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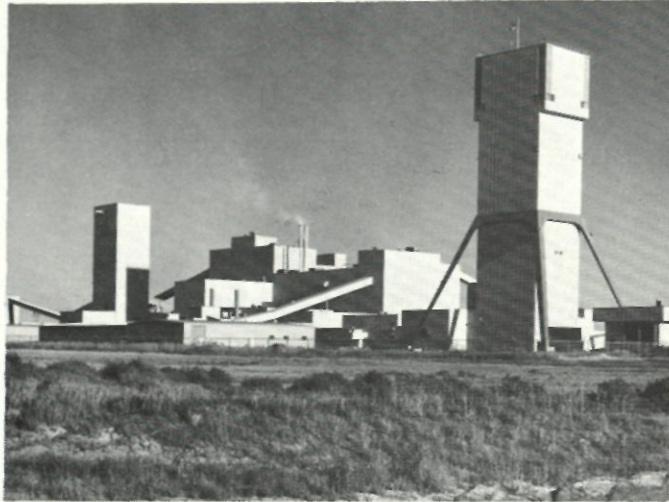
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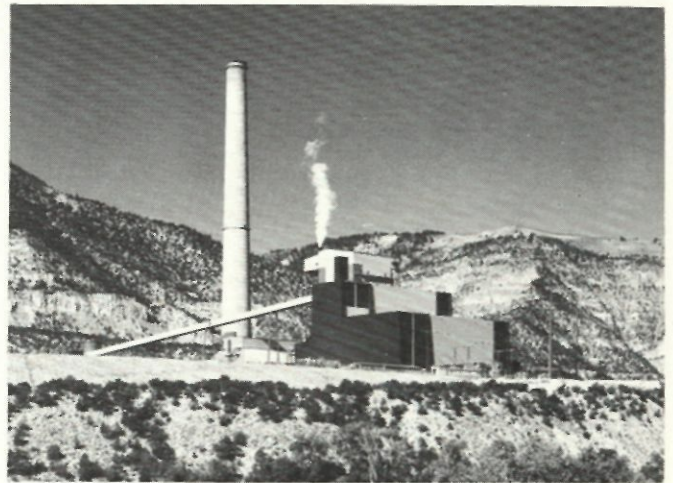
CAN THE RAILROADS SURVIVE?

America's most energy efficient
form of transportation

Stearns-Roger takes aim on facilities efficiencies and costs

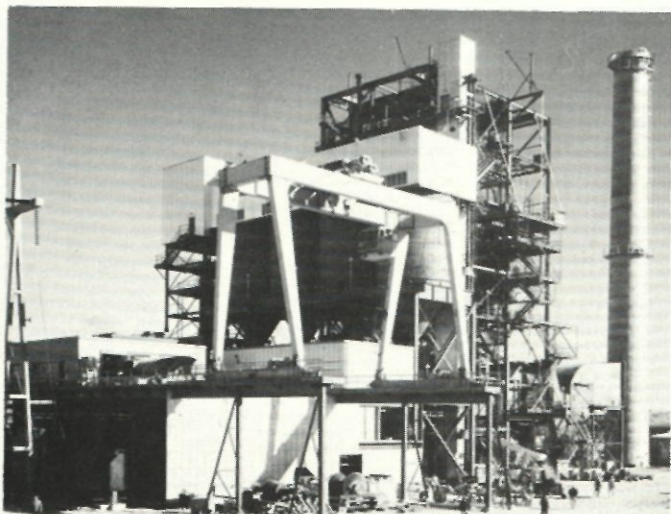


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COLORADO ENGINEER

college of engineering / university of colorado / member ecma / volume 77, number 3 / spring 1981

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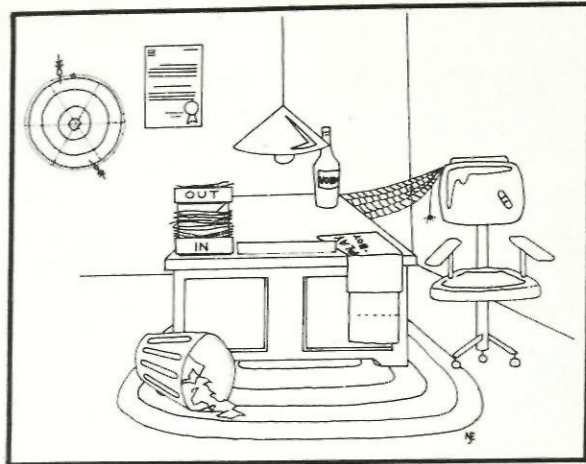


COVER

This month's cover features a Union Pacific freight train on the Colorado-Wyoming border. For more details see this month's article "Can the Railroads Survive?" Cover photo by Bruce Murphy.

The Editor's Outlook

Communication



Ready for another round of this? The topic today is communication. I don't mean the 400-level course in electrical engineering but communication between human beings.

One way to communicate an idea is graphically, with drawings and pictures. Most engineering students recognize this and do a good job of presenting a visual communication. Another one of the ways we must communicate is with standard written English. More than a few of us in the engineering school could use a little improvement here. Drawings cannot stand alone, and the English prose with which we accompany them is often a sorry mess. There is no need for a technical paper to be filled with long words and jargon, which serve only to make worse an already difficult task in communication.

In four (or five or six) years on this campus, it should be easy to learn the fundamentals of good English prose. Judging by the writing I see from other students, we don't all believe this. In some states (for example Georgia), students are required to prove by a special essay exam a certain minimum competency in English. This turns out to be the biggest obstacle between some engineers and their diplomas. It is too bad that some students feel written communication is secondary to engineering, when really it is an important integral part of it.

One way to make your writing better is to keep it short and simple. This is a concept most of us have heard many times, but it is an important one to remember. You don't need to write *Dick* *run* but long words and twisted sentences are to be avoided, especially when writing about a subject which is already difficult because of its technical nature. No one is impressed by your ability to obscure.

A reasonable amount of attention should also be paid to correct spelling and English syntax and grammar. There are numerous guides to help you with this. And those of us who find spelling easy have no sympathy for those who do not, but won't use their dictionary.

Engineers must also be able to communicate with non-engineers but often fail on this point. It takes extra work to present engineering ideas to a non-technical audience, work which some are unwilling to do. We can not be an isolated group who speak only among ourselves most of the time.

If you would like some practice on your communication skills, this magazine would be a good place to start. We are always looking for authors and other help, come by our office and talk to us about it.

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The Colorado Engineer is a member in good standing of the Engineering College Magazines Associated (ECMA). The current national chairperson of the ECMA is Ann Bitter (Director, Engineering Communications), 267 Mechanical Engineering Bldg, 1513 University Avenue, University of Wisconsin, Madison, Wisconsin 53706.

Subscription: Domestic: one year - \$5.00
Publisher Representative: Little-Murray-Barnhill, Inc., 1328 Broadway New York, New York 10001. Local ad rate card available upon request from the Business Office.

Entered as second class matter March 9, 1916 at the Post Office in Boulder.

POSTMASTER: Please send FORM 3579 to Colorado Engineering Magazine, Engineering Center OT1-7, University of Colorado, Boulder, Colorado 80309.

(COLORADO ENGINEER ISSN 0010-1538 USPS 122-960)

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NAVY OFFICERS GET RESPONSIBILITY FAST.

CAN THE RAILROADS SURVIVE?

Article and Photos by Bruce Murphy

Left on its current track, America's most fuel-efficient form of transportation may soon derail.



FIELD ENTERPRISES, INC. © 1980

Union Pacific 3507 Extra crept out of the Denver yard at 4:00 p.m. MDT. Behind it four other engines were helping to pull the 50 cars, each loaded with 90 tons of Kansas wheat. Ten hours and 683 miles later, 3507 Extra pulled into Rawlins, Wyoming, one quarter of the way to the west coast. This scene can be seen anywhere in the country, 365 days a year, rain or shine. The freight being shipped may vary, but they share a common bond: low-cost movement of goods by one of America's energy efficient industries, the railroads.

Never before has the issue of energy conservation been more important than today. For too long America has been foolishly wasting non-renewable fuels to satiate its desire to roam the asphalt snakes that wind along the rolling countryside from coast-to-coast.

Twenty five years ago, American industry embarked upon a course that now is seriously threatening to wipe out an entire transportation sector, *the railroads*. The improved development of the semi-trailor, has, over the years, taken away much of the prestige that the railroads once held.

Over a ten year period from 1967 to 1977, truck transportation increased by 41.5% per million cargo ton-miles. The railroads could

only muster a dismal 14.8% increase. During that same period, it was found that the number of existing and newly purchased trucks doubled, while existing freight cars and locomotives decreased by 16.5% and new purchases in 1977 were off nearly three to one over 1967 levels. What this suggests is that the railroads are losing out to the convenience of fast, easy transportation offered by the trucking industry. Accounting for only one-fifth of the total tons shipped each year, the trucking industry earned more money than any other cargo carrier for 1977, over \$67 billion. Surely this trend will have to change.

