion system operates as shown in the drawing; Forester (a) throws cinder block (b) onto road (c) and the car moves in the direction shown by the velocity vector according to the principle of reaction, analogous to a frog jumping when a pebble falls too close to his lily pad. How fast does it go? "Not nearly as fast as before the beer ran out", answered one forester. "It gets even slower when the propulsion system runs back to pick up his cinder blocks."




*School of Forestry's Lumped Reaction Vehicle (LRV)*
*Design is based upon principles discovered after many hours of observing bullfrogs.*

minnesota
# Technolog

A STUDENT MAGAZINE

The Technolog needs a new crop of talented I.T. students to keep up its technical orientation and to continue to print an award-winning magazine. The spirit that brought a thousand students onto Church Street on E-day can also print a first-rank magazine.

HELP NEEDED !!!

Writers, artists, researchers and photographers will be needed for next year. Our present staff is graduating, dead or perverted. We are a small friendly operation. The Technolog has made many people happy. For example A.C. Courant writes:

"I worked for the Technolog and I found fame and fortune."

M.C. Squared writes:

"Working for the Technolog cured my external mind tremors."

We can't promise that working for the Technolog will benefit you as much as it did these people, but we can promise you that we'll let you meet and touch the editor of the Technolog.

ONE LAST TRY

Remember the fun times on the old high school newspaper ? ( or dreaming about printing one underground) Have you always had the urge to express yourself? Have you always wanted to know how a magazine is conceived, typeset, and keylined? Do you want a good experience and a fantastic job reference? If the answer is yes to any of these, then come to the spring organizational meeting:

3:00 P.M.

Thursday, June 6

Room 2 Mechanical Engineering

We will begin planning for next year's magazine. If you can't make it then, call our office at 373-3298

# I.T. STUDENT BOARD

## *Committee on Committees*

### *Positions Open On Committees*

*Mech. Eng.*

- *Computer*
- *Display*
- *Library*
- *Scholastic Standard*
- *Curriculum*
- *Engineering Intern*
- *Scholarship*

*CICS*

- *Under-Graduate Advising*

*All I.T. Students*

- *SOS (Student Ombudsmon Service)*
- *Institute Consultive And Appeals Committee*

*The above is a partial list. If you are interested, check your Department office or I.T. Board Office, 230 TNCE.*

# Stan Kaufman Fights Water With Jelly...

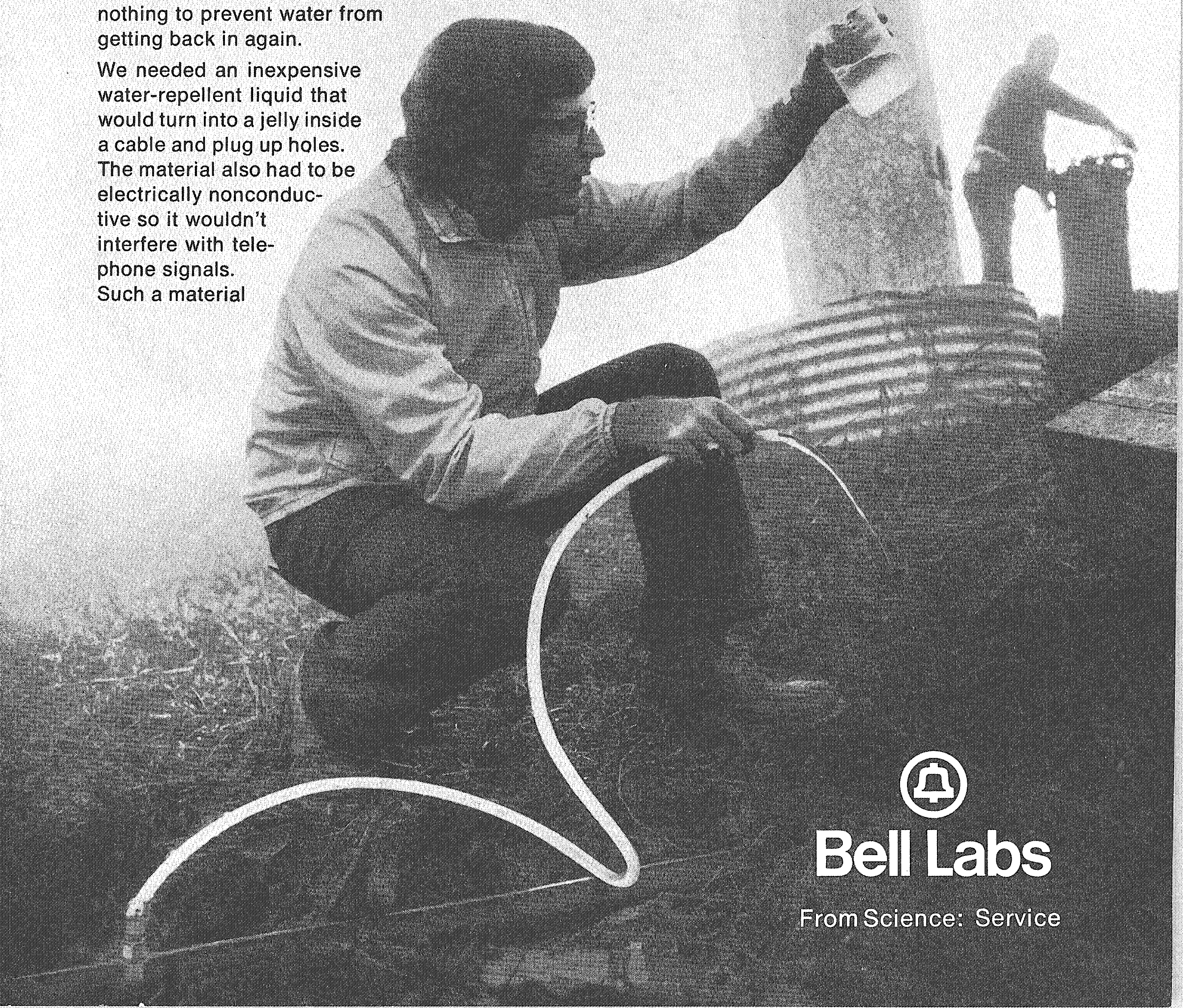
to keep people talking. Bell Labs chemical physicist Stan Kaufman invented a material that turns waterlogged underground phone cable into a water-free "jelly roll" that can carry calls again. Pumped through football-field lengths of cable as a liquid, the material forces water out and then turns to jelly—to keep the water out.

