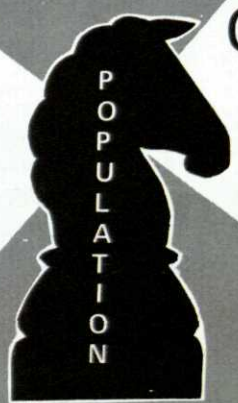
spartan engineer

MICHIGAN STATE UNIVERSITY
VOLUME 25 NUMBER 4
APRIL / MAY, 1972

IS MAN CHECKMATING HIS FUTURE ?



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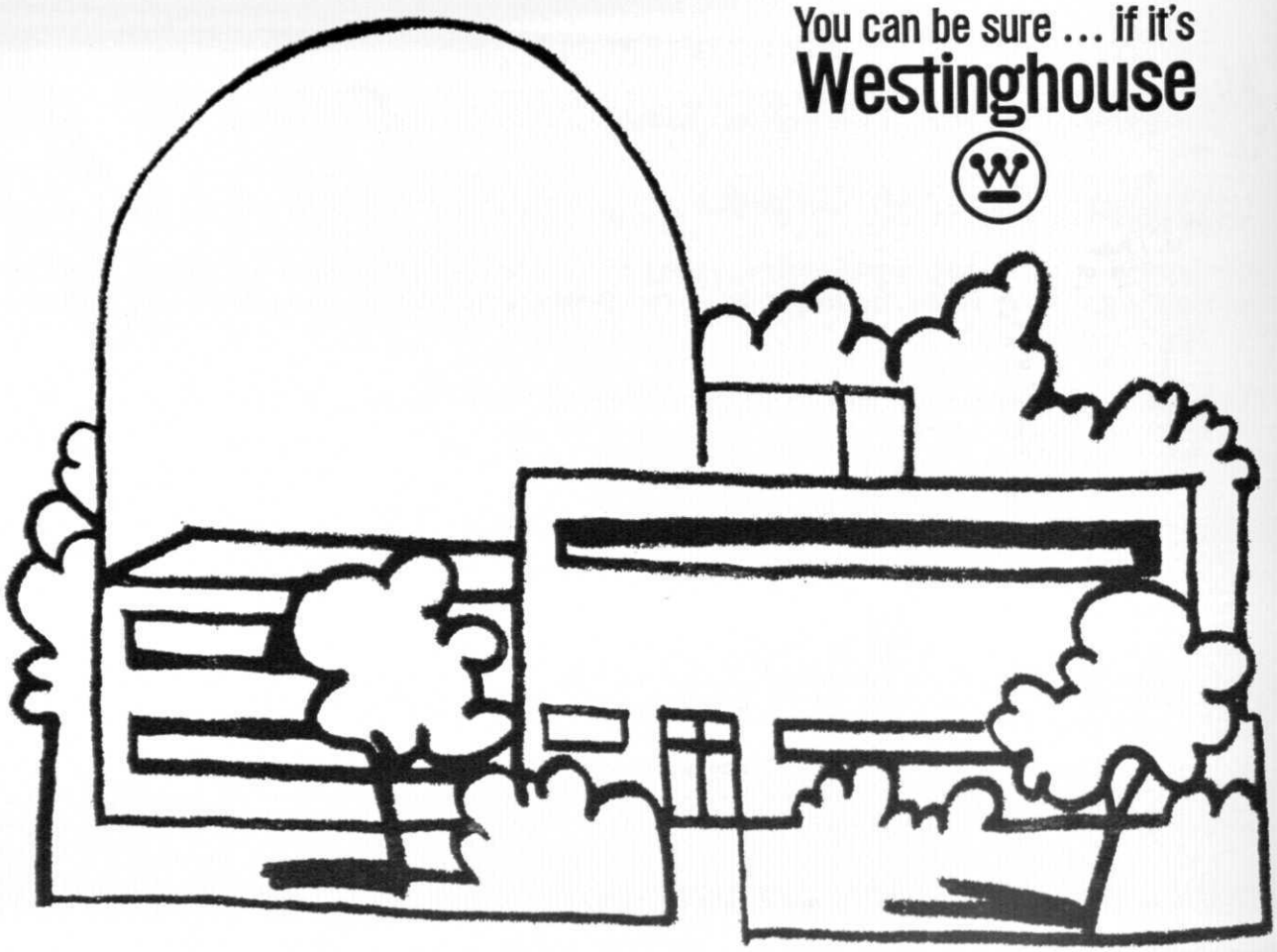


This months cover depicts the dangers of our dwindling resources and growing population.

