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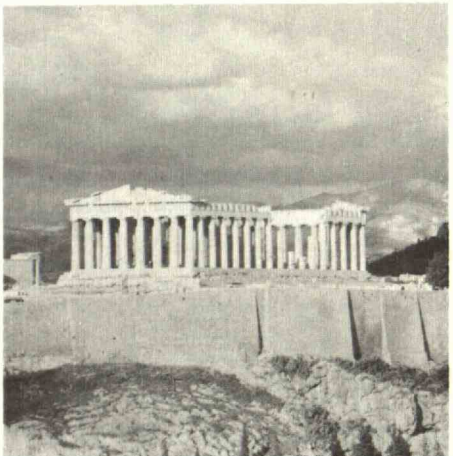

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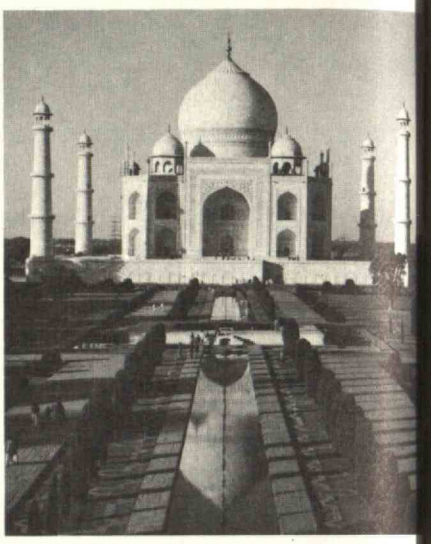

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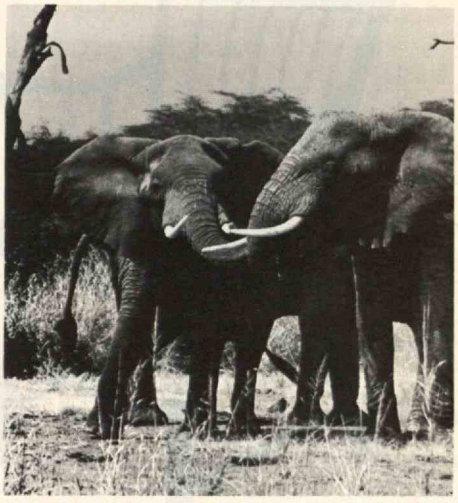

PARK; the spectacular masses of pink flamingos at LAKE NAKURU; black-maned lions and multitudes of plains game in MASAI-MARA RESERVE; the vast stretches of the SERENGETI PLAINS, with leopard, cheetah and large prides of lions, as well as great herds of zebra, wildebeest, and impala; the permanent concentrations of wildlife on the floor of the NGORONGORO CRATER; tree-climbing lions and herds of elephant along the shores of LAKE MANYARA; and the beaches and tropical splendor of historic MOMBASA on the Indian Ocean, with its colorful old Arab quarter and great 16th century Portuguese fort, and with optional excursions to LAMU or ZANZIBAR. The program also includes a visit to the famous excavations at OLDUVAI GORGE and special opportunities to see tribal dancing and the way of life of the Kikuyu and Masai tribes, as well as the great safari capital of NAIROBI. Optional post-tour extensions are also available to ETHIOPIA and the VICTORIA FALLS. Total cost is $2100 from New York. Departures in January, February, March, May, June, July, August, September, October, November and December 1975.

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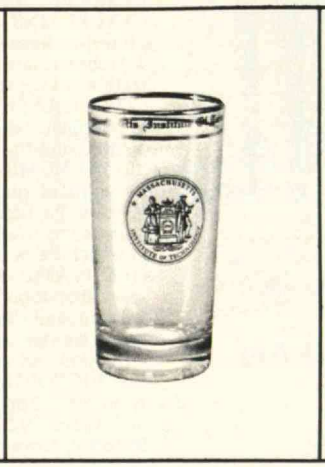

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Volume 77, Number 7
June, 1975

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Letters

The Trap of Sensationalism?

Dr. Cohn's article (*"Improved Fuel Economy for Automobiles," February, pp. 44-53*) impressed me as being exceptionally well researched, a comprehensive dissertation on the many available strategies for improving fuel economy. But instead of concluding in the same vein, Dr. Cohn fell into the trap of uninformed sensationalism.

His contemptuous statement, "Car buyers commonly select overpowered cars for irrational motives . . ." was undocumented, and "overpowered" was not properly defined. Most car buyers, technically unsophisticated, have more criteria than simplistic "economy." Frequently rational (though differing from Dr. Cohn), their reasons include appearance, upholstery, towing trailers and boats, accelerating into freeway traffic, mountainous driving, safe passing, good trade-in, and the greater safety they intuitively (and correctly) expect in large heavy "overpowered" cars.

Curiously Dr. Cohn confuses the horsepower required "to break speed limits" with vehicle horsepower requirements. Like designing a bridge to support the *average* traffic load! Volkwagen originally advertised "enough horsepower to break all speed limits!" — then increased its horsepower every succeeding year!

The 1951 Lincoln he lauded was unethically equipped with overdrive, invalidating his slur on engineering. The "377 m.p.g." achieved by Shell resulted from unacceptable constraints including much engine-off coasting. Saying that stylists turn cars into "symbolic penises" is like saying that typewriters have phallic-like platens sliding back and forth, to enchant women into tedious typing careers.

He wants *someone* to invest millions in a car with complete disregard of . . . appearance" (Saab? Citroen?). Yet I'm sure he wears neckties, has pictures on his walls, and a lawn around his house — all functionless wastes of materials and energy, proof of Simon's Second Law: "Nothing is so clear as someone else's duty."

Lewis B. Simon
Oxnard, Calif.

Dr. Cohn responds:

A car is overpowered when it has more power than is needed for the type of driving being done. Recall when almost all cars, even full-sized ones, were available with six-cylinder engines. These could break every speed limit in the country and were perfectly satisfactory for all normal driving, with the negligible sacrifice of having to forego some marginal passing maneuvers. Mr. Simon confuses my remarks on size and power. Perhaps he missed my suggestion (*p. 45*) that technological improvements in fuel economy could make large cars viable again.

I would define a "sensible" car as one having passenger accommodations equal to those in today's full-size cars (possibly better in some respects, such as seat height and head room) but designed according to the following ground rules:

— Maximum cruising speed of 55 m.p.h., and moderate acceleration capability.
— Complete disregard of styling and appearance.

It would be interesting to see how such a car would compare in cost, weight, and fuel consumption with today's full-size cars; I would hope that it would be considerably superior in all three respects.

Whether that 1951 Lincoln was or was not "stock," its performance at least proves that fuel economy can be achieved in such a heavy car in a driving pattern that approximates normal use.

Small Cars: How Safe to Be?

The balance between the need for energy and the need to protect people from harm must be decided by society as a whole; technologists have no special say. But technologists should raise their voices when the resulting standards are applied inconsistently. If society will not risk a life for a terajoule produced by nuclear means, it should be equally unwilling to risk a life for a terajoule from oil.

In your February issue (*"The Economics of Nuclear Power," pp. 14-25*) the public's concern for the dangers of nuclear power are once again cited as holding back this technology. Yet in the same issue Messrs. Tien, Clark and Malu (*"Reducing the Energy Investment in Automobiles," pp. 38-43*) suggest limiting the weight of automobiles to 2,000 lbs. to save energy.

Studies have shown that the risk of death or serious injury in an accident is more than twice as great in a small car than in a large car. Small cars are also involved in more single-car accidents. Even comparing small-car / small-car collisions with large-car / large-car collisions is invidious to small cars. There is no escaping the conclusion that small cars are more dangerous. A car can always be made safer at the expense of weight.

Given the present highway carnage of over 50,000 deaths per year, the cost of switching to small cars could easily exceed 10,000 lives a year. Serious injuries would be several times that. No credible scenario for nuclear plant disasters suggests so high an annual casualty rate.

The switch to small cars would, we are told, save 7.5 per cent of our national energy consumption. Nuclear power offers vastly more energy than that. If we applied the same standard of safety vs. energy to automobiles that we insist on for nuclear power, small cars would be banned.

Arnold Reinhold
Cambridge, Mass.

Automotive Fuel Economy: Beware the Gadget Market

Charles E. Cohn (*"Improved Fuel Economy for Automobiles," February, pp. 44-53*) seems to feel that we do not reap the benefits from easily available technology because "automobile manufacturers have, in the past, been extremely reluctant to adopt fuel-saving technology — especially where it originated outside their own organizations." This has been current folklore as long as I can remember, and certainly there is a grain of truth in it. On the same page I find, "Gadgets for improved fuel economy have found a ready market ... even though most have been proved technically unsound and ineffective." If this be so, does it not justify a somewhat skeptical attitude on the part of automobile manufacturers?

In 50 years of experience, I have had many such gadgets and techniques brought to my attention. Not a single one proved sufficiently effective to be viable. This does not mean that I believe the ultimate has been achieved in engine technology; it is now possible — mostly through improved techniques of measurement — to improve our understanding of the processes, limits, and trade-offs which determine the design of an automotive power plant, and it is in this direction that I believe the best opportunities for progress lie.

A sensible approach to this problem is to arrange the rules of the game so that it is very much to the manufacturers' advantage to produce cars that are economical of gasoline. This leaves the responsibility in the place where decisions are made.

A few errors of fact in Dr. Cohn's paper should be pointed out: bearing clearances run 0.001 to 0.002 of the diameter, not 0.0001 to 0.0002 in. as stated. There is good evidence to show that hydrodynamic lubrication does not normally break down "momentarily" at the end of the stroke, either for the piston skirt or the piston rings. And during normal combustion in the spark-ignition engine, the entire charge is in the gaseous state without benefit of a catalytic converter in the inlet system.

Edward S. Taylor
Cambridge, Mass.

The writer is Professor of Flight Propulsion, Emeritus, and associated with the Sloan Automotive Engine Laboratory at M.I.T.

Dr. Cohn comments:

That the field of automotive fuel economy has been, in the past, a fertile area for charlatans and scientifically illiterate inventors, and conversely has been largely neglected (until the energy crisis) by the technical community, is no reason to take an arbitrarily pessimistic attitude toward the field as a whole. The ideas in my article constitute significant changes in engine or car design which would be beyond the capability of the average mechanic; indeed, I agree that there seems very little that can be accomplished with devices simple enough to be installed in a few minutes by the average motorist.