Increasing fuel prices and national concern for the environment and fuel conservation may force the nation's industry to rely more on the railroads to move their goods. In 1977 the trucking industry accounted for only 21.5% of all ton-miles, using over 38 billion gallons of diesel fuel. The railroads moved over 32.9% ton-miles and used a miserly 4 billion gallons of diesel fuel. Converting this into usable heat, the trucking industry consumed nearly 15,000 Btu's (British Thermal Unit) per mile, while the railroads used only 661 Btu's per mile. (The conversion factor is 138,700 Btu/gallon.) What all these numbers mean is the railroads were far better in managing their fuel consumption and fuel intensiveness, per ton-mile of freight moved.



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Clearly the railroads have been able to demonstrate their fuel efficiency. But why over the last 25 years have they declined so far? Who is to blame for the rapid decline that has left people wondering if they can survive the next 25 years? Most people would point their fingers at the Federal Government.

With good intentions in mind, Washington saw to it that the interstate trucking industry should be given a fair chance to operate alongside the railroads. At a time when fuel was cheap and the public hadn't heard of OPEC (Organization of Petroleum Exporting Countries) the government imposed restrictions on the railroads in the spirit of free enterprise. What this did was to limit the rates and expansion of the railroads to the point where they could not operate profitably.

During the late 1960's it became apparent

"... new purchases in 1977 were off nearly three to one over 1967 levels."

that the railroads were in deep trouble. With non-existent profits, many railroads went bankrupt. Still the federal government ignored their problems which now included deteriorating track (mainly on the east coast) and lack of capital to replace old freight cars. The government suggested that it was the railroad companies' fault for not maintaining their equipment and tracks. The railroads countered by saying that they had been over-regulated and that they didn't have the necessary capital to make major repairs because of their low rates and tariffs. The government finally stepped in with ConRail (Consolidated Rail Corporation) in 1974, but for many it was too late. In short the government, through ConRail, was to purchase the existing railroads in the east and lease them

back to the same companies to operate. In turn, the companies, with supervision from ConRail, would restructure the lines to the point that they would be profitable. This involved liquidation of many right-of-ways, real estate, and rolling stock. The money acquired through this process was to help bridge the gap of money loaned by the government for capital improvements. To date, this quasi-nationalization of the railroads has not been very effective. The money needed to make large capital improvements has not been fast in coming. As is customary with bureaucracy, things take time. Comprehensive studies and plans like the USRA (United States Railway Association) Final Plan and the NTPSC (National Transportation Policy Study Committee) Study of Policies through the year 2000, have taken many years to produce with little action forthcoming. There is talk of rate and tariff deregulation in both the rail and trucking industries. The net effect of this would again be the same: the trucking industry would win over the railroads with their faster service.

Perhaps our government should examine how the railroads of Europe have fared over the last 30 years. NTPSC has looked at that question. Europeans have always relied on railroads to provide transportation for their people and for the movement of goods. Long before the advent of semi-trailors, an excellent network of railways existed. After World War II, most countries spent more to rebuild their decimated railroads than they did for their highways. After the appearance of modern trucks in the late 1950's, many countries moved to support their railroads over the trucking industry. In most cases this was a reflection of viewing the auto as a symbol of luxury and wealth; something that very few people could afford. Today all European countries have nationalized their railroads, insuring continued existence. Many Common Market countries have permitted their railroads to compete competitively by giving them pricing freedom for rates and tariffs. This has led to a healthy

growth of the railroads in most countries. With an excellent railroad network, goods can often move faster by rail than by truck. Noting that no nationalized railroad has turned a profit since 1964, the NTPSC study found that:

- In all countries, the railroad was the "back bone" of the freight movement. Truck movements were constrained in support of the railroads. This has led to an efficient and economic use of scarce fuels.
- Heavy trucking has not been able to generate the necessary fee revenue to adequately maintain the highway network across most of Europe. This has led some countries, most notably Switzerland, to limit trucking to operate only during the week and not on weekends.
- Nationalization of the railroads wasn't always necessary to provide financial support. Constraining the competitors by

ConRail has not been as effective to date as was hoped

deregulation of the railroads and tax incentives for businesses were found to have the most impact on railroad growth.

- Finally the study found that even the most stringent actions could not stop the growth of the trucking industry. Many industries could not use the railroads because their locations made it impossible to utilize the services offered by railroads.

What can the federal government do during the next 25 years to save the ailing railroads?


It has been estimated that over the next 25 years, the railroads will need from \$116 to \$322 billion dollars just to replace and expand their equipment and facilities. The highways and trucking industry will need a combined total just short of \$1.5 trillion dollars to maintain their status quo. On top of that, fuel prices are expected to rise by 1% per

DIESEL FUEL CONSUMPTION IN 1977



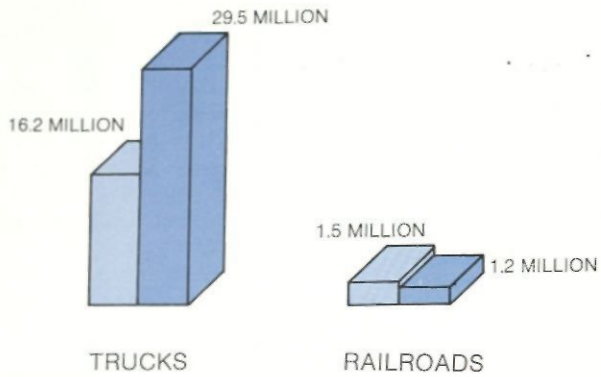
TRUCKS
38 BILLION

RAILROADS
4 BILLION

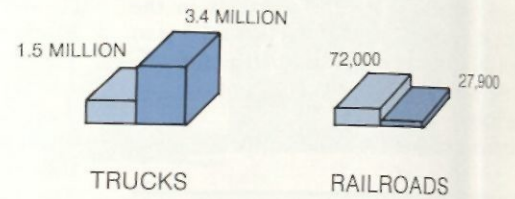
 = 5 BILLION GALLONS OF DIESEL

SOURCE: U.S. DEPT. OF TRANSPORTATION

NUMBER OF EXISTING VEHICLES



NUMBER OF PURCHASES

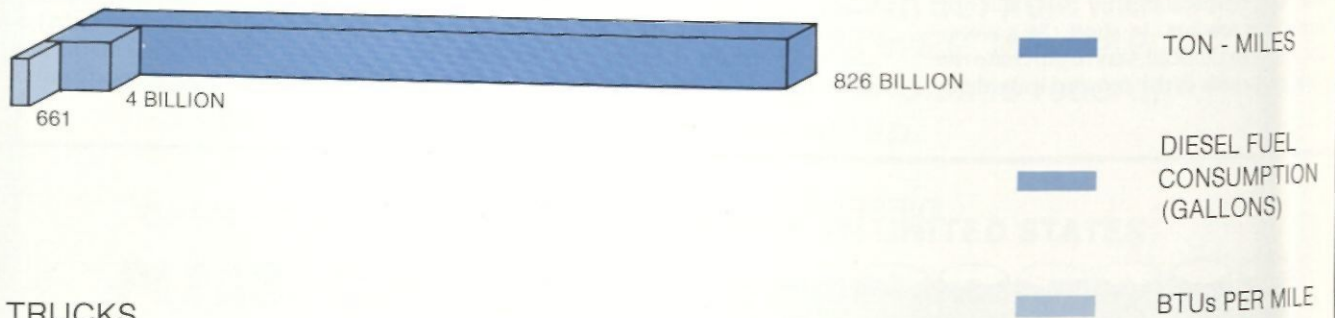


1967
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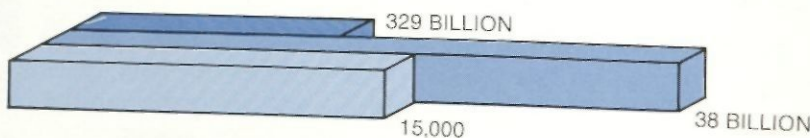
SOURCE: U.S. DEPT. OF TRANSPORTATION

TON-MILE/FUEL CONSUMPTION/BTUs PER MILE 1977

RAILROADS



TRUCKS



CONVERSION FACTOR IS
138,700 BTUs PER GALLON

SOURCE: U.S. DEPT. OF TRANSPORTATION



"Piggyback" trains have given coast-to-coast shippers an attractive alternative. They can deliver the trailer to the train on the east coast and remove the same trailer on the west coast. This saves the shipper both time and fuel when compared to interstate trucking.

year to 1985, and by 3% per year to the year 2000 for trucks. For the railroads, prices are expected to rise 5% per year to 1985, and decline to 4% per year to 2000. Clearly this indicates that money directed towards the railroads will have a greater rate of return than money directed towards the highways and trucking industry.

The government has responded to this with a \$2.1 billion dollar assistance package under the Railway Revitalization & Regulatory Act of 1976. Targeted primarily for ConRail, the assistance is a mere drop in the bucket. Perhaps the government should totally deregulate the railroads immediately while constraining the trucking industry as many European countries have already done.