spartan engineer

The Scientific Ecologically Open Minded Magazine

Member of the Engineering College Magazines Associated

MICHIGAN STATE UNIVERSITY

VOLUME 25
NUMBER 4

APR. / MAY, 1972

FEATURES

DEPARTMENTS

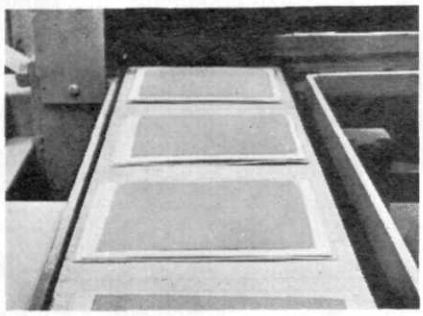
Member, Engineering College Magazine Associated / Chairman: Daniel L. Griffer, Jr. Iowa State University, Ames, Iowa / Publisher's Representative: Littell-Murray-Barnhill, Inc., 60 East 42nd St., New York, New York 10017. / 737 N. Michigan Ave., Chicago, Ill. / Published four times yearly by the students of the COLLEGE OF ENGINEERING, MICHIGAN STATE UNIVERSITY / East Lansing, Michigan 48823. / The office is on the first floor of the Engineering Building / Room 144, Phone 517 355-3520. / Subscription rate by mail $2.00 per year / Single copies 40 cents / Printed by Millbrook Printing Company/.

A statement of policy:

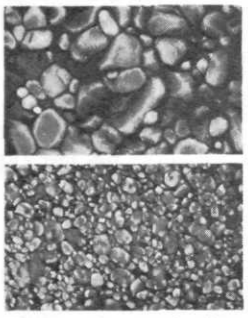
The objective of the magazine is to communicate the exchange of ideas between: students and professors, professors and professors, departments, and colleges within the university. The Spartan Engineer believes that the engineering world can no longer neglect the social interactions of the outside world and is dedicated to initiating programs within its bounds that not only seek to relate the latest discoveries of pure science, but also show a genuine concern for the questions troubling our environment. The Spartan Engineer also identifies with the American ideal of free enterprise and its attempt to perfect the efforts of mankind in constructing a new world through human engineering.

STAFF

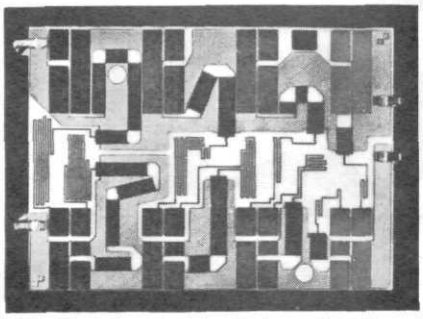
WESTERN ELECTRIC REPORTS



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.

SURVIVAL

EDITORIAL

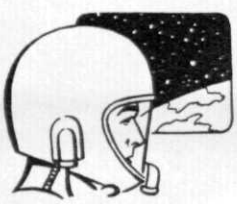
By the year 2000 the world population will have doubled, energy needs will approach gargantuan figures, and man will be using the last of his fossil fuels. If we are to maintain our present standards of living the limiting factors must be overcome. Energy from fossil fuels is the greatest limiting factor, and we have only started to use engineering technology in obtaining energy from other sources.

Atomic power parks have been proposed to handle future electrical loads. Reclamation of Deuterium from the ocean has been proposed as a possible source of energy. Sewage treatment has already been started in an attempt to reclaim some of our lost waters. Lake Erie is dead, but scientists are trying to bring it back to life. Our desert waste lands are giving way to arid farm lands. And the ocean produces as much algae as agriculture produces wheat, corn, and potatoes. Algae has been shown to be high in protein content, and could be a possible food source of the future. These are only a few of the ways man may solve his problems, but the tools he will use most in the solution are the engineering skills of his age.

Thus the role of the engineer in relation to his environment is increasing rapidly and may soon reach an expotential rate if man follows his strongest instinct—Survival.