There are, indeed, some cars that specify minimum crankshaft bearing clearances as small as 0.0002 to 0.0005 in.; with journal diameters around 2.5 to 3 in., the corresponding clearance/diameter ratios would be as I indicated. There is some, if not complete, breakdown of lubrication at the ends of the piston stroke; that is why cylinder wear is greatest in those areas. The Siemens development mentioned on page 47 of my article is in fact intended to provide a gaseous charge in the intake manifold, which is *not* the case in present engines, and thus to improve fuel distribution between cylinders.

What Role Automotive Maintenance?

I am continually surprised that in discussions of the conservation of energy through improved design and performance of automobiles (*see February, pp. 26-52*), little if any attention is paid to savings possible through careful maintenance.

By this I do not mean any single, simple action. Nor am I suggesting (since most people simply do not have the time or skills) a do-it-yourself approach. But I know that virtually every automobile I've owned in the past 20 years could have run better — and longer — if I'd ever been able to find trustworthy mechanics who would do what they were supposed to do, who knew how to do it, who would do it at a reasonable cost.

That last statement is intended to be deliberately *in*clusive of new car dealer's workshops and their "factory-trained" mechanics. It has a lot to do, too, with an attitude I suspect still prevails at the manufacturer level of allowing purchaser complaints to gather dust. I could cite dozens of incidents, ranging from non-repairs of both old and new cars, ranging across English, German and American vehicles. And, what has been done to my motorcycle (which I once thought might represent my own small contribution to New York's vehicular over-crowding) beggars both the imagination and any descriptive talent of mine.

If we were serious, as a matter of national public policy, about the kinds of problems the articles in the current issue of *Technology Review* describe, I suspect we'd be more concerned with regulation and control of repair performance. Nothing in my 35-year driving history leads me to believe that, even if a more efficient vehicle is designed and manufactured, our unregulated automobile mechanics won't manage to destroy its efficiency during the maintenance and repair cycle.

If better maintenance does in fact save energy, I would like to see some attention paid to what legislation might be necessary to ensure that mechanics do their jobs.

Bert Cowlan
New York, N.Y.

Understanding Production Functions

Kenichi Ohmae (*"Yokkakari: The Cycle of Dependence in the Japanese Corporation," January, pp. 40-47*) helps me understand some astonishing results obtained by two econo-sociologists in Vienna, Professors H. Millendorfer and C. Gaspari (see their paper, "Immaterielle und materielle Faktoren der Entwicklung," *Zeitschrift für National-ökonomie*, 31 (1971), pp. 81-120). Their finding is that the production function of the various nations of the world can be very simply written using an indicator (electrical energy) for the material input: capital and energy; another (literacy or number of engineers) for the immaterial input: capacity to process information; plus an empirical coefficient, societal efficiency, expressing the organizational capacity of society to use the inputs.

This last coefficient splits the world into five groups of nations, and Japan belongs to the last but one in order of decreasing value of the coefficient. This means a much larger input, material plus immaterial, is required in Japan to obtain the same G.N.P. of a more "organized" society (e.g., Brazil, in the third row).

Looking at the map of the nations having the same societal organization coefficient, it appears that their area corresponds quite strikingly to that of major religions, quite independently of the political regimes (e.g., Russia has the "catholic" coefficient). This points to a deep connection between productivity and *Weltanschauung*.

It would be very interesting to see this kind of analysis (developed in depth mainly for Austria) extended to Japan, as it would certainly help in understanding the internal mechanisms of society.

C. Marchetti
Laxenburg, Austria

An Automotive Diseconomy

There is no greater source of wasted time, wasted money, and frustration in America today than that due to unnecessary traffic lights. Experiments should be set up immediately to measure the average time taken by each vehicle in passing through every intersection equipped with traffic lights under two distinct conditions: the lights acting normally, and the lights blinking or off.

All other conditions of the experiment, such as day of week, time of day, etc., should be identical. Periods of light traffic should, of course, be surveyed first. The total amount of time and money that will be saved if this experiment is carried out will exceed our fondest expectations.

F. T. Leahy, Jr.
Laurel, Md.

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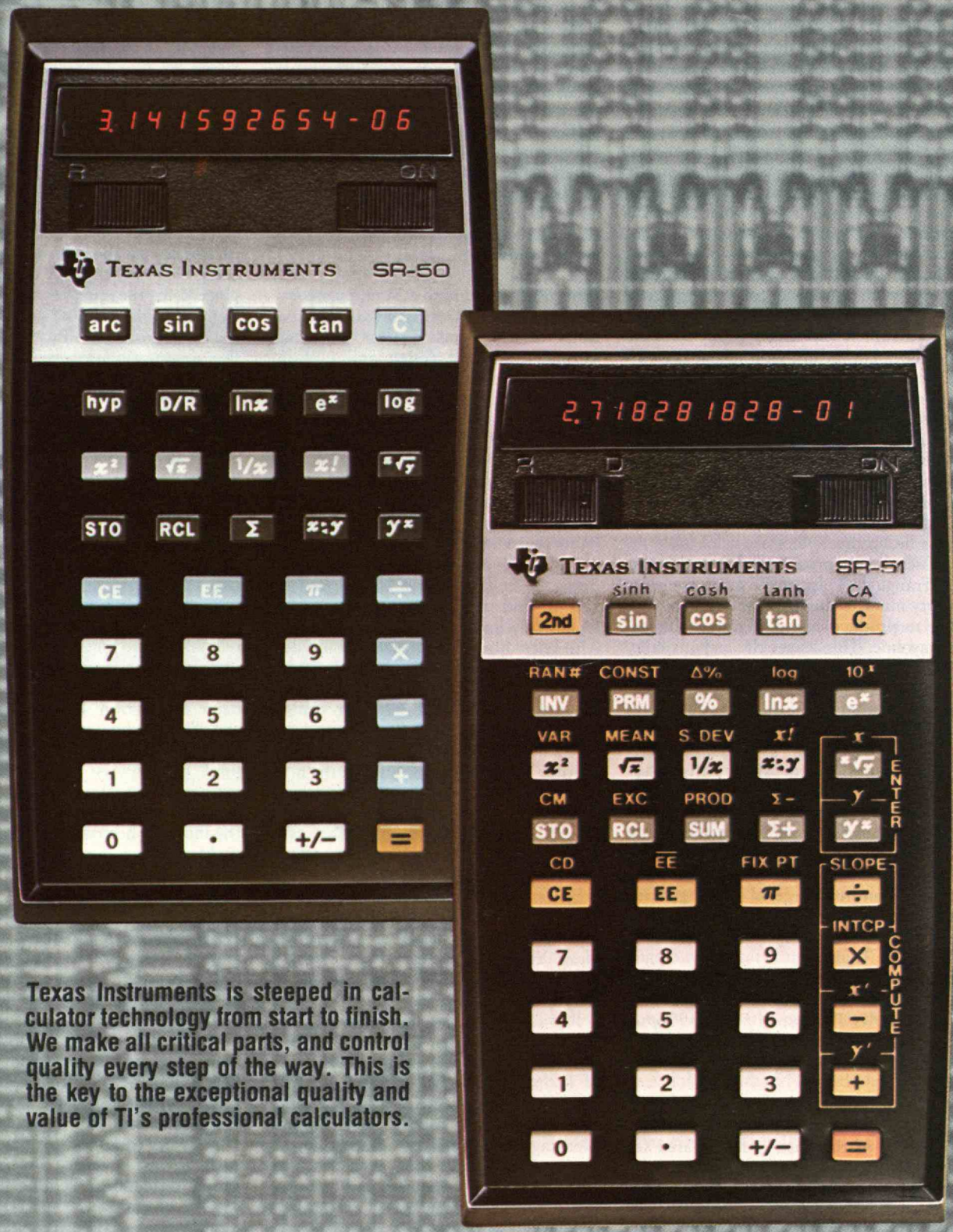

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Deg/rad mode selection switch	yes	yes
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Polar-rectangular conversion	yes	no
y^x	yes	yes
e^x	yes	yes
10^x	yes	no
x^2	yes	yes
$\sqrt{x}$	yes	yes
$\sqrt[x]{y}$	yes	yes
1/x	yes	yes
x!	yes	yes
Exchange x with y	yes	yes
Exchange x with memory	yes	no
% and Δ %	yes	no
Mean, variance and standard deviation	yes	no
Linear regression	yes	no
Trend line analysis	yes	no
Slope and intercept	yes	no
Store and sum to memory	yes	yes
Recall from memory	yes	yes
Product to memory	yes	no
Random number generator	yes	no
Automatic permutation	yes	no
Preprogrammed conversions	20	1
Digits accuracy	13	13
Algebraic notation (sum of products)	yes	yes
Memories	3	1
Fixed decimal option	yes	no
Keys	40	40
Second function key	yes	no
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fluid ounces	liters
gallons	liters
ounces	grams
pounds	kilograms
short ton	metric ton
BTU	calories, gram
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The Future Burden of Nuclear Waste

The several articles on the safety of nuclear reactors (*see October/November, pp. 14-15, 78-80*) will help resolve the "scare tactics" referred to more than once. But only once in these reports is the disposal of nuclear waste referred to, and that reference is to the effect that this problem is still unresolved.

My view is that this is actually the greatest question that must be overcome before nuclear fission can be considered a totally safe source of energy. With its long half-life, nuclear waste is placing an unrequested commitment upon many, many future generations. It is a problem that currently has been met only with temporary stop-gaps. A better answer should be brought forth before we speed our "progress" toward nuclear power.

Avi Ornstein
New Britain, Conn.

Evaluating Applied Research

While I accept the general principles which Professor Boulding puts forth in two essays on grant-making (*"Toward a Theory of Research Grants?", January, p. 5,* and *"A Spectrum of Strategies for Research Grants," February, p. 12*), I believe Professor Boulding did not differentiate sufficiently between basic and applied research in discussing possible strategies for deciding which research to fund. For example, in evaluating individual proposals with the National Science Foundation's R.A.N.N. (Research Applied to National Needs) urban technology program for which I am responsible, I seek assistance not only from academic research peers but from local government officials, staff of relevant federal agencies, and representatives of public interest groups such as the International City Management Association, the National Association of Counties, and the American Public Works Association. I have found the advice of such user groups to be of great value in assuring that the proposed research attacks a problem of priority to local governments and that it will produce a product likely to be used by local government officials.