"they can't spend 10 more years in committees . . ."

The implications are broad ranging. On one side, the labor unions would be screaming about lost jobs. The other side would be telling the country that they are saving many millions of gallons of fuel each year and that the air pollution levels are decreasing. Maybe the trucking industry should buy into the railroads and actively promote the use of "piggyback" trains.

The term "piggyback" refers to trains that transport semi-trailers on flat cars between major cities. Often these trains arrive faster than the trucks shipping identical goods, saving the customer many dollars in freight charges. Federal estimates have stated that if all restrictions were removed from this sort of operation, over 75 million gallons of fuel

"... they must start giving out blank checks immediately."

could be saved per year. While this would only save .4% of the total fuel consumption per year, it would have far reaching impacts. Air pollution and traffic congestion would be reduced. In addition over \$162 million dollars could be saved in shipping charges if more "piggyback" trains existed.

Another area in which railroads could be revitalized is through the efficient and increased use of computers. Better control and management of their freight cars could be achieved, thus saving money to be directed to capital improvements.

Overhead electrification of nearly 20,000 miles of eastern tracks could save the railroads anywhere from 1.5 to 2 billion gallons of fuel per year assuming that the electricity produced was from renewable resources.

In the end, everything that the government does will help the railroads. Unfortunately the government doesn't have much time left to make decisions affecting the railroads. They can't spend 10 more years in committees deciding on the best course to take. They have to step in and get their feet wet by giving out blank checks to get the railroads going again. Too much time has been spent talking about what needs to be done, but very little progress has been made to actually back up all those studies.

For too many years the American public ran around, as carefree as the wind, in their big expensive gas guzzling cars never knowing of \$1.50 gallons of gasoline or fuel shortages in Europe. We let the energy crisis creep up on us thinking that the fat cat oil compa-

nies were playing hide and seek with all the oil. Today we are paying the price for our frivolous ways. We are screaming at the government to help us save the precious fuel that runs our big expensive cars, to decrease and make the air pollution go away from our cities. In essence we are asking the government to take care of all the problems that we, the American people, have created.

At the turn of the switch we can kill a once giant industry, one that helped shape America, one that brought us into the age of the Iron Horse. It's time to think about saving something that is truly American, it's time that we save the *American Railroad!*

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- U.S. Department of Transportation, *National Transportation Statistics*, DOT-TSC-RSPA-79-15, 1979.
- National Transportation Policy Study Commission, *National Transportation Policies Through the year 2000*, 1979.
- United States Railway Association, *Final System Plan*, 1979.

Special thanks to the Union Pacific Railroad and Mr. Emmons for their permission to accompany a freight train to Rawlins, Wyoming last fall.

Bruce is currently finishing a semester that has taken him from the highs of the annual trek to Steamboat for a mid-semester skiing break to the lows of the gaming tables in Las Vegas.



Winter Consumer Electronics Show

By Kiyoshi Akima

A firsthand look at the latest and greatest in consumer electronics.

LAS VEGAS—The Winter Consumer Electronics Show, held every January, allows manufacturers of consumer-oriented electronics a forum for showcasing their new products. Companies ranging from AAL (Chicago, IL) to ZTI Ltd. (Brooklyn, N.Y.) and representatives from major distributors and retailers can get together and discuss business.

The big star of this year's show was the videodisc. Proponents of all three disc formats launched aggressive advertising and marketing campaigns. RCA has committed a record advertising budget to its campaign—more than it spent launching color television. RCA is planning to produce about 300,000 units this year. The other manufacturers are not being idle either. Hitachi, while making no secret of the fact that its format was developed by RCA, touted its unique features. Sanyo and Toshiba also stressed the features of their machines. However, videodisc is not expected to replace the video cassette recorder, just as tape has not replaced disc in the audio market.

A big controversy is brewing over stereo TV, or at least over the format. The supporters of different broadcasting systems are pushing the FCC (Federal Communications Commission) to adopt one system as the national standard. Stereo will allow bilingual broadcasts, with English on one channel and Spanish on the other, for example. Stereo TV is already being used in Japan.

Portable stereo, whether "Walkman," "Hipster," "Sportster," "Stereo-To-Go," or "Hip Pocket Stereo," is expected to sell well this year, according to a nationwide consensus of retailers. Small cassette players with light-weight headphones are ideal for outdoor activities ranging from jogging to

mountain climbing. Though most of the demand is for pre-recorded material, at least one manufacturer is offering an FM stereo tuner which fits into the tape compartment.

Another big item continues to be electronic games. Almost everything from backgammon to chess to football will be available in pocket-sized units. The various chess-playing computers are getting better. There are several models which will, through the use of a mechanical hand, actually pick up and move pieces on the board. The choices available in video games is also expanding. Atari, Magnavox (Odyssey) and Mattel (Intellivision) all have dungeon-type games as well as the popular "Space Invaders."

Computers are coming down in price. Commodore officially unveiled its VIC-20 computer, which retails for under \$300. APF, Sinclair, and Texas Instruments all lowered prices for their computers, while Radio Shack introduced a low-cost color computer. Radio Shack also announced it would phase out the original TRS-80 Model I.

A recent addition to the computer market is the Hand-Held Computer (HHC). They are units only slightly larger than a paperback book, weighing under a pound, but with much more power and versatility than a pocket calculator. Sharp, which also makes the TRS-80 Pocket Computer for Radio Shack, already has its model on the market. Matsushita (Panasonic and Quasar) plans to have its models on the market around mid-year. The HHC is small enough to be used in the field to collect data and run quick analyses, yet powerful enough, with peripherals, to take over many tasks currently handled by large, immobile mainframes. The available peripherals include printers, cassette tape adaptors, additional memory, color televisions, and phone modems, which will enable the HHC to be used as a smart terminal. And it runs on batteries! The color television interface is the only peripheral that requires AC power, but since the interface is also connected to a color TV, this is hardly a limitation. The heart of the Matsushita system is a 6502 processor (the same chip as used in the Apple computers).



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Toto, I have a feeling we're not in Kansas anymore.

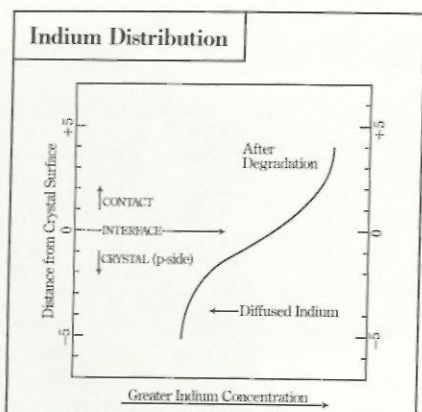
Or Colorado, for that matter.

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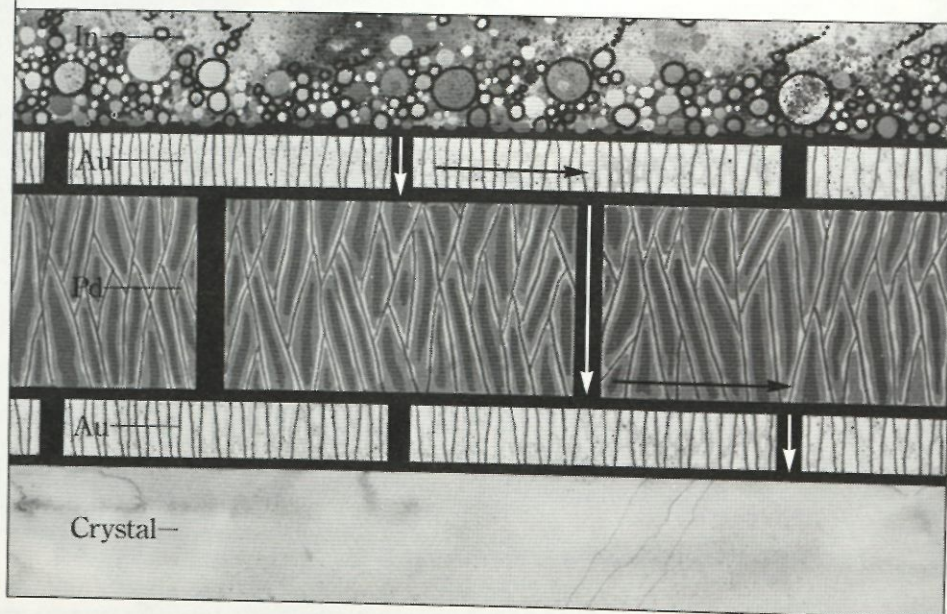
The Strategic Misalignment

Tunable semiconductor lasers can now measure specific gases in automotive exhaust with 25-millisecond response time. A successful strategy for improving laser reliability developed at the General Motors Research Laboratories makes this and other new spectroscopy capabilities practical realities.



Electron microprobe analysis of a crystal-contact interface, indicating indium penetration into the PbSnTe crystal.