Donald J. Willemsen

SPACESHIP EARTH

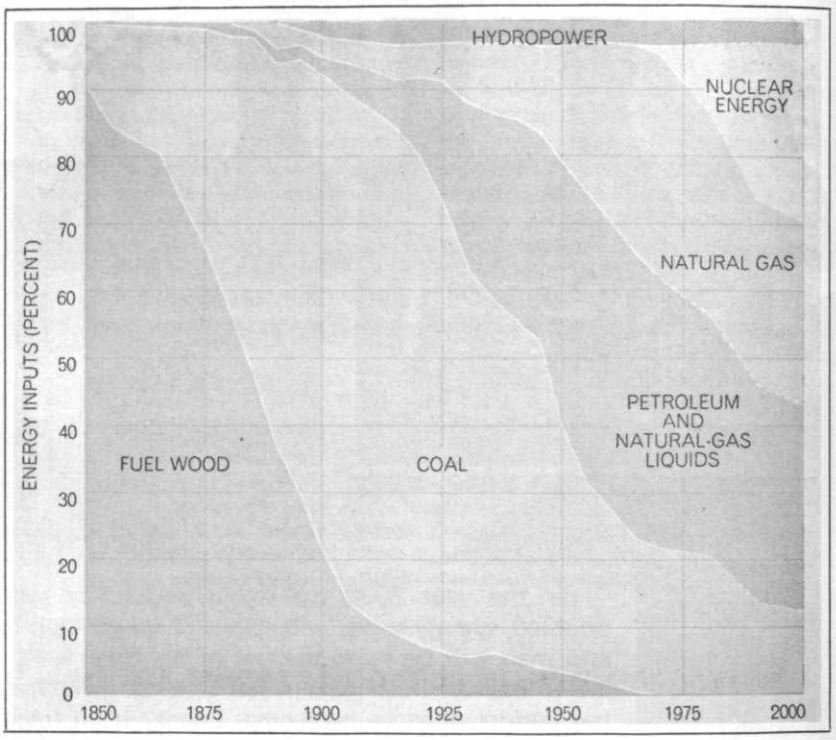


By Vincent Rybicki

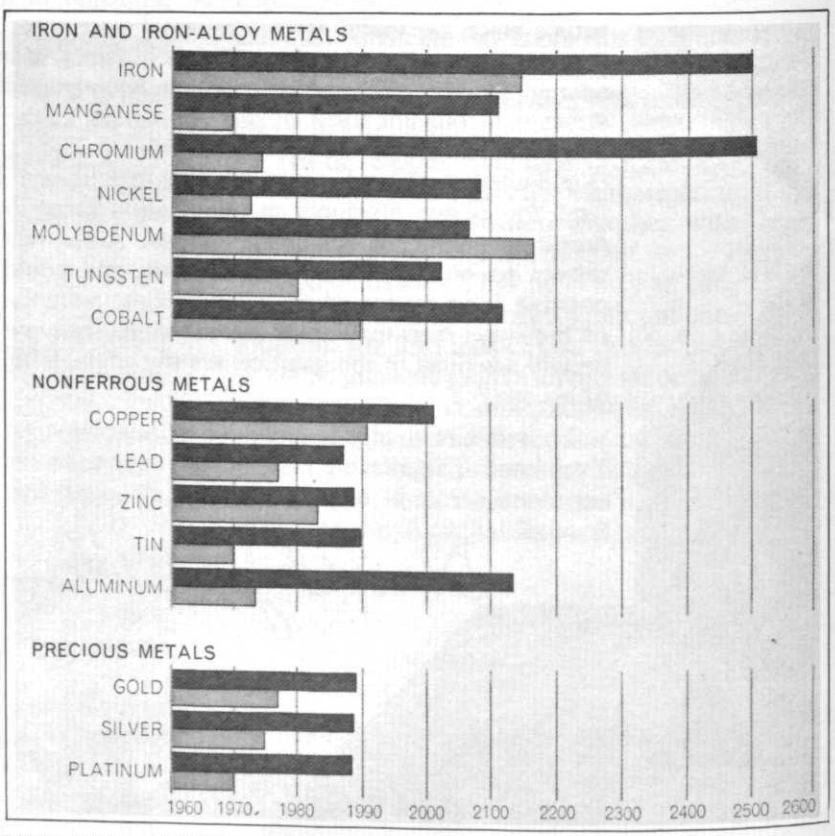
Consider fermentation. A few yeasts in the mash rapidly reproduce. As they multiply, live, and grow they pollute their environment with their own waste products – alcohol. If they run out of sugars or if they pollute their environment past 12% alcohol they die. The yeasts plight is that they are living in a closed system–just as we are.

Once we burn all of our oil and coal there is no more. Once all of our iron and aluminum corrodes and disperses over the planet it is no longer available to us. Without these natural resources most of us would die and those who remain would be doomed to a primitive agrarian existence with a life expectancy of less than 35 years.

(Continued on Page 6)



FOSSIL FUELS now account for nearly all the energy input into the U.S. economy. Coal's contribution has decreased since World War II; that of natural gas has increased most in that period. Nuclear energy should contribute a substantial percent within the next 20 years.



LIFETIMES OF METAL RESERVES are indicated for the world *(top)* and the U.S. *(color)*. These rough estimates are based on the assumption that the utilization of metals will continue to increase with population growth and rising per capita demand. They take into account, however, that new reserves will be discovered by exploration or created by innovation. It is estimated U.S. demands will increase four and a half times by the year 2000.

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.

"A good hurdler never jumps," the experts tell us. "He tries to duplicate the movements of sprinting. The head stays level. It's never higher over the hurdle than it is between them."

A level head helps overcome any obstacle. Take bearing problems. They're best approached by a person with training, determination and the ability to think things through.

Are you such a person? When you run up against a tough problem, are you able to take it in stride? And do you like the excitement of rugged competition, and the rewards that come from winning?

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And while you're at it, ask him to tell you about our $221 million expansion and modernization program.

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THE TIMKEN COMPANY MANUFACTURES TAPERED ROLLER BEARINGS, SPECIALTY ALLOY STEEL AND REMOVABLE ROCK BITS.

What are our major obstacles in maintaining a high standard of living? Just as with the yeasts, they are: an unchecked population growth, pollution, and a diminishing supply of natural resources. The population can be stabilized. The industrialized nations are well on their way towards accomplishing this. China and Japan have already achieved a stable population through self regulation. If a nation does not achieve a stable population through self regulation, mass starvation will do it for them. Our agricultural resources are limited. We can only feed, clothe and shelter a finite number of people.

Thankfully, the common man is now aware of pollution. Much is being done to solve the problem and though the cost will be high, it appears that the pollution problem can be solved.