The development of a research agenda is another activity in which the user communities obviously have a crucial role. Several types of input should be used. For example, in developing a program announcement for next year, I expect to use such sources as: a set of assessments of research on 19 specific municipal services which was funded by N.S.F.; a survey by Public Technology, Inc., of the research categories having highest priority to city managers; a survey of specific priority research projects listed by 27 technology transfer agents — technologists hired by local governments under another N.S.F. program; and interviews with federal agency officials, local government officials, staff of public interest groups, and researchers.

In a prior exercise to develop a program announcement, I was struck with the lack of an ongoing mechanism to assist in setting research agendas. I believe such a mechanism could prove very helpful to a number of federal agencies seeking to define research agendas on urban problems, for example. My conceptualization of such a process is still rudimentary. I would think it should allow for input from ongoing research assessments and surveys such as those mentioned above, as well as from a panel of distinguished representatives from both the research and user communities. I suggest that the establishment of formal mechanisms for assisting in developing applied research agendas is a sensible experiment to try in seeking to move toward Professor Boulding's goal of a rational grant-making process.

David R. Seidman
Washington, D.C.

Cooperation on Urban Technology

While I agree with David Rosenbloom in his review of my book on *Urban Technology* (*"How to Bring Technology to the City," February, pp. 66-67*) that urban technology and its delivery are complex, I take issue with his dismissal of national solutions.

Readers should be aware of the growing capability of Public Technology, Inc. (P.T.I.), a Washington-based urban research and development non-profit organization. Formed by the public interest groups (city managers, mayors, states, etc.), it has met with remarkable success in developing national solutions to technical problems. To cite just a few: water pressure regulators for fire hoses, hot-spot locators, automatic vehicle-monitoring systems. Note that these were developed by private industry in cooperation with members of P.T.I.

While P.T.I. is predominantly small-city oriented, a counterpart organization, the Urban Consortium (whose membership includes the 25 largest cities in the United States and for which P.T.I. serves as its secretariat) is getting under way to search for and distill common elements of common problems.

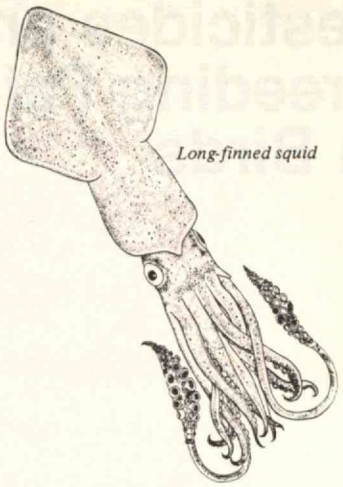
Without such cooperation, I believe limited city resources on an individual basis cannot serve effectively.

Herbert Fox
Old Westbury, N.Y.

The writer is Associate Dean of the Division of Science and Technology at New York Institute of Technology. — Ed.

To the Home of the Bean and the Cod

I am informed in your October/November issue (*"Call It Calamari," p. 81*) that "here" (presumably the U.S.) "there would be considerable market resistance to anything called squid." The conditional construction can mean only that nothing called squid has been marketed in the U.S. Sir, I grew up on the Pacific Coast and have visited that littoral many times in the



Long-finned squid

ensuing decades, and I know that squid have been marketed as squid in these states for at least 50 years. Perhaps you will pass the word that one can get squid in San Francisco almost as easily as he or she can get scrod *(sic. — Ed.)* in Boston.

Earl Cook
College Station, Texas
The writer is Dean of Geosciences at Texas A & M University. — Ed

The Editors respond:

Though Dean Cook's spelling of schrod makes clear his western origins, he is obviously on the right track. Our attention has been called by the New England Marine Resources Information Program at the University of Rhode Island to a recipe for "squid cacciatore Ranger Hall" which is said to have been developed (and devoured) by a class in invertebrate zoology at the University of Rhode Island. It is credited to *A Handbook for Beach Strollers* by Donald J. Zinn (Narragansett, R.I.: Marine Advisory Service of the University of Rhode Island, $3):

12 small squid
¼ clove garlic, minced
⅓ lb. mushrooms, sliced
4 slices bread, crumbled
1Tb. parsley, chopped
6 Tb. olive oil
¼-⅓ pint prepared spaghetti sauce
toast points
¾ tsp. salt
½ tsp. pepper
¼ tsp. oregano

Clean, skin and wash squid. Cut off the tentacles, remove the viscera and discard. With a sharp knife, slice the bodies into strips an inch to an inch and a half wide and set aside. Mix garlic, mushrooms, bread, parsley, salt, pepper, oregano and olive oil. Arrange around the center of a cast-iron skillet. In the center of the skillet pour your favorite spaghetti meat sauce and turn the heat to low. Place the squid strips in the warm sauce for about five minutes. Mix in other ingredients, turn heat up slightly and cook for 10 to 15 minutes, stirring occasionally, until squid is white, slightly curled and tender. Serve on toast points.

Pesticides and Breeding Failure in Birds

Environment/Technology
by
Ian C.T. Nisbet

The discovery in 1967 that wild birds were laying abnormal eggs suddenly put into perspective a number of previously puzzling observations of their reproductive failures and started a flurry of research activity. Eggs make unusually suitable material for quantitative biological studies, so ornithologists were soon collecting and analyzing samples from the field and searching in dusty museum drawers for half-forgotten egg collections. After eight years of study, the eggshell-thinning syndrome is probably known and understood better than any other problem in pollution ecology.

We now know that a wide range of predatory birds in Europe and North America are laying eggs with thinner shells than those laid before 1946. In a few species for which extensive historical series of specimens are available, the change took place suddenly between 1946 and 1949, and there has not been further marked change since 1950. In many cases the decrease has been small and is difficult to identify in view of the natural variability in eggshell-thickness, but present indications are that virtually all fish-eating birds and birds of prey are affected, at least to a minimal degree. In a few dozen species — primarily bird-eating and fish-eating predators — the average decrease has been 12 per cent or more, in extreme cases up to 20 or 30 per cent. Even 12 per cent exceeds the natural safety margin and many of the affected eggs are broken during incubation: most of the populations involved suffer partial or total reproductive failure and the worst-hit have declined drastically. In at least 25 species the degree of eggshell-thinning has been shown to vary in parallel with concentrations of chlorinated hydrocarbons — especially DDE — in the eggs. The syndrome has been duplicated experimentally in a number of captive species by exposing them to DDE in the diet; in at least one species the symptoms observed in captive and wild birds matched closely. During the last two or three years some wild species have shown a partial recovery as levels of environmental contamination have dropped.

A Bizarre — and Deadly — Phenomenon

Although the general picture is now reasonably clear, the eggshell-thinning phenomenon has a number of bizarre features which caused much confusion when they were first reported:

— Induction of severe eggshell-thinning appears to be a curiously specific property of *p, p'* -DDE, the long-lived environmental metabolite of DDT. A number of recent studies have suggested that DDE is the only chemical significantly associated with eggshell-thinning in wild birds. Although several other chemicals induce eggshell-thinning in captive species, the degree and duration of the effect are usually small; DDE has a uniquely severe and prolonged effect, continuing in some cases up to a year or more after exposure. PCBs, which are comparable in structure and toxicity to DDE, now appear to have little or no effect, except perhaps to potentiate the action of DDE. Even DDT itself and DDD, close structural analogs of DDE and more directly toxic to birds, have little or no effect.

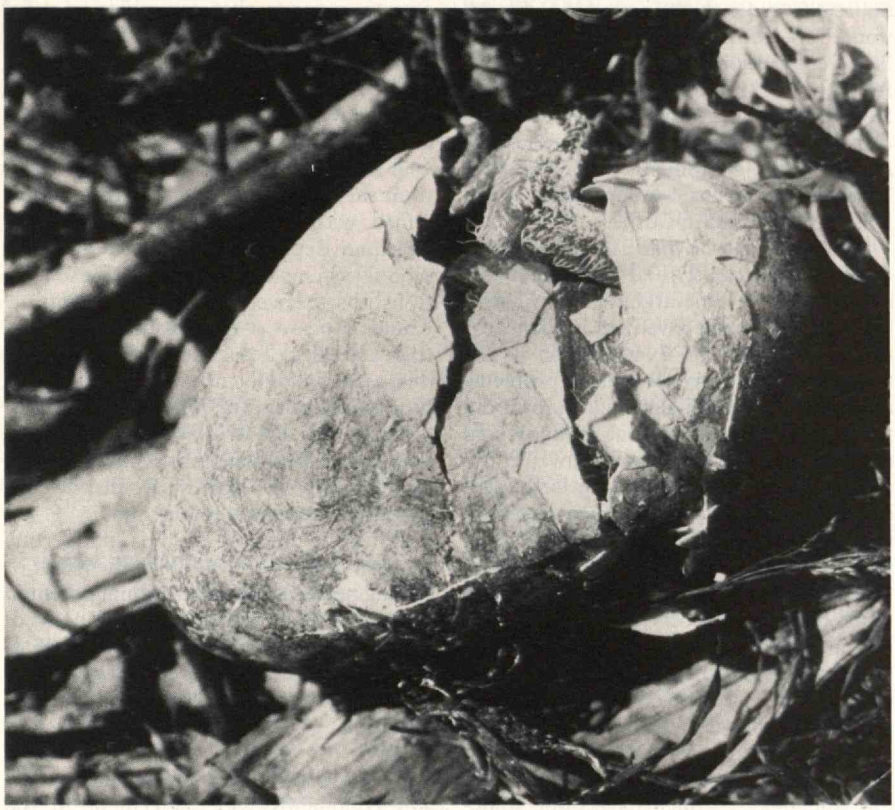
— The response to DDE varies markedly from species to species. Initial attempts to demonstrate the effect in the laboratory had little success because the conventional experimental subjects — chickens, quail, and pheasants — proved to be generally resistant. And unfortunately, the species most affected in the wild are difficult to breed in captivity, although falcons and owls have been used effectively. The best experimental species has proved to be the mallard duck, which displays a response similar to that of many wild species.

— The dose-response relation is peculiar. It is steep at first, so that small doses produce a large initial response, but becomes progressively less steep at higher doses. The more sensitive species are measurably affected when residues of DDE in their eggs reach 1 p.p.m., and the effect is largely complete at residue levels of about 10 p.p.m. Higher exposures yield little additional effect.