Diagram of hypothetical indium diffusion paths for a three-layer contact structure of Au-Pd-Au.



THE ACHIEVEMENT of long lifetime and frequency stability makes the lead-tin-telluride diode laser a practical infrared spectrometer. Earlier innovations brought to this laser the characteristics of increased power, higher temperature operation, greater efficiency and wider tuning range.

Operating in the 5- to 10-micron range, the PbSnTe laser spectrometer can resolve the time-dependent emission of carbon monoxide, sulfuric acid vapor, methane and other species of interest in automotive exhaust. This permits measurement of transients in carbon monoxide to carbon dioxide gas conversion in a

catalytic converter. This capability represents a significant advance over conventional spectroscopy instrumentation. The laser is also being tested by NASA for use in detecting the molecular species involved in chemical reactions in the stratosphere.

New knowledge of the process by which laser reliability is compromised has been revealed in fundamental studies conducted by Dr. Wayne Lo and his colleagues at General Motors. Dr. Lo's investigations have demonstrated that laser lifetime and stability are limited by the development of excessive electrical contact resistance. He has been able to stop increases in resistance by devising a multilayer ohmic contact consisting of different metal films. This configuration has extended laser operating lifetime to more than 1,000 hours and increased shelf-life to an estimated 25 years.

Slow degradation due to a gradual increase in contact resistance was observed in idle lasers stored at room temperature, but not in lasers maintained at a maximum temperature of 77 K, despite several hundred hours of continuous operation. These results suggested the temperature-dependent process of diffusion.

Degradation occurred primarily on the p-type side of the laser, where the contact consisted of a thin layer of gold followed by a

layer of indium. Electron microprobe analyses revealed that indium, a semiconductor donor, was diffusing through the gold layer into the crystal, apparently causing a reduction in hole carrier concentration near the p-surface. This effect was counteracted to a great degree by sandwiching a thin layer of platinum between the layers of indium and gold. Laser reliability reached a full year.

When degradation was still observed, although to a reduced extent, Dr. Lo advanced the hypothesis that diffusion and transport were taking place along grain boundaries in the polycrystalline contact layers. He proposed replacing the Pt-Au barrier with a three-layer structure. Since palladium film structures have fewer grain boundaries than those of platinum, providing fewer leakage paths for the indium, Pd was tested in place of Pt.

DIODE LASERS composed of $Pb_{0.86}Sn_{0.14}Te$ and fabricated with a variety of contacts were maintained at 60°C in order to accelerate aging, with periodic interruptions for testing. The results showed that a multilayer structure of In-Au-Pd-Au, in which the grain boundaries tend to be misaligned, provides maximal reduction of indium penetration, confirming Dr. Lo's hypothesis.

The misaligned boundaries force diffusion to take place laterally, which slows transport into the crystal. The additional layer slows the process even further.

Solving the contact problem represents the culmination of efforts that began at General Motors with the development of an "ingot-nucleation" vapor transport method for growing crystals. The resulting crystals are of high purity, with a dislocation density of less than 1000 cm^{-2} . Lasers made from these crystals incorporate a low temperature cadmium-diffused p-n junction. This process, invented by Dr. Lo, increases the laser's output to five milliwatts.

A tuning range of 500 cm^{-1} and pulsed operating temperatures of up to 140 K are achieved by a two-step annealing process. This technique induces a graded carrier concentration that increases infrared light confinement in the laser structure, thus reducing losses and increasing output.

"These innovations," says Dr. Lo, "combine to produce a laser that allows us to make measurements previously impossible."

THE MAN BEHIND THE WORK

Dr. Wayne Lo is a Senior Research Scientist in the Physics Department at the General Motors Research Laboratories.

Dr. Lo was born in Hupei, China. He did his undergraduate work at Cheng-Kung University in Taiwan. He received an M.S. from the University of Rhode Island and a Ph. D. in electrical engineering from Columbia University in 1972. His doctoral thesis concerned the characterization of deep-level states and carrier lifetimes in gallium arsenide light-emitting diodes.

Before undertaking graduate studies, Dr. Lo was instrumental in setting up the first American transistor production plant in Taiwan. In 1973, he joined General Motors, where he is currently in charge of semiconductor laser and spectroscopy research.



General Motors

People building transportation to serve people

Death of a Phycomyces

A look at the aging process of Sporangiohores

by R. Igor Gamow and Ellice Goldberg

*I grow old, I grow old
I shall wear the bottoms
of my trousers rolled. . . .
T. S. Eliot*

Rolled trousers and balding heads are all results of aging but not the cause. Although we are all aware of the results of aging the causes of this universal phenomenon is as much a mystery today as it was in the days of Ponce de Leon as he searched for the Fountain of Youth.

The sperm and the egg unite and with conception the growth and the entire pattern of life begin. But for each and every organism there comes a point in development in which this pattern of life previously generated begins to wane and the aging process slowly begins. In terms of developmental biology the initiation of aging finally culminating in death is as natural a process as is the union of the egg with the sperm.

How does one scientifically study the cause of aging? Aging can be defined to be a decrease in function as a function of time. In man a loss of strength, a loss of memory, and the loss of agility are all examples of functional loss.

The giant aerial sporangiophore of the fungus *Phycomyces blakesleeanus* has been

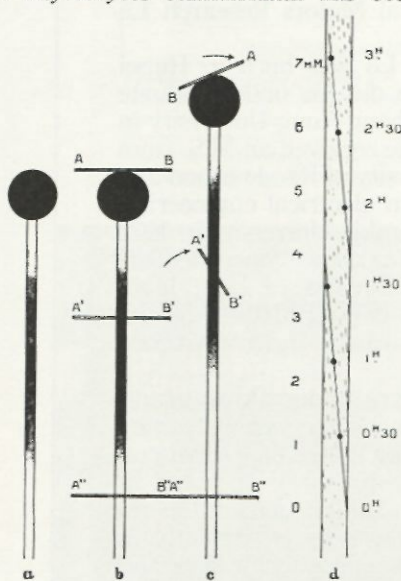


Fig. 1. Schematic representation of spiral growth. a. Sporangiophore with zone of growth; b. with needles above, in and below the zone of growth; c. the same sporangiophore some time after; d. the path of a point above the zone of growth.

extensively studied for the past one hundred years by sensory physiologists. The appeal of the system is that this large single cell exhibits a wide variety of well-defined responses as a result of a host of different stimuli: it responds in a graded manner to both unilateral and uniform light stimuli, to gravity, to touch, and lastly, to physical barriers located in the vicinity of the sporangiophore. The entire life span of the sporangiophore is in the order of 30 hours, and during this life span, it undergoes, even in the absence of a stimulus, a variety of well defined behavioral changes. The changes are in terms of rate of growth, length of the growing zone, and the direction of spiral growth. Except for one early report, no attempt has been made to correlate these changes with the onset of senescence. Because of the extensive knowledge accumulated about the system during the past 100 years and our many years of experience working with this particular system, our Chemical Engineering laboratory is well suited to initiate aging studies using *Phycomyces*. Our goal will be to delineate which functions of behavior change as a result of age and whether these functions can be restored by changing such factors as the light program, the temperature, the humidity, and finally, by the addition of known chemical inhibitors and stimulators. During the past ten years a large number of behavioral and nutritional mutants have been isolated, and we will attempt to correlate how the measured changes in function in the wild type correlate in time with the changes in function in the mutants. If we do find a

specific mutant(s) that ages differently from the wild type and if these changes can be modified, we can then attempt to distinguish between the cause and the result of aging.

The first person to study both spiral growth and aging in *Phycomyces* was A.J.P. Oort of the Netherlands. Figure 1 and Fig. 2 are taken directly from his classic 1931 paper.

One of the authors (E.G.) last year attempted to repeat Dr. Oort's original experiment, i.e., does the *Phycomyces* sporangiophore reverse direction of rotation just before death (Fig. 2). The number of degrees the sporangiophore rotates during growth can be measured by placing a marker (a thin glass thread) on the head of the sporangiophore and timing the rate of rotation as the sporangiophore ages. After a great deal of "fussing" one of us (E.G.) did verify the original 1931 finding—just before death a reversal of growth does occur. This an important finding since the original results of Oort, although published has not found its way into the modern literature.

Future plans for the laboratory include experiments that will try to uncover other behavioral changes that occur during aging, correlation of such changes may lead to the final unraveling of the results of aging from the causes of aging. Can aging be studied? The answer to this question is yes and we have described just one of many possible methods.

Ellice is currently finishing up her last semester as an undergraduate in Chemical Engineering. She plans to attend medical school this fall.