The last major problem of decreasing availability of natural resources is the most crucial. What happens when copper becomes scarce? We will have to mine lower and lower grades of ore. The lower the grade of ore the more energy it takes to extract and purify the desired product. The more energy you use the less you have available for future generations and the sooner your source of energy runs out.

Our known reserves of fossil fuel are estimated at 100 years worth with quality drastically decreasing with time. Our hydroelectric capacity is near its maximum now besides the fact that new dams meet stiff opposition from local residents and pseudo-ecologists. Large scale solar power is almost pure science fiction at this time. That only leaves us with nuclear energy to provide us with power. Many are opposed to nuclear power, but without it, in 100 years there won't be any power besides muscle, wind, and water. We can't go back without drastic loss of life and happiness; we can only go forward.

By 1980 a great deal of our electrical energy will come from fission reactors, but fission reactors are still only a crutch on the way to the solution of the problem. Fissionable uranium 235 is a scarce element and, at $30.00 a pound, is not expected to last as long as our coal reserves. Breeder reactors which produce more fissionable material than they use extend our energy reserves enormously but a vast amount of engineering work is still required to make them practical. Once in operation they could extend our energy reserves by 500,000 years assuming a steady state global population of 7 billion and a per capita energy consumption 20% more than the current U.S. rate.

A dueterium fusion reactor would extend our energy reserves by 2.7 billion years. Though a dueterium reactor would be the best solution, fusion technology is still in its infancy and it will require a great deal of time and research before we can build a reactor.

With sufficient energy gold can be extracted from sea water, air and water can be converted into pertrochemicals, and an extremely low grade ore can be converted into a pure metal. With sufficient energy at their disposal our future generations can maintain a high standard of living.

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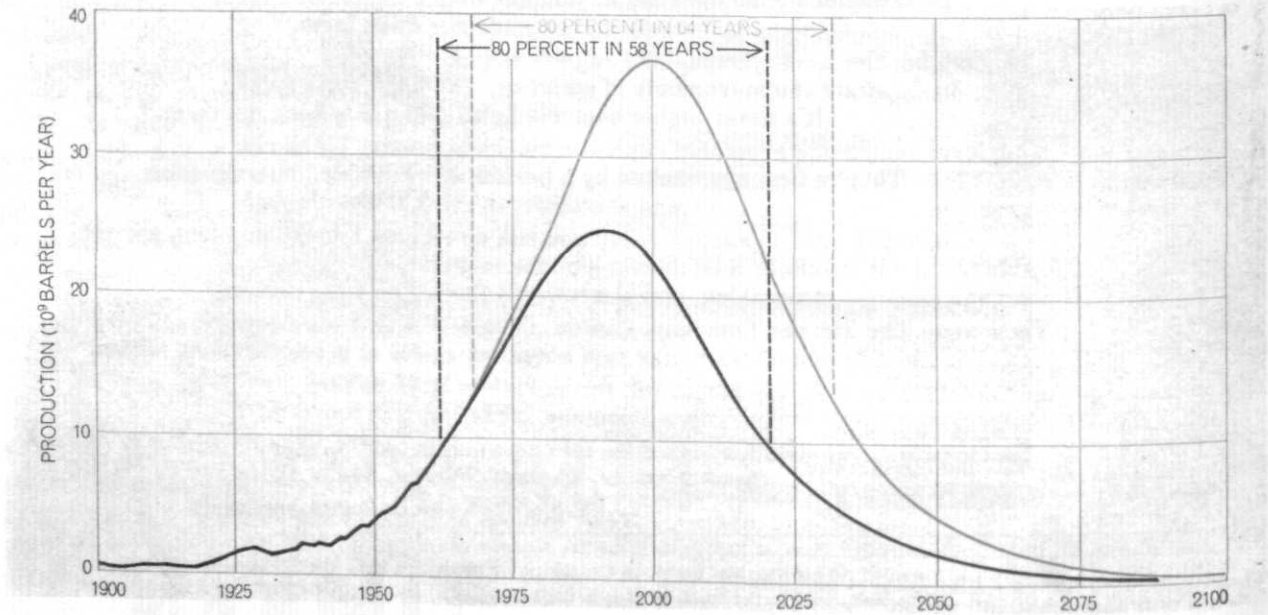


CYCLE OF WORLD OIL PRODUCTION is plotted on the basis of two estimates of the amount of oil that will ultimately be produced.

The top curve reflects Ryman's estimate of $2,100 \times 10^9$ barrels and the bottom curve represents an estimate of $1,350 \times 10^9$ barrels.

PUZZLE PAGE

A five dollar prize will be awarded to the first undergraduate engineering student to turn in the correct solutions in Rm. 210 E.B.