In part because of these unusual features the eggshell-thinning phenomenon has aroused intense controversy. At first there was legitimate reason to debate the conclusiveness of the early results and the specificity of the causative mechanisms proposed. Critics, however, have focused their attacks primarily upon minor points of experimental design and statistical analysis, which often have little bearing on the conclusions in dispute. The intensity of the attacks has been maintained despite the publication of massive supporting evidence. One useful outcome of the controversy has been to focus attention on the variability of the birds' response, but critics still quote negative results in resistant species as disproof of the general phenomenon.

One consequence of the dispute as to whether DDE causes eggshell-thinning has been to divert attention from a more interesting scientific question: the extent to which eggshell-thinning is a cause rather than merely a symptom of reproductive failure in various species of birds. Although thin-shelled eggs are often broken, breakage is not usually the sole cause of failure in wild birds. Thin-shelled eggs often fail to hatch even when artificially incubated and protected against damage. Recent studies have shown that DDE is related not only to thin eggshells but also to shells which are less porous, so that the oxygen supply to the embryo is reduced at critical periods of growth. DDE is also directly toxic to embryos, which may die from this cause alone.

Moreover, DDE is not the only chemical found in wild birds' eggs at significant concentrations. Dieldrin and PCBs are also embryotoxic and so suspect as causes of hatching failure in several bird populations. Deaths of chicks after hatching have been associated with exposure to dieldrin and several other chemicals. Further, dieldrin, PCBs, and DDE have been associated with abnormal behavior of chicks hatching from contaminated eggs. All these chemicals have a variety of biochemical effects on hormone levels and enzyme functions which can affect breeding performance indirectly. DDE and PCBs impair the parental behavior of some birds. Even egg-breakage may result from behavioral aberrations in the parents rather than from structural weakness in the eggs: birds of several species in highly contaminated areas have been seen breaking their



A number of species of predatory birds in Europe and North America are laying eggs with thinner shells than those laid before 1946. And the populations of the worst-hit have declined drastically. The culprit: Chlorinated hydrocarbons. Particularly DDE — supposedly non-toxic by-product of DDT.

eggs even before they showed external signs of damage.

A Sad National Symbol

Thus these toxic chemicals affect bird reproduction in a number of ways: the identification of DDE as the primary cause of eggshell-thinning does not necessarily mean that it is the primary cause of reproductive failure. Unfortunately, measuring reproductive success in birds is more difficult and time-consuming than measuring eggshell thickness, and it is only in the last few years that critical studies of factors influencing reproductive success have been completed. In one well-studied species, the European sparrowhawk, eggshell-thinning and egg-breakage became widespread and significant from 1947 onwards and are attributable primarily to DDE. However, average reproductive success fell further after the introduction of aldrin, dieldrin, and heptachlor in 1956. Recent studies show that failure to lay and embryonic deaths are now significant causes of breeding failure, and these appear most closely associated with contamination by dieldrin. Several other European studies have identified dieldrin as a significant cause of failure in addition to DDE. In North America, however, dieldrin has been clearly implicated in only a few cases, mostly related to specific local applications. Several recent studies of birds of prey have indicated that reproductive failure in widespread populations is closely correlated with DDE residues and that other toxic chemicals play only a minor role. The overwhelming importance of DDE, an unforeseen and supposedly non-toxic by-product of DDT, is one of the most curious features of the entire problem.

As I pointed out last month, it is unlikely that birds, as a class, have been affected much more severely by persistent toxic chemicals than have mammals, fish, or other groups. Our special knowledge of the damage to bird populations is largely a function of the ease with which they can be counted and studied. Even among birds, the effect is not general: only a few dozen species in North America are known to be substantially affected. What is unfortunate is that these include some of the largest, most spectacular, and most valued birds on the continent. In an ironic twist of fate, one of the species most severely affected, the bald eagle, is the national emblem of the United States.

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Associate Director of the Scientific Staff of Massachusetts Audubon Society; he is a graduate of Cambridge University, England, in physics (Ph.D. 1958).*

A Technology for Educational Art?

Technology/Society
by
Kenneth E. Boulding

Until about a year ago I was a member of that large group of professors who despised audio-visual aids. We never looked at television; we thought slides were only for people who had never quite mastered the use of language.

My conversion began when I was persuaded to use slides in a public lecture series in California last summer and discovered, much to my surprise, that they facilitated communication with my audience. The second stage of my conversion came through a collaboration with my artist son, Mark, on a couple of short slide shows. This opened my eyes to the extraordinary power of picture sequences in the teaching of ideas. The capstone on my conversion was a rather accidental viewing of an installment of the Bronowski television series "The Ascent of Man," a milestone in the development of film's extraordinary educational potential.

Visual Aids: Impoverished Handmaiden

We have had audio-visual aids with us, of course, for a long time. Most universities have audio-visual departments, most often staffed by technicians who react to demands rather than create them. In the grade schools and high schools much more use is made of such media than in universities — mainly, one suspects, to lighten the almost intolerable burden on the teacher. Educational art clearly exists but usually only as a weak, supplemental form for the transference of ideas.

In the practice of the arts, indeed, one can detect three major areas. The first is the fine arts, where the artist does his own thing. Then we have commercial art or propaganda, where the artist does the seller's or propagandist's thing. In this one should include the great cathedrals, the stained glass windows of Chartres, the created worlds of the illustrator, church music and national anthems, magazine ads — often more interesting than the editorial text, posters, and so on.

One would like to see recognized a third division of educational art, in which the skills of the artistic community are mobilized in the interest of learning. A cynic might argue this would be only propaganda in a new disguise, but one hopes the cynic might be wrong. Educational art, however, lacks institutions, lacks conventions, and as a result lacks funds. We think nothing of putting $10,000 a minute into television commercials. The educational artist scrapes by on second-hand equipment and miniscule funds, unless he has a sponsor such as the British Broadcasting Corp.

What case can be made for taking educational art seriously and devoting major resources to it? One argument is the desperate need for improvement in the learning process. It is no exaggeration to say that the solution to all human problems ultimately resides in learning, both in the sense of disseminating what we know and discovering what we do not know. Yet the techniques of human learning, and especially of teaching, have changed very little in 2,500 years. Education is still a craft industry with a degree of technological sophistication in its methods that does not much exceed that of shoe repair. As far as method is concerned, I teach very much the way Plato did because this is the way I was taught. Craft technology certainly should not be despised. Shoe repairers, after all, do succeed in repairing shoes, and teachers frequently succeed in educating students. We must have done something right or we would not be where we are today with this vast and unmanageable volume of knowledge. Every increase in human knowledge, however, makes all the more acute the problem of transmitting it from one generation to the next. One can visualize a point coming within a century when the stock of knowlede may be so large that we will have to devote all our educational resources to transmitting it, with neither time nor money to increase it. So an improvement in the efficiency of the learning process should have a high priority.

Education in the Laboratory: Still Testing

Unfortunately, the social science research devoted to the learning/teaching process has achieved remarkably few useful results and has had little impact on the practice of teaching, especially at the university level. Even in the lower schools its impact is at best dubious. The research literature suggests that something matters but nobody knows precisely what, and that the things we do know matter very little. One can send a well-motivated student away with a textbook for six months and he or she will often return to do as well in examinations as the students who were shepherded through tutorials, entertained with television, and so on. The Coleman Report reveals a pattern in the school systems of distressingly loose relationships between input and output. Could it be — a dangerous thought — that statistical research methodology in this case is simply not very productive? One would not want to abandon research altogether, but how do we find variables that matter not just statistically but epistemologically? Up to now, it must be confessed, the record is rather dim.

Could it be — another dangerous thought — that our failure is the result of having neglected the educational potential of art and its methods? From the point of view of social ecology, the scientific community and the artistic community have much in common. Both proceed through mutation — that is, creativity — and selection — that is, criticism. Scientific criticism is no doubt more finely tuned and commands wide agreement in the scientific community, though the influence of fashion is not to be wholly neglected. Likewise in the artistic community, criticism is not arbitrary; it has distinct patterns and also produces widespread agreement from time to time.

Teaching, alas, has virtually no "invisible colleges," no communities of criticism, no method by which innovations may be either propagated or evaluated. Could art be used in many different forms — drama and poetry, pictures, slides, movies, music — to improve the learning process and to create communities of criticism in teaching? In the light of the enormous importance of improving the learning/teaching process, perhaps this is a question we should take seriously.

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado.

Book Reviews

Housing Shortages: The Epidemic Spreads Upward

Housing and Economics: The American Dilemma
Michael A. Stegman
Cambridge: M.I.T. Press, 1970, xvii + 517 pp., $15.

Housing Urban America
Jon Pynoos, Robert Schafer, and Chester W. Hartman, eds.
Chicago: Aldine Publishing Co., 1973, x + 597 pp., $25.

Reviewed by Bernard J. Frieden

When urban problems held the national spotlight in the mid-1960s, none received greater attention than housing. New agencies were created, new programs enacted, and earlier programs administered in new ways. A succession of task forces, study groups, and presidential commissions — though inevitably working under intense time pressure which made careful research and analysis impossible — drew on the best and most informed thinking of experts in the field. And many recommendations were in fact enacted in a series of nonstop policy innovations.

These new federal policies thrust in many directions at once: relieving racial segregation and improving housing opportunities for blacks and other minorities; promoting innovation in construction methods to lower home-building costs; strengthening tenants' rights; opening new job opportunities in construction for minority groups; giving the poor a greater voice in housing and community development; increasing private investment in home mortgages; making mortgage credit available in previously "redlined" inner-city neighborhoods; enlarging and transforming low-income subsidy programs to offer home-ownership as well as rental apartments to poor people. Administrative reform was undertaken, as well, to link and coordinate activities in Washington and in the field. And the Model Cities Program tied social programs to physical renovation, giving special emphasis to improving the conditions of life in impoverished neighborhoods.

Although most of these initiatives were conceived and planned during the Johnson Administration, they continued to move with a surprising impetus during the first Nixon Administration. In the early 1970s, federally-assisted housing accounted for a totally-unprecedented one-fourth of all housing starts in the country. So for a short time many observers believed the country was finally moving to solve housing problems that had been recognized ever since the New Deal but had been dealt with only sporadically and on a piecemeal basis. But as researchers applied new methods of program evaluation to the emerging results, it soon became evident that the problems were far from being solved. The judgements of the policy advisors and experts of the 1960s led to some scattered successes, but there was also evidence of deep-seated problems that were not yielding.