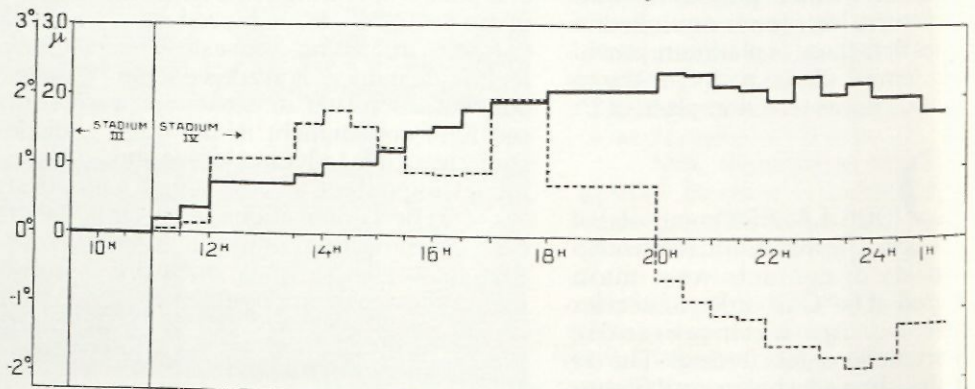


Fig. 2. Rotation and growth in length during the greater part of stages 3 and 4.

Abscis: time in hours. Observations were made at points of time marked |.
Ordinate: - - - - - Rotation in degrees per min. Left-handed rotation negative.
————— Growth in μ per min.

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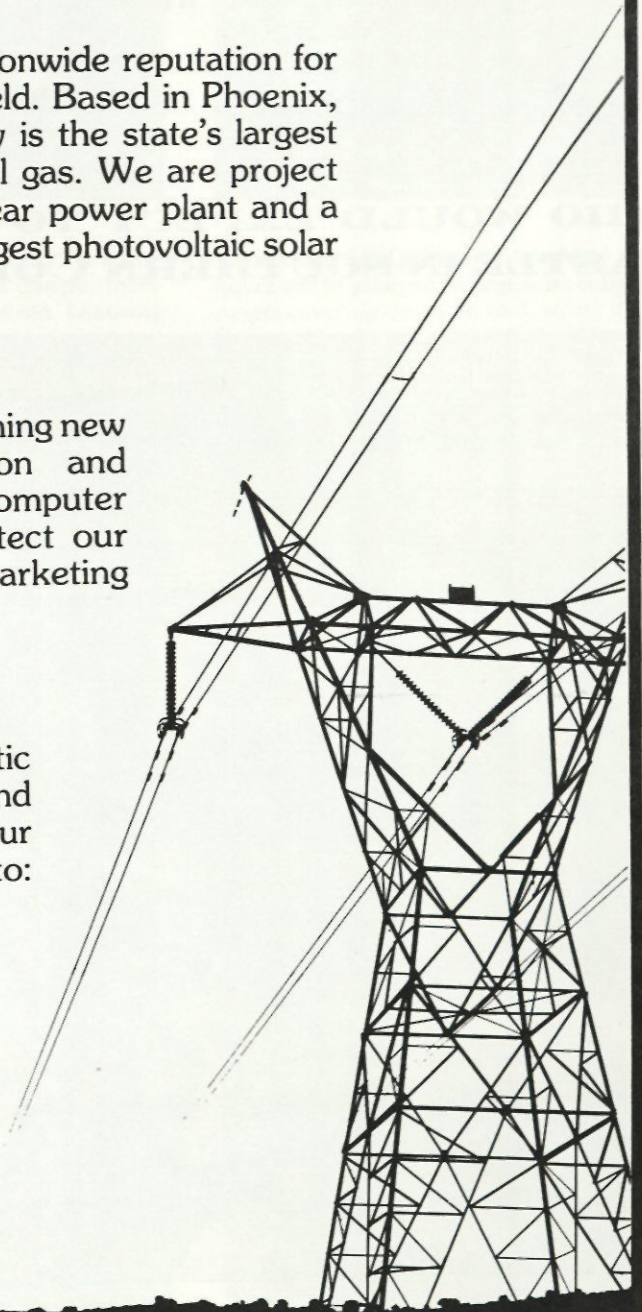
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OF BISHOPS AND KINGS

BY NICKI POLIAC AND KELLY LIPP

PHOTOGRAPHY BY KELLY LIPP

WHO WOULD EXPECT TO STUMBLE UPON A MEDIEVAL CASTLE IN SOUTHERN COLORADO?

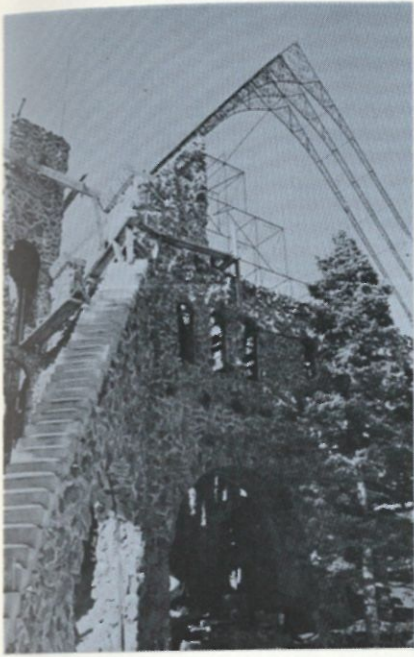


You don't have to travel to England or the Rhine River to catch a glimpse of a Medieval castle. There is one being built right here in Colorado.

On a few acres of land in the Wet Mountains, West of Pueblo, Colorado, the Bishops began their interesting land improvement project. The entire design rests in the minds of the father and son; there are no blueprints. After twelve years of hard work, the dream is beginning to take the shape you see here. The Bishops estimate completion will take 15 more years. Oh well, Rome wasn't built in a day, either.

So far, some 7000 tons of rock, wood, cement, and iron have been laid in place, all by hand. The rock and timber is brought from the surrounding mountains. The timber is cut at one of two sawmills operated by the Bishops. The iron work is done at their ornamental iron shop in Pueblo. Many talents are displayed in this project: iron worker, bricklayer, carpenter, engineer and many others. Come with us on a tour of this fascinating project.

The tower on the left will soar to a height of 100 feet and will be topped by a 30 foot flagpole displaying the American flag. The tower will house an elevator operated by a network of pulleys and weights, as there is no electricity on the mountain. The arched slits in the tower will be covered with handmade stained glass and the tower will be supported by three buttresses, one on the left and two behind.



Venturing through the breezeway and through the front doorway, one feels he is on a journey to yesterday. The doorway will be filled by a hand carved wooden door that will weigh more than a ton. The Bishops promise to have an "ugly knocker" to match the castle. Once inside, one is greeted by the sight of a tower shaped fireplace right in the



middle of the "torture" room. On the walls, strange chains and manacles dangle, relics from the torture chambers of old. Glancing upward, a myriad of timbers are seen crisscrossing the floors above. At the back of the room, a spiral staircase ascends to the upper levels.

The staircase encircles a large tank which



will contain 2400 gallons of diesel fuel. This liquid will be pumped to large solar collector panels covering the south roof, where it will be heated by the sun. Diesel fuel will be used since it won't corrode the pipes that it is pumped through and it won't freeze during the subzero winters. The heated fuel will be pumped throughout the castle and radiated,



Trevor Byer's software takes a hard look at telephone traffic.

As a result, calls flow more smoothly through the nationwide network.

Shortly after Trevor Byer came to Bell Labs in 1976, we asked him to join a design team tackling a big job. Their task: find a way to determine the accuracy, completeness and timeliness of the hundreds of millions of traffic measurements collected weekly in the Bell System. The job was important because engineers and managers at each Bell telephone company use the measurements to assure that enough equipment and circuits are available to meet customer demands.

The solution that Trevor Byer's team came up with was the Centralized System for Analysis and Reporting, or CSAR. Trevor focused on determining how

much information telephone company managers needed, and how that information could best be reported to them. His responsibilities ranged from software design and systems engineering to field testing of reports and training of CSAR users. With a BS and MS in Electrical Engineering from the University of Illinois, Trevor was prepared for the job.

Here's how CSAR works. Once a week all the Bell telephone companies transmit performance data from their computers to a central computer in Piscataway, N. J. Overnight, CSAR analyzes the information, organizes it for use in many ways, including management reports designed by Trevor, and stores it for retrieval the next day.

From their own computer

terminals, CSAR users in the telephone companies request a variety of reports: from summaries of switching system performance for an entire company to detailed performance of individual switching systems. The reports can be displayed graphically to summarize performance trends over weeks, months, or longer.

CSAR is one of more than a hundred computer-based systems used by the Bell System to provide better network performance and better service to customers.