Water sometimes seeps into cable damaged by plows, lightning, gophers, or sharp rocks. Phone calls going through the cable become noisy or don't go through at all. Until now telephone companies had to abandon waterlogged cable, or dig it up and replace it, or use acetone to flush out the water. Once the acetone was evaporated, however, there was nothing to prevent water from getting back in again.

We needed an inexpensive water-repellent liquid that would turn into a jelly inside a cable and plug up holes. The material also had to be electrically nonconductive so it wouldn't interfere with telephone signals. Such a material didn't exist, so we asked Stan Kaufman, a 1970 Ph.D. from Brown University, to tackle the problem.

Drawing on his knowledge of molecular structure and working with telephone company engineers—sometimes in muddy cable trenches—Stan came up with a new compound. A Western Electric engineer modified a pump to force the compound through long lengths of cable. And during field trials, operating telephone engineers suggested installation procedures.

Bell Telephone companies are happy because they don't have to dig up as much waterlogged cable, which often runs under highways and people's lawns, and because restoring an otherwise good cable helps hold down the cost of providing telephone service.



# Sales and Service.
# 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.

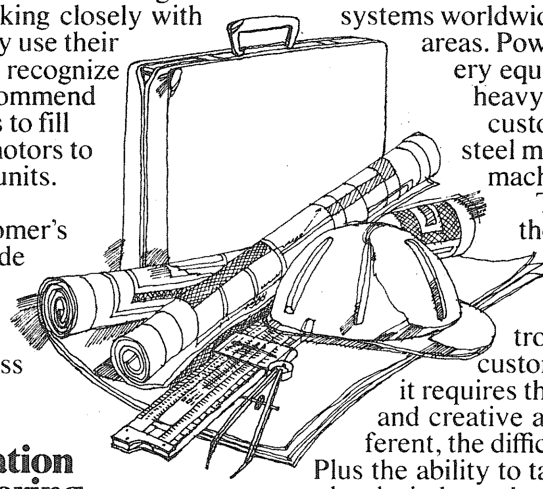
Basically, engineering at GE (and many other companies) can be divided into three areas. Developing and designing products and systems. Manufacturing products. Selling and servicing products.

This ad outlines the types of work found in the Sales and Service area of 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-3, 570 Lexington Ave., New York, New York 10022.

## Sales Engineering

Sales engineering is technical marketing. Sales engineers at GE are the important liaison between GE manufacturing facilities and utility, industrial, distributor and governmental customers. Working closely with assigned customers, they use their technical background to recognize customer needs and recommend GE products or systems to fill them. From small AC motors to huge turbine-generator units. Requires a thorough understanding of a customer's business, as well as a wide range of GE products. Plus the ability to work well with people and to recognize a good business opportunity.



## Application Engineering

Application engineers are technical experts who work closely with the sales engineer and the customers' engineers. Their job is to analyze special problems and equipment needs of customers, then determine the optimum GE products or systems to meet them. There are two kinds of application engineers. The first works out of a sales operation and is adept at applying a wide variety of products to create a "system" that meets the customers' needs. The second works in a product manufacturing department and is a specialist at applying the products of that one department. Both must have in-depth knowledge of the customers' technical needs. They often consult with product planners and other marketing personnel to suggest ideas for new or modified products.

## Field Engineering

Field engineers at GE plan and supervise the installation and service of large equipment systems worldwide in two main customer areas. Power generation and delivery equipment for utilities. And heavy apparatus for industrial customers such as paper and steel mills, chemical plants and machine tool manufacturers. They specialize in either the mechanical/nuclear or electrical/electronic areas. Since field engineers are often called to troubleshoot and correct a customer equipment problem, it requires the technical competence and creative ability to handle the different, the difficult and the unexpected. Plus the ability to take charge, lead people, and make independent, on-the-spot decisions.

## Product Planning

Product planning is a marketing function. Product planners make sure a product line offers what customers need at competitive prices. They determine the need for a new or modified product, product availability, market size, cost structure, profitability, specifications and distribution channels. To do this, they work with market researchers, application and sales engineers, finance experts, marketing management, plus design and manufacturing engineers. Their engineering background is a big plus. This work requires self-starters who can coordinate a project and sell their ideas to management.

**GENERAL ELECTRIC**
An Equal Opportunity Employer