The political outcomes were equally troublesome. Less than five years after President Johnon had signed the monumental 1968 Housing Act, President Nixon was able to suspend with impunity virtually all low-income housing programs. And abruptly, the rapid innovation and massive implementation gave way to the current phase of study, reflection, and more cautious experimentation with new ideas.

Two recent anthologies present excellent overviews of the new understanding of housing problems that has arisen in the past few years. Michael Stegman's *Housing and Economics: The American Dilemma* reflects primarily the attitudes of the Johnson years, but with unusual foresight into difficulties that surfaced later. *Housing Urban America,* edited by John Pynoos, Robert Schafer, and Chester Hartman, is a considerably longer and more ambitious anthology. Completed in 1973, it draws more extensively than the Stegman volume on the actual experiences of housing programs in the field. In the midst of rapid economic upheaval, events of the 1960s are often considered part of the historic past, suitable for revivals of nostalgia about the Civil Rights movement but of dubious relevance to the present. Pynoos *et al.* argue otherwise: the issues will not go away, even though our political and economic climate is changing.

Housing Markets: A Hopeless Competition?

It is fair to ask, however, where the perspectives of the 1960s fell short in suggesting future agendas for government action. Both these volumes focus, quite properly, on the housing problems of the poor, fully recognizing their connection to the housing industry oriented to the American population at large. Yet they convey a misleading impression that the housing industry and its institutions are operating successfully for most Americans, and only require adjustments to do for the poor what they already do for the middle class. Today, however, with housing production at the bottom of the worst slump in 15 years, there is good reason to doubt that the needs of most Americans can be met, let alone those of the poor who cannot pay their own way in the private market.

After years of steady progress in improving housing conditions, we may now be entering a period when some part of the middle class will begin to share the problems that formerly were confined to the poor. Both volumes point out correctly that federal policy has given higher priority to helping middle-income families and the housing industry than to subsidizing the poor. Yet even these efforts have failed to cope with the housing industry's chronic instability given shortages of mortgage capital, rising costs, and tightening environmental regulations that make production more difficult. An important question for the future, then, is why federal policies intended to assist the industry and the middle-income buyer have had such limited success. Unless the industry can do a better job of meeting middle-income housing needs, the poor will find

themselves in hopeless competition for a limited supply of good housing.

Further, both volumes sense only in part the changes in the poor's housing problems. Recent research at the M.I.T.-Harvard Joint Center for Urban Studies has suggested conclusions different from those of past presidential study commissions: the number of low-income families living in physically inadequate housing has been shrinking steadily and substantially, while the number of low-income families forced to spend an excessive share of their income for housing is growing at an alarming pace. Almost half the 13 million households classified in the Joint Center's study as housing-deprived in 1970 were living in physically sound, uncrowded housing but paying excessive rents in relation to total income. Another change, recognized only in part, is that for a large number of the urban poor, slum conditions blanket neighborhoods, not simply individual units. In many cities, whole communities have become substandard by virtue of inadequate public services, high crime rates, and deteriorated environments, even though many houses within them meet the usual criteria of adequacy. Both these problems of cost and neighborhood are important items on any future agenda for housing reform.

Local Solutions to a National Problem

Compounding the difficulty of devising future policies is the extreme local diversity of housing markets and conditions; yet in their effort to provide a synoptic view, the authors of both these books tend to treat housing on a national scale. The key questions of housing costs and neighborhood conditions will necessarily require very different approaches to different housing markets: uniform national policies will simply not produce uniform results. For example, one pilot test of housing allowances (direct cash assistance to help the poor find decent housing in the marketplace) has worked surprisingly well in Kansas City, where vacancy rates were high and the recipients were able to find reasonable alternatives. In a tight housing market, such as New York's, the same approach would probably work poorly and inflate rents for everyone. How to reconcile federal policymaking with the fine tuning needed for locally-differentiated programs remains a central dilemma — particularly since federal housing agencies in the recent past have been unable to cope successfully with far simpler administrative issues than this.

Finally, the analysis of housing politics presented in *Housing Urban America* already seems outdated by events. Articles in this volume stress the political effectiveness of the private sector and of the homebuilders' lobby. The major subsidy programs initiated in 1968 for new home ownership and rental housing went to great lengths to provide incentives for the full participation of the private sector. Indeed, the homebuilders' lobby was instrumental in securing the enactment and implementation of these programs. Yet by 1972 these same programs proved remarkably vulnerable to relatively limited scandal and mismanagement uncovered by journalists and Congressional investigators, even though the overwhelming majority of housing produced was free of scandal and serious financial difficulty. Why the powerful homebuilders' lobby and other well-heeled producers' interest groups were unable to give better protection to these programs is an open question of some importance.

In the past, housing research has seldom been either systematic or cumulative. Independent researchers pursued their own interests, while editors of anthologies did their best to erect order from a diverse spectrum of articles. With researchers today funded more generously and engaged in larger-scale federal experiments and evaluations, we may expect a better base of knowledge with which to pursue the next phase of policymaking. These two books will make the job easier.

Bernard J. Frieden is the Director of the Joint Center for Urban Studies of M.I.T. and Harvard University, and Professor of Urban Studies and Planning at M.I.T.

How and Why to Import Natural Gas

Liquefied Natural Gas
W. L. Lom
New York: Halsted Press of John Wiley and Sons, 1974, viii + 178 pp., $18.

Reviewed by John M. Bradley

Energy equivalent to 40 per cent of U.S. oil imports is wasted each day in natural gas flared at wellheads of the oil exporting countries. Many analysts, including this writer, propose that the quickest and least expensive way to supplement our country's natural gas supplies — which are themselves running dangerously short — is to import natural gas in liquefied form from such countries where it is now being wasted as a by-product of oil production. Such an enterprise could also draw on enormous unused reserves of "formation" natural gas (natural gas not associated with the production of crude oil) in other countries such as Colombia, Trinidad, Algeria, and Canada, which can only be brought to the U.S. market as liquefied natural gas (LNG).

This book is an analysis of the technologies and economics involved in such an enterprise. It provides a complete and basically conservative analysis. One reservation is necessary: increasing costs have rendered some of the author's economic analyses obsolete.

Maintaining the Advantages of Gas

The cleanliness and controllability of gas make it an indispensable fuel for many operations such as metallurgical and ceramic heat treating, food processing, and the manufacture of fertilizer, in addition to its use as a domestic fuel. Curtailment of supply would cause unemployment, economic dislocation, and enormous controversy. Hence the importance of the subject of this book.

LNG tankers and a couple of American import terminals are already built and not fully utilized, and more of them are under construction. The technology for imported LNG has been proved in 14 years of LNG imports to countries other than the U.S. Thus, the investment in research and development — and to some extent of capital — necessary for an imported LNG industry has already been made. LNG tankers are inherently safer than gasoline or crude oil tankers because LNG containers within them are necessarily separate from the outer shell of the hull. As a result of this difference, and of other safety features which have been developed in conjunction with the U.S. Coast Guard and other qualified authorities, LNG tankers command lower insurance premiums than do gasoline tankers.

Should it become plentiful, LNG fuel could supplement our gasoline supplies; it is the highest-octane non-leaded fuel available for spark-ignition engines, and since it is a gas it eliminates the problem of carburetion; there is a normal, uniform fuel distribution to all engine cylinders. As a result, hydrocarbon, carbon monoxide, and nitrogen oxide pollutants can be kept so low that catalysts need not be used on conventional internal combustion engines to meet the 1975 standards for engine emissions. The distribution problems could be minimized and the environmental advantages maximized by having urban taxis, buses, and delivery wagons use this LNG fuel.

Synthetic Gas as an Alternative

The only alternative potentially large new source of gaseous fuel for the U.S. is by synthesis from coal, and this process presents technical, economic, environmental, and safety problems which seem far greater than those associated with imported LNG. The cost for plants to produce such substitute natural gas (SNG) from coal is presently estimated at about $5 per annual million ft.^{3} of SNG produced; assuming 20 per cent per year for depreciation, interest, and return on investment, the capital cost of this SNG becomes $1 per million ft.^{3} produced even before the cost of coal, labor, and other current operations are computed. An enormous amount of steel and capital investment will be required if such technology is to be in place by the time domestic natural gas is se-

verely curtailed, and both will probably be in short supply for decades to come.

An alternative use for this SNG technology is to let such a plant produce ammonia instead of methane. Instead of converting the carbon monoxide and hydrogen produced from coal into methane, let it be used to produce ammonia by the standard reactions with air and steam used today in virtually all commercial ammonia plants. A plant designed to produce 250 million ft.^{3} per day of SNG could produce 11,000 tons per day of ammonia. This is the amount of ammonia now produced by the use of 375 million ft.^{3} of natural gas; thus, by producing ammonia this "SNG" plant could effectively bring to the marketplace 50 per cent more genuine natural gas than it could by producing SNG.

There are other potential hazards and diseconomies in SNG as its development seems now to be conceived under the aegis of Project Independence. The thermal efficiency of proposed SNG-from-coal plants is low: over 160 B.t.u.s of energy from coal must be consumed to produce 100 B.t.u.s in SNG; most of the other 60 B.t.u.s will go into thermal pollution and the evaporation of scarce water supplies. A single 250-million-ft.^{3} SNG plant will consume enough water to irrigate 2,500 acres of western crop land in the same area where it is now proposed to produce coal and its SNG product. The S.N.G. process yields about one cubic foot of carbon dioxide for every cubic foot of SNG, and the disposal of this enormous by-product may well turn out to absorb additional scarce energy and capital resources. As we dig deeper for coal, the danger of mine accidents will increase (coal mining is already the nation's most dangerous industrial occupation), and if we choose to strip mine the enormous quantities of coal required to substitute synthetic for natural gas, there will be severe damage to the large areas of productive land in the West.

Imports of natural gas have a very different set of environmental hazards, some of which have been considerably overemphasized in the popular press. Unfortunately, Dr. Lom in *Liquefied Natural Gas* chooses to discuss the safety problems associated with LNG management without adequately describing the technology which has and is being used to solve these problems with the result that in the 14-year history of international transportation of LNG, there has been no fatal accident.

The author, who graduated from M.I.T. with the Class of 1947, has been associated with Cabot Corp. in the development of LNG importing facilities for the East Coast.