1. Can 19^{19} be represented as the sum of a cube and a fourth power?

* * *

2. Reconstruct the following exact long division in which the digits have been indiscriminately replaced by X's except in the quotient where they have almost been entirely omitted.

```
        ________8____
XXX)XXXXXXXXX
    _XXX_
      XXXX
      _XXX_
        XXXX
        XXXX
        * * *
```

3. a) In 1918, on the day that the armistice of World War I was signed, three married couples celebrated by having dinner together.

b) Each husband is the brother of one of the wives, and each wife is the sister of one of the husbands; that is, there are three brother-sister pairs in the group.

c) Helen is exactly 26 weeks older than her husband, who was born in August.

d) Mr. White's sister is married to Helen's brother's brother-in-law. She (Mr. White's sister) married him on her birthday, which is in January.

e) Marguerite White is not as tall as William Black.

f) Arthur's sister is prettier than Beatrice.

g) John is 50 years old.

What is Mrs. Brown's first name?

* * *

4. Smith, Brown, and Jones agree to fight a pistol duel under the following unusual conditions. After drawing lots to determine who fires first, second, third, they take their places at the corners of an equilateral triangle. It is agreed that they will fire single shots in turn and continue in the same cyclic order until two of them are dead. At each turn the man who is firing may aim wherever he pleases. All three duelists know that Smith always hits his target, Brown is 80 per cent accurate and Jones is 50 per cent accurate.

Assuming that all three adopt the best strategy, and that no one is killed by a wild shot not intended for him, who has the best chance to survive? What are the exact survival probabilities of the three men?

LAST ISSUE'S WINNER: *Gary Ingvaldson*

Last issue's answers.

1. 125, 200, 320 and 200, 320, 512.
2. The missing pages were 255 thru 286.
3. The fly's chance of survival is .75.
4. There are C_N^4 or (N-3) N-2) (N-1) N/24 intersections and $C_N^4 + C_N^2 + 1$ or (N-3) (N-2) (N-1) N/24 + (N-1) N/2 + 1 regions in the circle.
5. The free throw is worth 8 points and the field goal is worth 11 points.

INSTANT ELECTRICITY. YOU CAN EVEN FLOAT IT TO TOWN.

Portable gas turbine generators, mounted on barges and trucks, are being plugged into existing power networks to boost capacity. And nickel's helping make it happen.

One tool that more power companies are using in both their short- and long-range efforts to close the generating gap is a down-to-earth cousin of the jet aircraft engine, the gas turbine.

A typical turbine, hitched to a generator, can produce enough power to light a city of 25,000 people. (Above, *eight* turbines are ganged on one barge. Combined output: 156,000 kilowatts!)

The beauty of the turbine is that it can be bought and set up almost anywhere in a matter of weeks. And it can be turned on and off in mere *seconds*. Which makes it ideal for those muggy summer evenings when everybody gets home and hits the air-conditioner button at once.

Gas turbines have proved such a boon to utilities that sales of them are soaring. Last year, they actually accounted for more than *one fifth* of power companies' total new generating capacity.

At the volcanic heart of the turbines, where temperatures reach 1,800 degrees, only specially designed superalloys can be used. Almost all of these alloys contain a high proportion of *nickel*—up to 78 percent. Nickel is vital for the properties required for dependable turbine service. It helps to provide alloy stability and corrosion resistance.

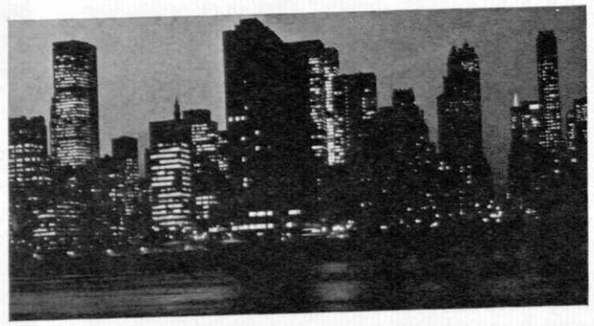
Just as our metal is a helper, so International Nickel is a helper.

We assist dozens of different industries all over the world in the use of metals. We offer technical information. And the benefit of our experience. Often, Inco metallurgists are able to *anticipate* alloys that will be needed in the future, and to set about creating them.

This kind of helpfulness, we figure, will encourage our customers to keep coming back to us.

And that helps all around.

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



INTERNATIONAL NICKEL HELPS.

terminus ? 2002

By Weston Fisher

In 1971 the U.S. imported 23 percent of its oil, and Europe and Japan were almost totally dependent on foreign oil to meet their demand for petroleum liquids. In the next decade the world demand for petroleum is expected to almost double. In this same period, U.S. domestic oil and gas resources are predicted to near depletion. These projections are important because of petroleum's role as an energy resource in the U.S. economy.

Oil and gas together presently contribute approximately 76 percent of our total energy supply, coal 19 percent, nuclear power about 1 percent, and hydroelectric power about 4 percent. The exhaustion of our domestic oil and gas, combined with a doubling U.S. demand for energy in the next ten years, requires that the U.S. energy industries quickly discover and develop alternatives to domestic oil and gas. Government and the industries look to coal, nuclear power, and increased oil imports as the only significant alternatives over at least the next thirty years.

Oil imports are expected to rise from the 23 percent at present to 40 percent by 1980. To prevent dependency on foreign oil above the 40 percent level will require:

–rapid development of Alaskan and offshore oil,/

–massive development of the coal reserves of the Rocky Mountain Region from North Dakota to the Four Corners,/

–Federal support and encouragement to the development of the Colorado, Utah, and Wyoming oil shale lands, coal gasification, and nuclear power.