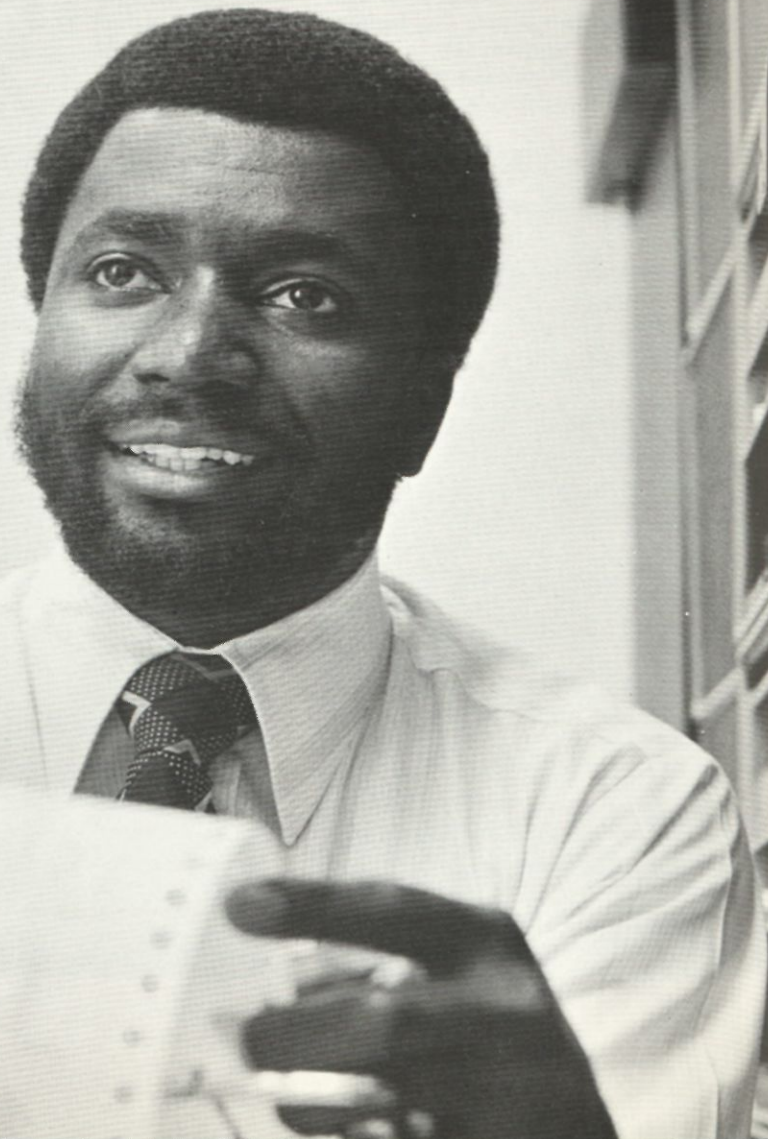
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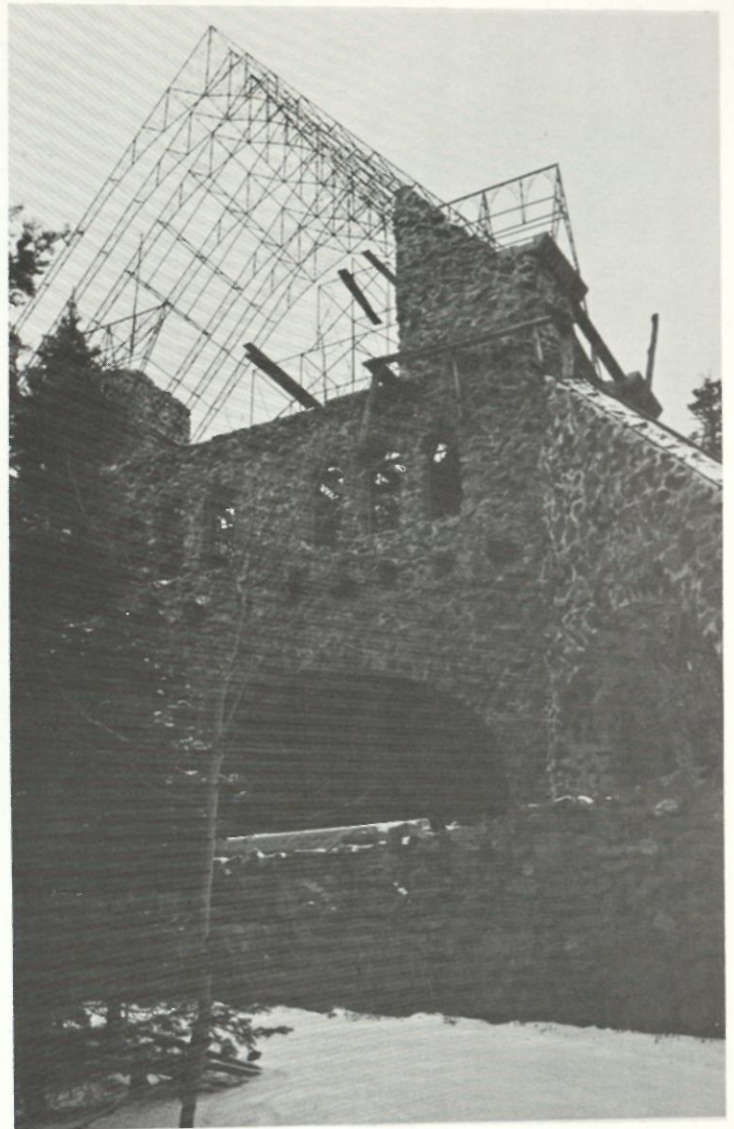
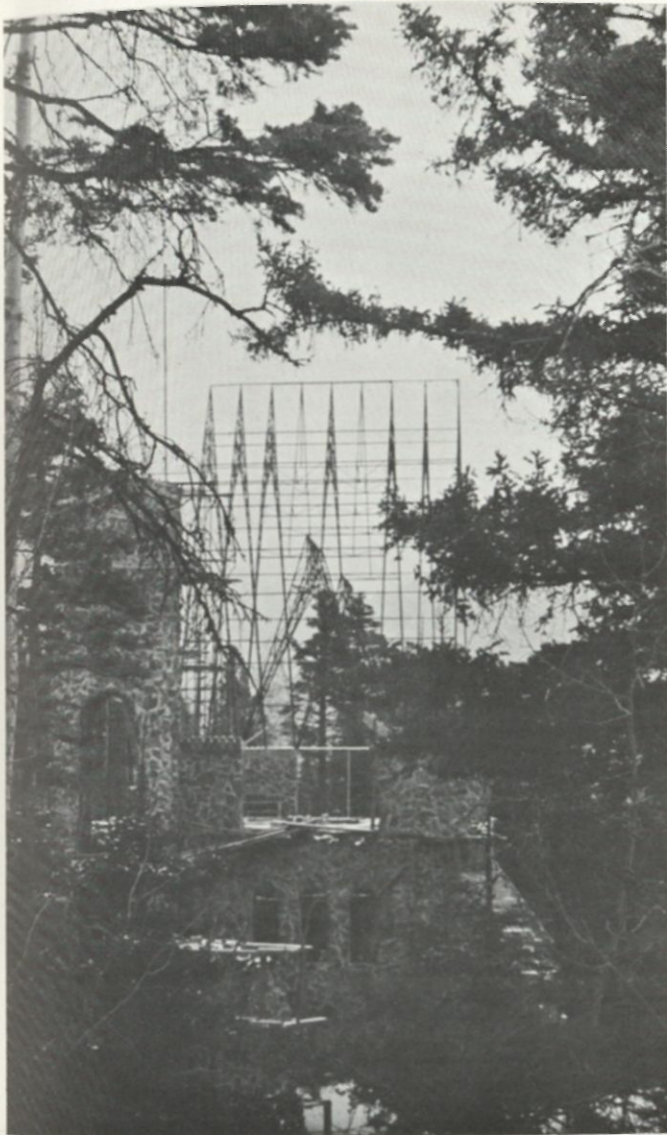
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From Science: Service





to heat this huge building. Six fireplaces, aside from the one on the first floor, will also aid in heating.

Climbing to the second level, you begin to get an idea of what the inside might look like in the future. It will be rough finished, like the castles you see in pictures, and will have low arches and a hardwood floor. This second floor will primarily be a museum.

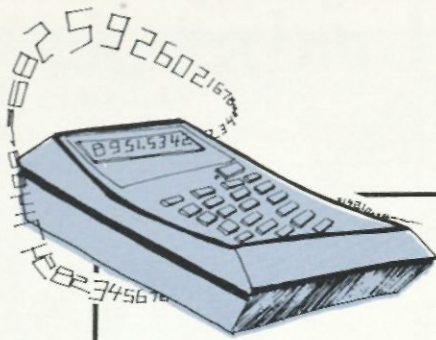
The third floor will be used for weddings, parties, and other large gatherings. The high ceiling will enclose a beautiful pipe organ obtained from the Sacred Heart Church of Boulder. After bits and pieces have been added to it, it will be displayed at one end of the cavernous third floor. At the other end, an old stained glass window, donated by a church (name unknown), will be placed. The window behind the organ will be designed and built by the Bishops, using recycled glass and iron.

Despite the fact that there are no floor plans or any type of documentation on this beautiful sight, it is the most perfect demonstration of skill and engineering. If you take time to notice the very fine details of the castle, you would notice that every wall is perfectly vertical, every corner is perfectly square, and most important of all, everything fits right into place. Once the Bishops finish the castle itself, they plan to construct a 6 foot wall enclosing the entire lot.