Our mineral resources will deplete "with a whimper, not a bang." Using geology to predict the course of that depletion will help us manage it.

Earl Cook
Dean of Geosciences
Texas A & M University

The Depletion of Geologic Resources

Will shrinking resources limit population and economic growth? This question has been argued since the 19th century English economist Robert Malthus first challenged the optimistic economic-growth doctrine published in 1776 by Adam Smith. The debate flares today against a backdrop of rising prices and shortages of food and other energy resources, pitting two views of the economic and physical world against each other. On the one hand are those who profess belief in a "natural" economic growth rate, in the market economy's ability to allocate resources for maximum social benefit, and in the perpetual development of new resources through technology; they propose the disintegration of cartels, the freeing of the market, and increases in production as appropriate national strategies. On the other hand are those who believe that no exponential rate of increase for anything tangible can be sustained indefinitely, that natural-resource exploitation is subject to the clear constraints of the law of diminishing returns, and that the ingenuity of man will not overcome the laws of physics; they argue for increased controls on the market, government allocation of scarce resources, and decreases in consumption. The concerned citizen wonders which view is correct or better to follow in making national decisions.

Deciding what to believe is difficult. The wide range of expert views, for example on the future availability of fossil fuels to the U.S. consumer, and the poverty of knowledge of many of the journalists, economists, and politicians who seek to interpret the information given them, allows ample opportunity to adopt a view that accords with one's own interests, beliefs, and desires. Yet it will be extraordinarily important to the nation to see the future wisely, if not clearly, and for this reason I shall attempt to give here an argument which, although not new, may be helpful to the perplexed. It is an argument based on my own bias in favor of the use of geologic knowledge in the interpretation of geologic resources, and of history as a guide to the future.

First, I point out that no country is wealthy whose economy is based on fishing, forestry, or agriculture. Wealthy nations are those whose economies are based on the exploitation of fossil fuels, metals, and construction minerals, all of which are mined. Technology applied to these resources is the basis of the high material levels of living enjoyed by the industrialized portion of the world's people. Therefore, if the resources prove to be finite and nonrenewable, the wealth of nations not only faces severe resource constraints, but is ephemeral. I shall discuss only nonrenewable resources, although a similar argument could be made for the renewable ones when they are depleted by use faster than they are replenished. I define depletion as a reduction in the total amount of a resource ultimately available for use by mankind.

The Economic Nature of Geologic Resources

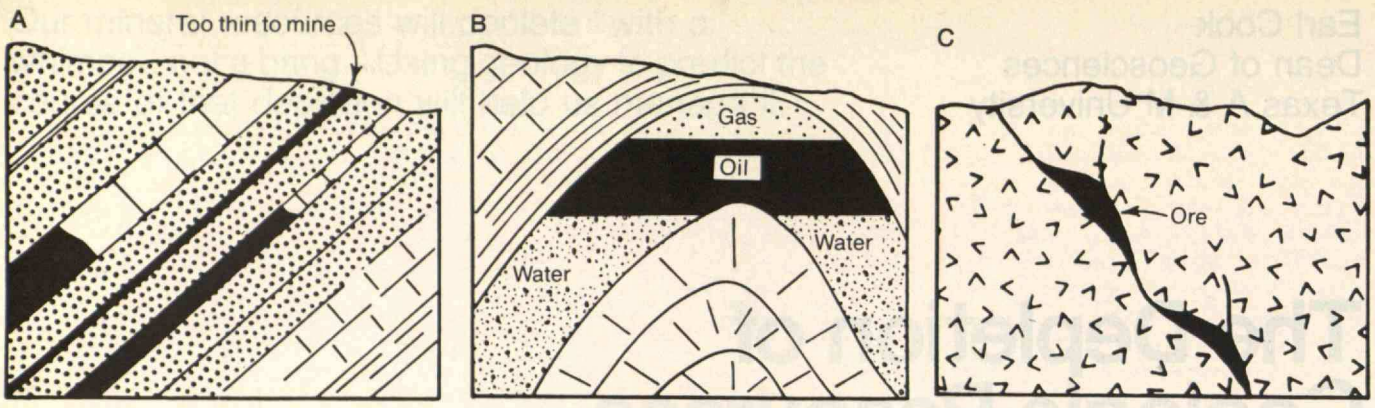
Rates of consumption for minerals and fossil fuels have been increasing exponentially for several centuries, but only within the past hundred years have they grown large by present-day standards. During these hundred years, we have used science and technology in two ways to expand our resource base:

— By increasing the efficiencies of discovery, recovery, processing, transport, and application of natural materials so that leaner, deeper, and more remote deposits could be exploited.

— By discovering and developing new methods of utilizing previously worthless materials.

Important to both has been a progressive lowering of the cost of fossil energy per unit of work or useful heat obtained. Cheaper energy, along with technological ingenuity and discovery, has greatly extended the availability of non-energy resources. If copper, for example, still had to be mined as it was a hundred years ago, the energy or work costs of mining and milling the copper-bearing rock would be so high that only relatively rich ores, say 5 per cent or more in copper content, could be mined, and the enormous low-grade "porphyry" copper mines which today produce a large portion of the world's copper would be impossible. Today at least one copper mine can profitably mine rock containing only four pounds of copper per ton; at that grade (0.2 per cent), every ton of copper produced requires the breaking, transport, and milling of 500 tons of rock and, in addition, the removal of perhaps an equal amount of waste material. A great deal of energy — more than 8,000 kilowatt-hours — is required to produce a ton of copper today, but the cost of that energy is low compared to the energy costs of supporting the equivalent in men and mules; furthermore, the efficiency of modern power shovels, trucks, and locomotives greatly surpasses that of animals or steam engines.

It is no wonder that industrialized and aspiring nations alike have developed a pervasive faith in mankind's ability to maintain the flow of benefits obtainable from energy and other geologic resources in the face of increasingly adverse geologic and geographic conditions. Does this faith appear justified? To put the matter another way, is depletion real?



To consider these questions, we must look at the nature of geologic resources — geochemical concentrations of materials that can be recovered and used at a profit. The profit may be in the form of an energy surplus, as from the exploitation of fossil and nuclear fuel deposits, or it may be in the form of an energy saving, as in the lessened expenditure of human energy and time when one uses steel in place of wooden implements and utensils.

Defined in these terms of direct or indirect energy profit, the concept of a geologic resource becomes one of energy economics. Energy economics differs from energetics in that human time and effort are incorporated as reference values for all formulations. In energy economics the utility of a product is measured by its capacity for saving human time and effort rather than by the ratio of its energy savings (or yield) to its energy cost.

Limits to Geologic Resources

There are several kinds of limits to geologic resources. First, the *limit of comparative utility*: a resource is a resource only while it can be used to perform a function desired by man better or more cheaply than another resource can. If the cost of one resource rises to a level at which another resource can be substituted at a lower cost for comparable utility, substitution will take place and a limit will have been imposed on the first resource. If, however, there is no substitute of comparable utility available, the limit to the utilization of a resource will be the point at which no one in the society is willing to pay the cost of production, because doing so would lower his level of living more than foregoing use of the resource. The *living-level degradation limit* will be higher for some resources, say diamonds, than for others, say food; in fact, foregoing the use of food entails such penalties that people will continue to produce or purchase it even though their level of living deteriorates thereby. The ultimate limit to geologic-resource use will be set by the limits of the natural energy subsidy in fossil and nuclear fuels, in solar radiation and the hydrologic cycle. Wherever and whenever that natural subsidy — the excess of useful energy above the work required to obtain it — is used entirely in the supply of food and shelter, or in food, shelter, and leisure, there can be no nonenergy geologic resources. Finally, the limit to geologic energy resources is the *limit of net work profit;* when it takes more energy to find and recover the fossil fuels than can be gotten from them in useful form, there will be no more oil, gas, or coal resources — although there may be a considerable amount of each left in the ground.

The basic question of depletion, therefore, is whether or not the work-profit limit will be reached, or demand will cease, short of attempting to extract the desired resource, at enormous expense, from ordinary rock and seawater. For some resources, we can say with assurance that the work-profit limit will be reached long before ordinary rock can be profitably mined. The fossil fuels are the best and most important examples. The energy potential represented by the average concentration of carbon in the earth's crust is 2.6 kilowatt-hours per ton, not nearly enough to crush and grind it to liberate the carbon for use. (In one large modern copper-ore mill, grinding and classification alone take 7.87 kilowatt-hours per ton of ore milled.) We can thus be sure that the sharp physical boundaries that characterize coal and petroleum deposits are also economic boundaries. Because no recycling of the fossil fuels is possible, depletion is approximately coincident with production, and ultimate exhaustion is a certainty.

But in the case of uranium, there exist very large low-grade deposits in which the potential energy is much more than sufficient to break, transport, and pulverize the rock, and then to recover the uranium. Even average crustal rock may contain enough uranium — 1.7 parts per million — to justify mining and processing into fuel elements for breeder reactors which can produce 13,680 kilowatt-hours per ton of such rock at a conversion efficiency of 60 per cent. The unknown factor here is the energy requirement for the extremely fine grinding and multi-stage recovery that would be needed.

Was C. K. Leith Wrong?

Forty years ago, geologist C. K. Leith called attention to the coming exhaustion of U.S. mineral resources, claiming that ". . .despite a magnificent endowment [of metals and fuels], depletion is further advanced than even mining men generally realize." At the time Leith wrote, proved reserves of crude oil, zinc, and lead in the United States were 15 to 20 times larger than production, the Lake Superior iron ores appeared to have less than 20 years of measured supply remaining, and known copper reserves were about 40 times the 1934 production. Wrote Leith: "Further discovery and the use of lower grade resources will extend the life of most of these resources, but the range of possibilities is now pretty well understood, and with maximum allowance for such extension, the figures are sufficiently small, when compared with what we hope will be the life of the nation, as to be matters of public concern . . . Discovery has not stopped, but the

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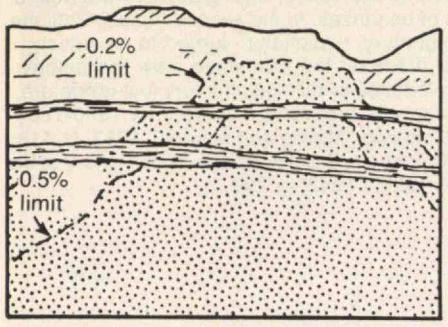


Mineral and energy resources tend to occur in different modalities — a geologic fact of great consequence for human efforts to exploit them. Drawing A shows a resource, such as coal, that generally occurs in large beds. These resources are exploited by simply mining and crushing the ore, and the present limits to exploitation are economic: deposits cannot be exploited if the seams are too thin or too deep. Drawing B shows a resource, such as crude oil and associated natural gas, that occurs in small bodies of high-grade "ore." Our extractive ability depends largely upon the efficiency of our extractive technology. The situation is similar for small high-grade deposits of silver, shown in drawing C. Drawing D shows a gradational copper deposit; the lower the percentage of copper in the ore, the greater the quantity of ore available. Here, there comes a "cutoff grade" below which exploitation is unprofitable.

rate has been slowing . . . Of 33 metal-mining districts that have yielded the greatest wealth to date only five have been discovered since 1900 and none at all since 1907 . . . The rate of discovery of oil and gas continues high, but . . . the chances of finding another East Texas or Kettleman Hills are not promising."