The role of nuclear power is expected to be crucial. To make up the difference between energy demand and the diminishing supply of domestic oil and gas, planners project that nuclear energy use will rise from the present 1 percent to an estimated 30 percent by the century's end, with as many as 950,000+ megawatt reactors, of primarily breeder design.

It does not appear the transition to these energy sources will be smooth. Already environmental opposition to nuclear power has produced a slowdown in the entire commercial reactor program, and with problems of solidification and disposal of high level wastes yet to be overcome, as well as radioactive emissions at plant sites and other technical problems, the slowdown is likely to continue. A massive commitment to electrical energy from breeder reactors might not be possible if the reactor program is indefinitely delayed for environmental reasons.

Similar opposition from environmental "intervenors" is beginning to be felt by the coal industry and is intensifying as strip-mining for coal increases in the Rocky Mountain States. Coal gasification programs and major strip-mining operations for oil shale may also be jeopardized by environmental opposition.

Of major concern are the international, political and economic implications of a 40 percent dependency on foreign oil by 1980. Because of rising world demand, and because the Organization of Petroleum Exporting Countries (OPEC) is bargaining more effectively, the price for foreign oil is likely to rise considerably over the next ten years. While the U.S. population will be able to absorb major price increases by switching to smaller automobiles, electrified mass transit, train rather than truck transport for produce and manufactured goods, and expanded rail passenger service. The same is not true for Japanese and European consumers; since they are already efficient in their use of fuels and yet will have to face still higher petroleum prices.

For example, with the price of gasoline in France at $1.20 per gallon, small cars, subways, and electrified rail have become common features of the French transportation system. As a result, further price increases may only be partially absorbed by greater transportation efficiencies; thus making it probable that further increases would have very adverse effects on the French economy.

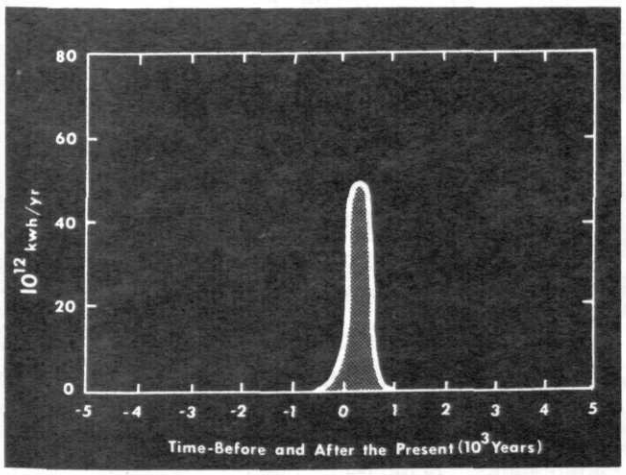
Rising prices for imported oil may have a greater impact on the economies of the petroleum importing, developing, countries than on the developed nations, because import payments for oil represents such a high proportion of their total import expenditures. Wherever possible, the developing countries should design their transportation systems and industries to utilize indigenous hydroelectric and geothermal power and fuel resources. It is ironic that several of the developing countries which import petroleum already have extensive highway systems, but little or no electrified rail systems. This is partly the result of the support of highway construction by international aid organizations like USAID and the World Bank.

For all countries without large reserves of fossil fuels or hydroelectric power, nuclear power appears to be the only alternative to deteriorating balance of payments positions. Thus most of the world's developed and developing countries are attracted to nuclear power, even though the technology of commercial reactors is barely twenty years old and many unsolved social and environmental problems remain associated with it. Will the obvious near-term benefits outweigh long-term costs, or are the developed and developing countries taking nuclear power for their bride with only half

a promise that their house will be kept clean and that there is nothing behind the doors?

Is there another way of meeting the world energy demand? Part of the answer may lie in the U.S. growth curve for energy use, since we consume about 35 percent of the world's annual energy supply. Why has our consumption been doubling every ten years while the American population is doubling every seventy? Could the rate of growth for energy consumption be slowed without a drastic fall in the GNP? Might not per capita consumption be held constant by a combination of consumer education, taxation of electricity, natural gas, and gasoline, together with government and industrial support of more efficient use of energy and of non-energy intensive industries?

Stabilization of per capita energy consumption in the U.S. would of course not solve the problem of how the U.S. might reduce its 95 percent dependency on non-renewal coal, oil, and gas for its energy supply; nor the problem of how to persuade other developed countries that they should also reduce their rate of energy growth. It would, however, minimize the environmental and social impact of the short-term alternatives (nuclear power, oil imports, and strip-mined coal) and help stretch out fossil fuel supplies until new alternatives are developed, whether fusion, geothermal or solar in origin.



Epoch of exploitation of fossil fuels in historical perspective from minus to plus 5,000 years from present.