If you are ever in the vicinity, you cannot pass up the opportunity to see the Bishop Family Castle.

Believe it or not but Nicki is still in Engineering. Here she is pictured sitting on the thin steps of the castle with the father of the Bishop family. Nicki still has interests in skating, backpacking, and lots of fun things that have to do with the outdoors.





CALCULATOR UPDATE

By Kiyoshi Akima

What's new under the sun?

Most of the advances in calculator design unveiled at the Winter Consumer Electronics Show were not technological, but cosmetic. The manufacturers have recognized the large women's market and are making efforts to reach it.

The addition of cosmetic features such as bright coloring, pendant chains and other jewelry-type extras has increased demand for calculators. But Jack Wolbrink, marketing manager of Texas Instrument's professional calculator division, believes luring women buyers does not depend on high fashion appeal alone. "If women use calculators in school, home and office, then they're seeking the same functions as men—quality and performance features. Catering to a women's market may, at most, involve slimmer styling so that the items can fit into a purse."

Feminine fashion appeal will be emphasized heavily by Panasonic this year, according to Tom Nugent, national sales manager. They introduced a new line of woman-oriented handheld models at the

show. Nugent believes slim styling and cosmetic appeal are important to women, but also that the calculators are bought mostly by men for their spouses and girlfriends' birthdays, graduations, and for Christmas.

Sanyo is going in for "pure fashion and color" for its product line, according to national sales manager Martin Gerber. Silver and gold plated finishes will figure heavily in the new units. "We're aiming at achieving that total jewelry look," says Gerber. "We anticipate strong sales of gift items for this year for both sexes."

At the extreme end, Pierre Cardin is offering a designer calculator to catch the ladies' eye. It will be 14-karat gold and go for \$7,500.

One of the major technological innovations uncovered at the show is the solar cell. It's tough to use a calculator in the dark, a fact that manufacturers of solar-powered calculators are stressing in their pitch for an old product seemingly come of age.

Once considered as a novelty, solar calculators are growing in appeal. A combination of improved solar cell technology and rising battery prices has suppliers promoting solar as the next great calculator technology. The increasing awareness of the need for energy conservation doesn't hurt, either.

Proponents say not even a passing cloud is going to turn out the lights on the latest generation of solar calculators, some of which can even function with as little light as provided by a single candle.

Hewlett-Packard has made some additions to their already impressive HP-41C system. The HP-41CV is a basic HP-41C with the equivalent of four memory modules built in. This allows the user to have full memory and still have all four interface ports free. The CV also features a redesigned keyboard for improved legibility. For those who already have a '41C, HP has available a Quad Memory Module, which will give the user the equivalent of a CV with three free ports.

HP is also stressing the "system" approach for the HP-41C with two additional items. The HP-41 System I contains a 41CV and a Card Reader, while the System II will also include a printer/plotter. Both the System I and System II include substantial savings in price over the individual components purchased separately.

Rumblings were heard from Texas Instruments about their new top-of-the-line calculators, but nothing concrete was revealed.

Both Panasonic and Quasar showed prototypes of their Hand-Held Computers. They are expected to be available about mid-year. For more details, see the WCES report elsewhere in this issue.

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News News

HAND ME THAT VACUUM TUBE

Faculty shortages and equipment obsolescence—the two biggest problems facing engineering schools across the country—ranked as a major topic of discussion at the American Defense Preparedness Association's (ADPA) Engineering-Scientific Personnel Meeting, held in Arlington, Virginia, December 10-11, 1981.

Also during the meeting, American Society for Engineering Education (ASEE) President Vincent S. Haneman, Jr., received a plaque from Gen. Henry A. Miley, Jr., ADPA president, for "outstanding contributions to engineering-scientific personnel."

The meeting, co-sponsored by ASEE and the National Society of Professional Engineers (NSPE), was called to examine a perceived shortage of engineers and scientists during the next 20 years and what effect the shortage will have on national defense.

Members from academia described the bleak and growing problems of faculty attrition and faculty obsolescence, combined with an unprecedented surge in the number of young men and women entering engineering schools.

"The engineering schools cannot now obtain sufficient faculty to continue enrollments at their present levels," says Haneman, dean of engineering at the University of Alaska. "The present estimated shortage of faculty exceeds 2,000 persons. Most engineering schools now limit enrollments and several have reduced capacity for the future."

A lack of "up-to-date" equipment in engineering school laboratories is hurting the quality of their programs, Haneman adds. One study says the average age of engineering lab equipment exceeds 14 years. Taken in the light of the rapid development of new technology—which doubles every five years—engineering students may as well work with stone tools.

Given this situation, the ADPA conference-goers readily saw the impact the problems of engineering education will have on national recruiting for the future. While such major defense manufacturers as Lockheed, Rockwell and General Electric do not presently feel a personnel pinch, they most likely will in the near future. "The capability of the United States to produce viable products in both defense and civilian markets will be eroded. Lead times to expand enrollments is on the order of eight to ten years; so even if corrective action begins immediately, most industries will feel the personnel pinch soon," Haneman says.

The military faces its own special problems in recruitment and retention. They find it increasingly difficult not only to recruit uniformed personnel but also civilian workers. In addition, the vast difference in salary an engineer in the armed forces receives and what private industry is willing to pay, makes retention of trained personnel difficult.



THANKS MA BELL

DENVER, COLORADO, March 1981—The University of Colorado College of Engineering and Applied Science has received a \$53,000 gift from Bell Telephone Laboratories.

The gift represents a matching tuition payment for employees enrolled in the company's Graduate Study Program at the University, and a \$10,000 check for the University Computer Center.

Dr. Arnold Weber, CU president accepted the gift from M. A. Flavin, executive director of the Denver Laboratory, at a luncheon March 17 at the Denver Laboratory.

There are 32 employees studying for a master's degree at CU this year in computer science, electrical engineering, and mechanical engineering.

At the luncheon, in addition to Flavin and Weber, were Frank Barnes, acting dean of engineering; Paul Zeiger, chairman, Computer Science Department; Robert Christopher, chairman, Mechanical Engineering Department; and BTL directors T. M. Quinn and W. T. O'Shea.

WOMAN ENGINEER DESIGNS PERSON-HOLE COVER

You may have to look closely to notice the differences, but new and lighter Bell Labs-designed manhole covers are gradually appearing in streets across the country.

Not only is this the first major redesigning of the standard telephone company cover in 52 years, but it also marks a first in the field—the manhole cover's designer is a woman.

Mildred Paret, a member of technical staff at Bell Labs in Whippany, N.J. and the first woman civil engineering graduate of Cooper Union in New York City, is responsible for the updated design.

"There were three reasons for the new design," Paret noted. "We wanted to design a cover that was lighter in weight, especially with more women entering telephone company craft positions.

"We also wanted to increase security and provide a drier environment within the manhole to protect cables and other telephone equipment housed beneath city streets."

The new cover is indeed lighter, weighing about 250 pounds, compared to the 315

pounds for the old cover. "It has a tapered solid underside, which reduces its weight, but has additional material at stress points, which gives the cover an added feature—more strength. Under test conditions, the old cover withstood loads of up to 60,000 pounds but the new cover will withstand loads of up to 80,000 pounds. These test loads were applied to the cover to simulate the contact area of a motor vehicle wheel," Paret noted.

The design also eliminates the bolts craftspeople had to replace in the field. Now there is a locking bolt mechanism that permits the cover to be replaced in any position



and the bolt assembly rotated to lock it in place. And, to prevent water damage, a special gasket, which fits snugly around the cover, is used.

But perhaps the most easily noticed difference is the new Bell System logo that graces each cover and provides quick identification of Bell System manholes for telephone company work crews.

Paret admits civil engineering is still not considered a traditional field for women, and yet the number of women entering the field is rising.

"In 1948, when I entered the field, I didn't know women were not supposed to be engi-

neers. What I did know was that I should be independent and self-sufficient," Paret said. "Only in the last several years, as the women's movement has grown, have I begun to realize just how independent I was, back then, in taking a chance in this area."

Paret worked for 10 years as a civil engineer before leaving to start a family. She credits Bell Labs with giving her encouragement and help when she decided to reenter the field in 1968.

"Bell Labs agreed to hire me on a part-time basis, so I still had time to be with my children as they were growing. Gradually I began working on a full-time basis," Paret said.

"Also, by 1968, when I reentered the engineering world, the technology had changed drastically. I was given the opportunity by Bell Labs to catch up with new technology by participating in several education programs. Bell Labs also assisted me in getting my master's degree at Fairleigh Dickinson University."

Paret recommends civil engineering as a career for women to consider. "This field is terrific for women. But here, as in all fields, the important thing for women to remember is to set goals and make everyone aware of what their goals are."

Paret believes the increasing number of women choosing engineering as a career is solving some of the problems she faced early in her own.