Was Leith right or wrong?

Since 1935, more crude oil (77.3 billion barrels) has been discovered in the U.S. than had been discovered from 1857 through 1934 (62.0 billion barrels). The rate of discovery, however, has been declining ominously in recent years, as documented by the American Petroleum Institute. The sole exception to this trend occurred in 1968, when the Prudhoe Bay oil field on Alaska's North Slope was discovered; it was added to proved reserves in 1970. During the latest five years of record, domestic production has exceeded discovery by an order of magnitude. In the same period, 4.5 times as much natural gas has been produced as has been discovered. Neither technological improvements in exploration and recovery nor higher prices have been able to overcome these sagging discovery rates. At the end of 1973, the ratio of proved reserves of crude oil to consumption was less than nine, and would have been about six but for Prudhoe Bay.

As for zinc, since 1935, when Leith wrote, the U.S. has produced more than it did prior to that year. In 1968, the ratio of measured domestic reserves to primary consumption (defined as U.S. demand less secondary or scrap supply) stood at 24, despite the fact that demand had soared and more than a third of U.S. supply was being imported as metallic zinc. The U.S. mine production of zinc in 1968 (529,000 tons) could have been maintained for some 64 years on the then-known reserves (33,730,000 tons).

Although U.S. lead production since 1935 does not equal the pre-1935 total, the ratio of measured reserves (35,300,000 tons) to primary consumption (898,000 tons) in 1968 was 39, and the 1968 mine production could have continued for 90 years without further discovery.

The Lake Superior iron ore of Leith's day has been exhausted, but it has been largely replaced by taconite, a low-grade iron-bearing rock not considered to be ore in Leith's day; the present ratio of measured reserves to primary iron consumption is 17. At the 1968 rate of U.S. mine production, the reserves would last more than 35 years.

Since 1935, more copper has been mined in the U.S. than in all the years prior to that time. Based on 1968 figures, the ratio of reserves to primary consumption was 56, and U.S. mine production could have continued at the 1968 level for 74 years without new discoveries.

What has happened between 1935 and 1975 is that new discoveries have extended crude-oil, zinc and lead reserves, new technology has "created" large new reserves of iron ore and copper, while recycling has decreased primary demand for zinc, lead, iron, and copper. The percentage of U.S. consumption represented by secondary or scrap metal in 1968 was 20 for zinc, 38 for lead, 36 for iron, and 45 for copper. Increased prices, for reasons to be discussed shortly, have extended copper reserves substantially, iron ore moderately, lead and zinc modestly, and crude oil hardly at all. Because U.S. consumption rates for these geologic resources have risen substantially since 1935, the achievements of geologists, mining engineers, and metallurgists are all the more outstanding.

In the short term, at least, Professor Leith appears to have been wrong. The continuous-creation school of resource analysts would classify him as a doomsayer of the past whose forecasts went awry for the same reasons that those of present day Cassandras will miss the mark. The physical-limits school, on the other hand, would point to the very important role in prolonging domestic reserves of imports from countries where depletion is not as far advanced, and to the sharp downward trend of the reserves-to-production ratio for U.S. oil and gas as a sign of the future for all geologic resources. The fact remains, however, that in regard to the major industrial earth resources of Leith's time, the U.S. is substantially worse off now only in oil and gas. Let us now look at the different ways in which such resources occur, to see if we can find other guides to understanding — still in pursuit of an answer to the question, is depletion real?

Modes of Occurrence Affect Depletion

Geologic resources display modes of occurrence that affect the ability to mine them economically (see the illustrations above). Three modes are discussed here: (1) irregular, sharply bounded, solid deposits of valuable metals such as mercury and silver, and sharply confined accumulations of interstitial fluids such as crude oil and natural gas; (2) tabular solid bodies of nonmetallic minerals such as coal, salt, phosphate rock, and potash minerals, generally with sharp physical limits; and (3) deposits, mainly of metallic ores, characterized by gradational boundaries, among which are many of copper, iron, aluminum, and uranium.

Resources of the first class commonly can be extracted at relatively low cost compared to their value; thus the

The production history of a single silver deposit — the Comstock Lode in Nevada. The curve shows three stages of depletion. In the first, lasting from 1860 into the 1880s, high-grade ore was found and mined in a series of bonanzas. In the second, lasting until the end of the nineteenth century, exploitation turned to previously ignored ore of a lower grade. In the final stage, new technology made possible the exploitation of tailings and very low-grade ore, but little additional value was produced. The data for 1860-1881 are from Eliot Lord, "Comstock Mining and Miners," 1883, p. 416; the data for 1882-1920 are from Grant H. Smith, "The History of the Comstock Lode, 1850-1920," 1943, p. 297.

metals may be completely mined out, while oil and gas extraction from most reservoirs will be simple and swift until a cost limit imposed by the physical reluctance of the reservoir rock to yield its remaining fluid hydrocarbons is reached — a limit commonly so abrupt that it has an effect on extraction similar to that of the sharp physical boundary of a silver vein. Resources of the second class are directly exploitable with little or no processing other than breaking and cleaning. Because they commonly are of fairly low economic value, they become uneconomic to mine when too thin, too deep, too fractured and tilted, or too far from market. Resources of the third class are the most sensitive to improvements in technology and rises in price, either of which may extend greatly the amount recoverable; but even deposits of this class generally show a marked drop in the strength of metallization as the barren surrounding rock is approached.

These modes of occurrence and the relative values of the materials sought determine what may be called modes of depletion. Resources of the first class are characterized by *ore-body depletion.* Resources of the second and third classes are subject to *economic-limit depletion;* the salient limiting factor in the second class is the cost of recovery, while in the third class it is the grade of the ore. Yet a third depletion category can be established, *multiple-source depletion,* for those geologic resources that display two or more common types of occurrence for which the exploitation costs differ substantially.

Ore-Body Depletion: Mercury, Silver, and Crude Oil

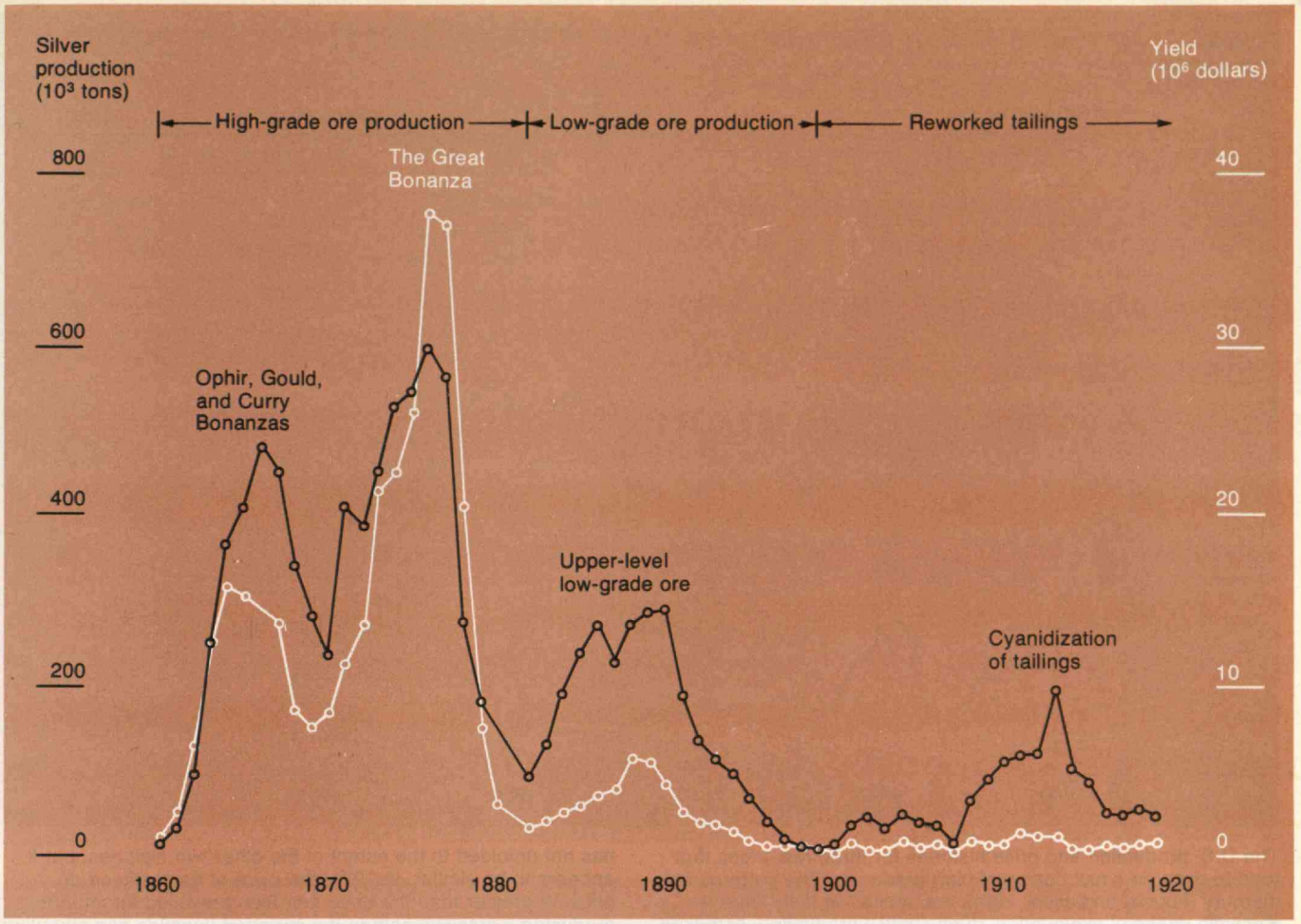
Ore bodies of both mercury and silver tend to be hundreds to thousands of times more concentrated than the average crustal abundance. They also tend to have very sharp boundaries. Because of these features, limits to exploitation tend to be geologic rather than economic. We should expect, therefore, to find evidence of depletion in the production histories of both metals, even in the face of technological improvements and higher prices.