A major R. & D. program sponsored by government and industry to expand the use of alternative sources of energy, and more efficient energy technologies, would help reduce the economic impact of a slower growth rate for energy consumption. In addition, if energy industries could be encouraged to diversify into non-energy intensive conglomerates rather than continue their present movement toward concentrated control of fuels (e.g. oil, uranium, and coal), they would be able to withstand the economic effect of public programs designed to moderate energy use.

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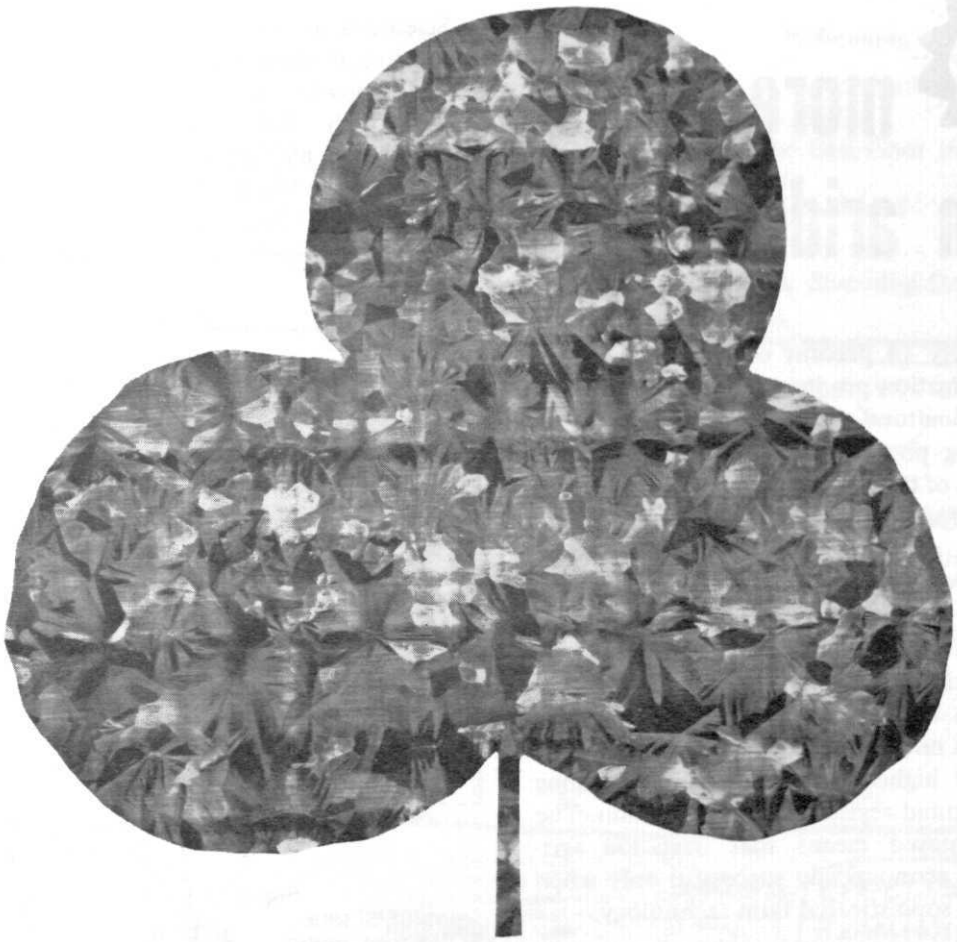

How FLOWERS OF ZINC guard steel against rust for 20 years and more

The myriad of shining zinc "petals," which galvanizing deposits on steel, form both a shield and an "electric fence" against rust. ☐ The layer of zinc protects first as a mechanical barrier which completely covers the steel to seal out corrosion's attack. Zinc's secondary defense is called upon when the protective coating is scratched, gouged or worn through to the steel itself. Then, an electrochemical current of galvanic action fences these gaps and the zinc slowly sacrifices itself as it continues to protect the steel. This action takes place because, in the galvanic series, zinc is less noble than steel and will corrode sacrificially . . . fighting a stubborn delaying action against corrosion's attack. ☐ No other material provides the combination of strength, corrosion-resistance and economy found in galvanized steel. That's why it's so widely used in guard rail, bridges, transmission towers, reinforcing rods, automobiles and many other industrial applications.

Galvanized steel guard rail on the New Jersey Turnpike has a record of no passenger vehicle breakthrough and no maintenance after ten years.