"When I entered the field and until just a few years ago, I was one of the few women in my area. There were several professional problems facing women within the field, such as: limited advancement possibilities; lack of field assignments; few women peers to relate to, and a lot of work performance comparisons made between female and male engineers," Paret noted.

"Now as more women are becoming engineers they are relating to women peers. The competition with male colleagues is still there, but it is not a big problem because

there is much more communication between men and women."

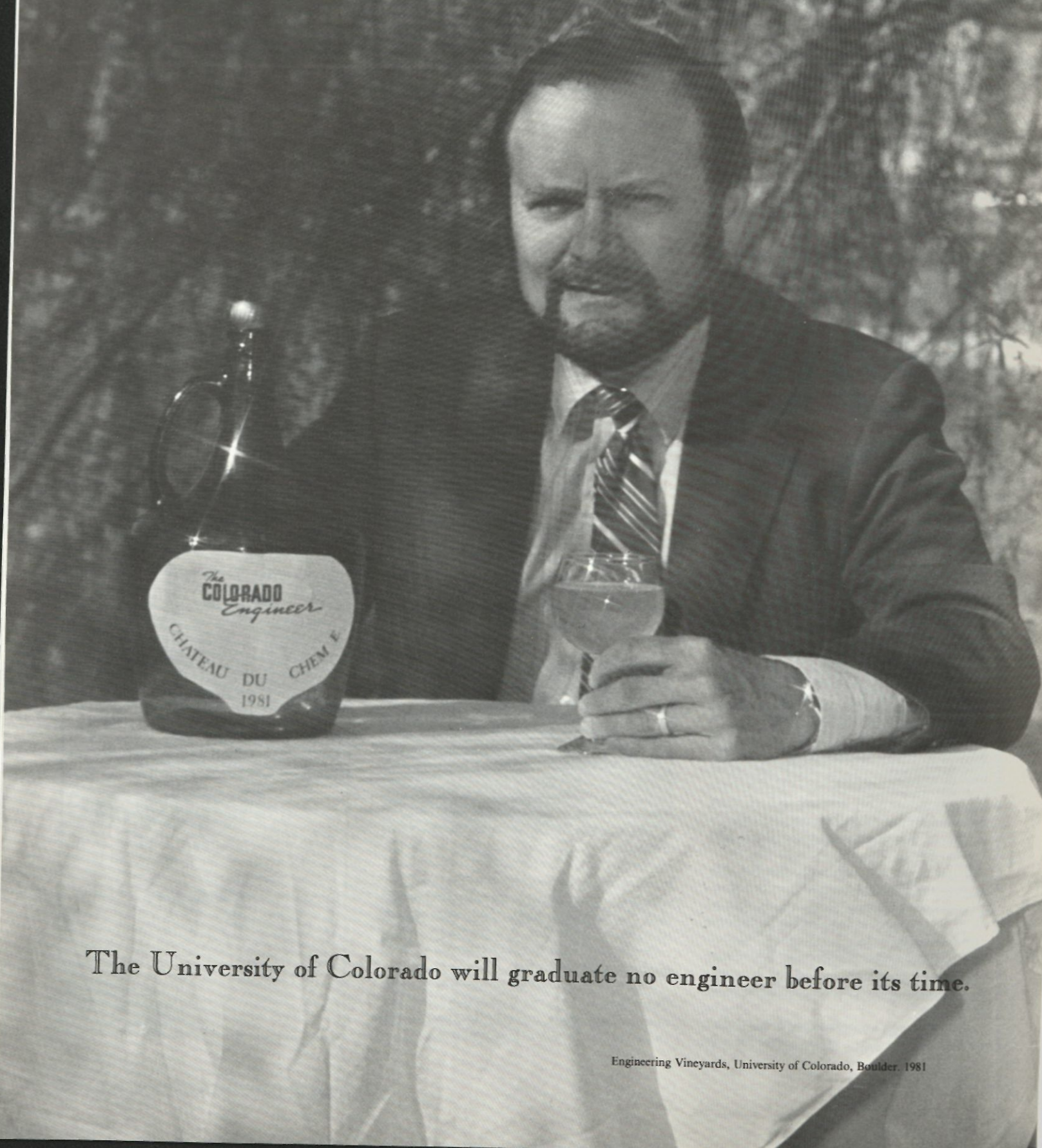
Paret's new manhole cover design is already in use in Illinois and Indiana. Western Electric, the manufacturing unit of the Bell System, will shortly be furnishing the new design to Bell Telephone Operating Companies in Florida and Tennessee. Eventually, the new design will be introduced throughout the country. The cover will be used in new construction areas and will replace the old covers as the need arises.

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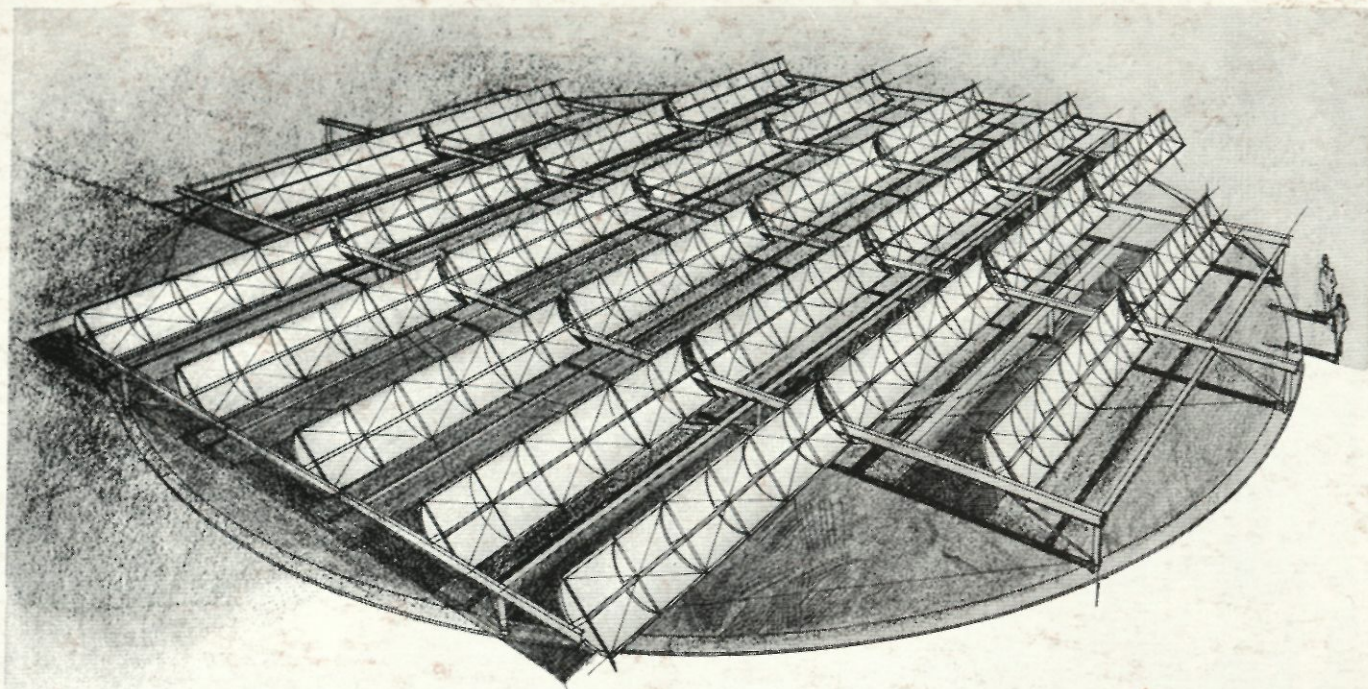
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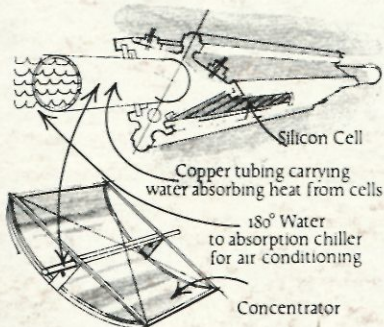


8 years ago, we designed turntables to track records. Today, we're designing turntables to track the sun.

What you're looking at is a turntable that measures 146 feet in diameter — a turntable programmed by computer to track the sun's azimuth while concentrators track the sun's elevation. Nine of these turntables are being designed to power marine-mammal life-support systems at Sea World in Florida.

The photovoltaic concentrator system uses high-intensity silicon solar cells to convert sunlight

SOLAR CELL RECEIVER ASSEMBLY



into electric power and is under study by General Electric for the U.S. Department of Energy. Parabolic troughs on each turntable are formed of aluminum sheets covered by a reflective film laminate. They are angled to concentrate energy

on a focal line of solar cells. DC power generated by the photovoltaic cells will be converted to AC power providing up to 300 kw of peak electricity—enough power to service about 40 average homes.

Water circulated through copper coolant piping in the solar cell assembly and carried to absorption chillers would be used to air-condition a

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