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more foods from arid lands

By Bob Norby

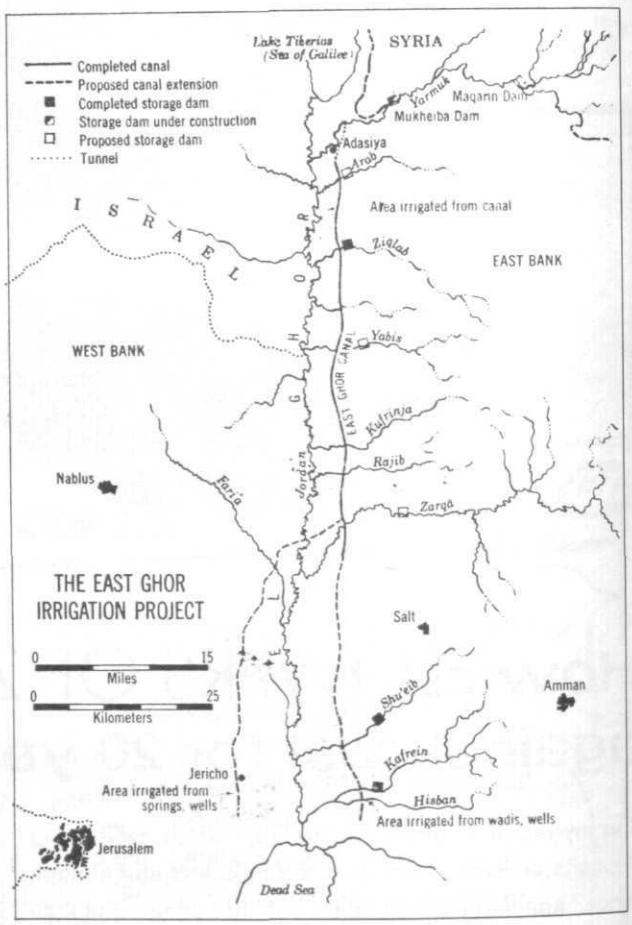
Approximately 14 percent of the world's crop lands under irrigation produce a fourth or more of the world's agricultural crops. As the food needs of rapidly growing population continue to increase, more and more of the arid and semiarid regions will be cultivated, for much of this land is capable of year-round use, and conditions are more favorable than in humid regions for the control of insects and disease and the advantageous timing of water application. One estimate is that by the year 2000 there will be twice the present 370 million acres under irrigation, even though the cost of new irrigation projects, which now average almost $400 per acre, is substantially higher than the cost of bringing new land in humid regions under cultivation. The investment required means that irrigation agriculture can be economically successful only when combined with sophisticated farm technology.

Jordan began constructing a large scale irrigation project in the Jordan rift valley, or El Ghor (see fig. I) as it is referred to locally in August, 1958. The East Ghor irrigation project involves the diversion of the river Yarmuk to provide an irrigation supply for approximately 30,000 acres of cultivable land in the northeastern part of the Ghor. The canal offtakes from the Yarmuk is about five miles above the Jordan-Yarmuk conference. The flow of the river is diverted through a side channel excavated below the natural bed of the river. From the diversion point the water is carried through a mile long tunnel through a rocky spur to the 45 mile long canal.

Unfortunately, due to the inefficiency of traditional farming methods, the project is not as successful as expected. In an attempt to improve agricultural practices in the project area, in particular to encourage farmers to experiment with new crops, improved seeds, fertilizers and pesticides, the Agricultural Extension Service provides a technical assistance and advice program. Cash loans and incentive grants are made available to farmers, but, most important, farmers are encouraged to adopt better methods of irrigation. At present, farmers are often wasteful and extravagant in their use of water.

Scientists at the University of Arizona believe they have devised an integrated system that will provide power, water, and food for coastline desert. With their approach, waste heat from engine-driven electric generator sets is used to desalt sea water. The resulting fresh water, in turn, is piped to vegetables planted within controlled-environment greenhouses of air inflated plastic.

(Figure 1)



Because they lack beams or other supports, these greenhouses admit more sunlight; they are also less expensive and easier to erect than conventional greenhouses. Using the normally wasted heat of the engine-driven generator sets to provide fresh water for agriculture is practical and more efficient, although this method is far too costly for openfield farming.

The Arabian Shiekhdom of Abu Dhabi is planning to construct a power-water-food center designed by the University of Arizona and prefabricated in Tucson. This facility will have forty greenhouses, each consisting of double half-cylinders connected by tunnels and each covering 4,600 square feet. Abu Dhabi now imports its fresh vegetables from Lebenon and these sell for as much as $1.50 a pound. Their goal is to reduce this cost

to about 20 cents a pound and to produce perhaps two million pounds of high-quality vegetables a year.

Even the use of all available land combined with our rapidly improving agricultural technology can keep pace with our growing population much longer. People must recognize the need to stabilize the world population before we exhaust our resources.

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OUR SECOND STORY FINDS MANNY AT THE "ROOTS" OF A NAGGING PROBLEM...
IT LOOKS DEAD... I THINK I'LL CUT IT DOWN
AS USUAL, ACTING SWIFTLY...
OUR BOY BECOMES THAT FAMOUS ERADICATOR...
SUPER ENGINEER!
...AND WITH HIS SHARP SAW, SOON ALLEVIATES THE PROBLEM!
LET'S SEE, IF MY CALCULATIONS WERE CORRECT, IT SHOULD FALL... YES, DOWN! GOOD OLE' GRAVITY AN' ACCELERATION!
ZIHH...
ZAHH...
ZI HHH...
CRA... CRACKKK!
GAS 47 FEET AHEAD
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Take the matched component system, MS210W, over on the right. That turntable is automatic, with cueing and anti-skate controls. It's precisely matched to a Sylvania solid state FM Stereo/FM/AM receiver.

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GTE SYLVANIA

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The microbes digest cellulose. And cellulose is what nearly two-thirds of all municipal garbage and farm refuse are made of.

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