The cases of mercury, an essentially depleted resource in the U.S., and silver illustrate the relation between prices and ore-body depletion. As can be seen by price and production curves on pages 20 and 21, U.S. exploitation of both mercury and silver appears to have gone through three phases: a waxing phase, during which increases in production caused the price to fall; a mature phase during which price and production were more or less in equilibrium; and a waning phase, during which successive surges in price have evoked progressively weaker surges in production.

The waxing phase represents a period of falling real cost because of new discoveries, improvements in technology, and economies of scale. This falling cost stimulates demand. Increased production hastens the exhaustion of high-grade, low-cost deposits and puts pressure on technology to counter increasingly adverse geologic and geographic conditions. When technology begins to lose the battle, which will happen sooner for some materials than for others, real costs rise and the waning phase is entered. Prices rise with the costs of increased production, and demand will fall with the falling utility of increasing the resource's use. Sharply rising prices will stimulate the search for a substitute; if found, the production of the primary resource will cease at the point where the cost of an additional increment produced exceeds the cost of an equally useful increment of the substitute.

These historical patterns reflect the depletion histories of individual mining districts. The depletion history of the Comstock silver lode, for example, illustrates a simple depletion pattern characteristic of high-grade, sharply bounded, and vertically-limited mineral deposits (next page). The Comstock vein system, a candelabra with tabular branches, is typical of fractures that fill with ore minerals at shallow depths; the system is rich and intricate near the surface, barren and simple a few thousand feet below. Its production history shows three distinct stages. In the first stage, during which the greatest part of the lode's total value was extracted, high-grade ore was mined at a fast rate. In the second stage, it became possible because of technological improvements to mine lower-grade material bypassed in the first stage. In the final stage, waste material and some very low-grade ore were processed by a new technology, but little was added to the value already produced.

U.S. crude oil depletion has not advanced as far as mercury and silver, but it appears to be developing in similar fashion (see p. 21). During its waxing phase, in the early part of this century, gluts of oil drove the price down to or below the actual cost of production. Proliferation of automobiles and trucks was stimulated by cheap fuel, and demand grew. The passage to a waning phase, about 1971, was abrupt because of the large cost differential between domestic and foreign crude oil at a time of strongly rising demand, a differential that forced a rapid shift from domestic production to imports. Current, artificially high world crude-oil prices have encouraged exploration for new domestic reserves and have stimulated new efforts to recover more oil from existing wells. It is almost certain, however, that we shall not see a production response

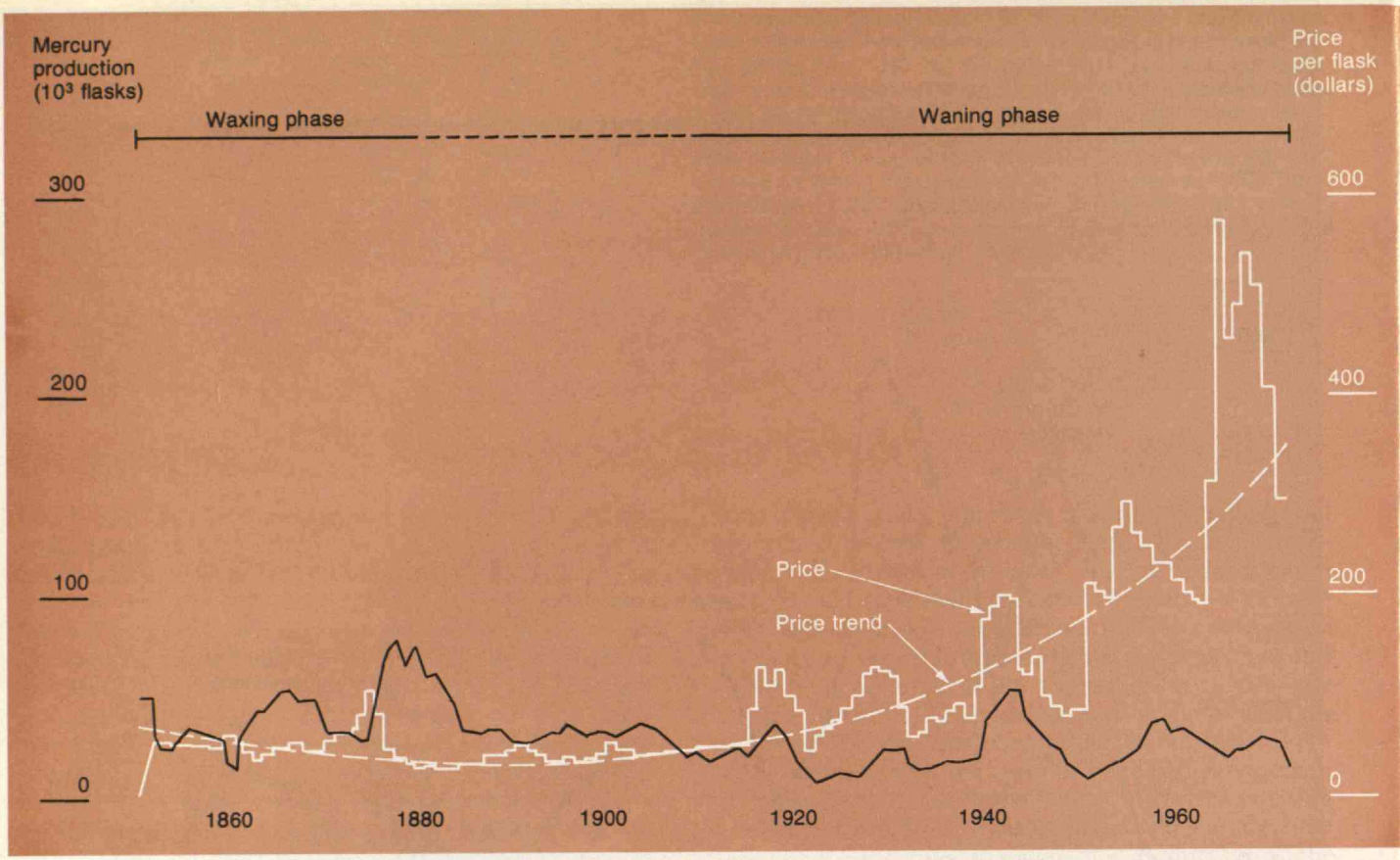


equivalent to the price rise, because depletion of crude oil reflects its geologic occurrence in small, sharply-bounded accumulations in the upper part of the earth's crust, and therefore the costs of finding and recovering crude oil and natural gas follow steep exponential curves with depletion. Ultimately energy from other sources is bound to be cheaper than energy from the last few undiscovered domestic oil pools. High prices will prolong production, but not by much; if the present oil cartel of exporting countries should collapse and world oil prices fall sharply, the end of the U.S. production curve would be abrupt. On a world scale reserves and production capacity are increasing faster than consumption; we are still in the waxing phase of the *global* production history of crude oil. Current forecasts by oil company officials place the world production peak at about 1990, after which there may be a rather sudden decline in production.

Economic-Limit Depletion: Copper

We have seen that mercury, silver, and crude oil are substances for which the economic limits to exploitation tend to coincide with physiochemical boundaries in nature. The world's major copper mines, on the other hand, are ore bodies which have economic limits that are not nearly so coincident with natural physiochemical boundaries. Here the question is whether or not technological advances, economies of scale, and the utility value of the metal will continue to increase the depth from which ore can be recovered profitably, and decrease the grade of usable ore until the average crustal abundance of copper (0.126 pounds per ton) is reached. The present average grade for ore being produced throughout the world is about 1.7 per cent copper content, while the grade of all known reserves is close to 1.0 per cent.

Much — 53 per cent — of the world's known copper reserves are in so-called "porphyry copper" deposits, of which Toquepala and Cuajone in Peru are typical (see figure on p. 24). The mass of "mineralized" rock in these deposits has the shape of an inverted and truncated cone, within which the copper content ranges from 1.32 per cent to below 0.45 per cent, the present "cutoff grade," below which mining and processing would be unprofitable. Rock containing between 0.45 and 0.20 per cent copper is, however, being mined and stockpiled for later leaching by sulfuric acid. The illustration shows that the volume of ore does not increase continually as the grade drops. Cross-sections through the mines show that the deposits have rather sharp lateral geochemical boundaries, and downward the diameter of the mineralized cone decreases. The unit cost of mining increases with depth. Moreover, the energy cost (per pound of copper) for mining and milling the ore increases inversely with grade and directly with depth. At Cuajone, if the ore cutoff grade were to fall from the present 0.45 per cent to 0.20 per cent, the total copper recovery would be increased by only seven per cent. At Toquepala, the largest mine in Peru, a similar situation exists: Lowering the cutoff grade from 0.45 per cent to 0.25 per cent would have increased recoverable copper, as of January 1, 1974, by less than four per cent. Since economies of scale appear to have been exploited fully, and since energy costs are rising, it does not appear likely that the ore reserves in these



The U.S. production and price histories for three resources that tend to occur in small bodies of high-grade ore. The patterns for mercury (above) and silver (right) are similar: at first, there is a waxing phase of exploitation, during which production increases and the price falls. A mature phase follows, during which production and price both stabilize. Finally, exploitation enters a waning phase, during which the price rises, but production's response is sluggish at best. The bottom right chart shows production and price curves for domestic crude oil. This history has not unfolded to the extent of the other two histories, but it appears to be similar. In 1971, the price of domestic crude became greater than the price that then prevailed for imports, producing a massive shift to the imported supplies and curtailing domestic exploitation. More recently, though, the sharp price increases for imports have prompted increased efforts to develop and exploit the domestic reserves. Two predicted curves for domestic production are shown at the right of the crude-oil chart; one includes North Slope production.

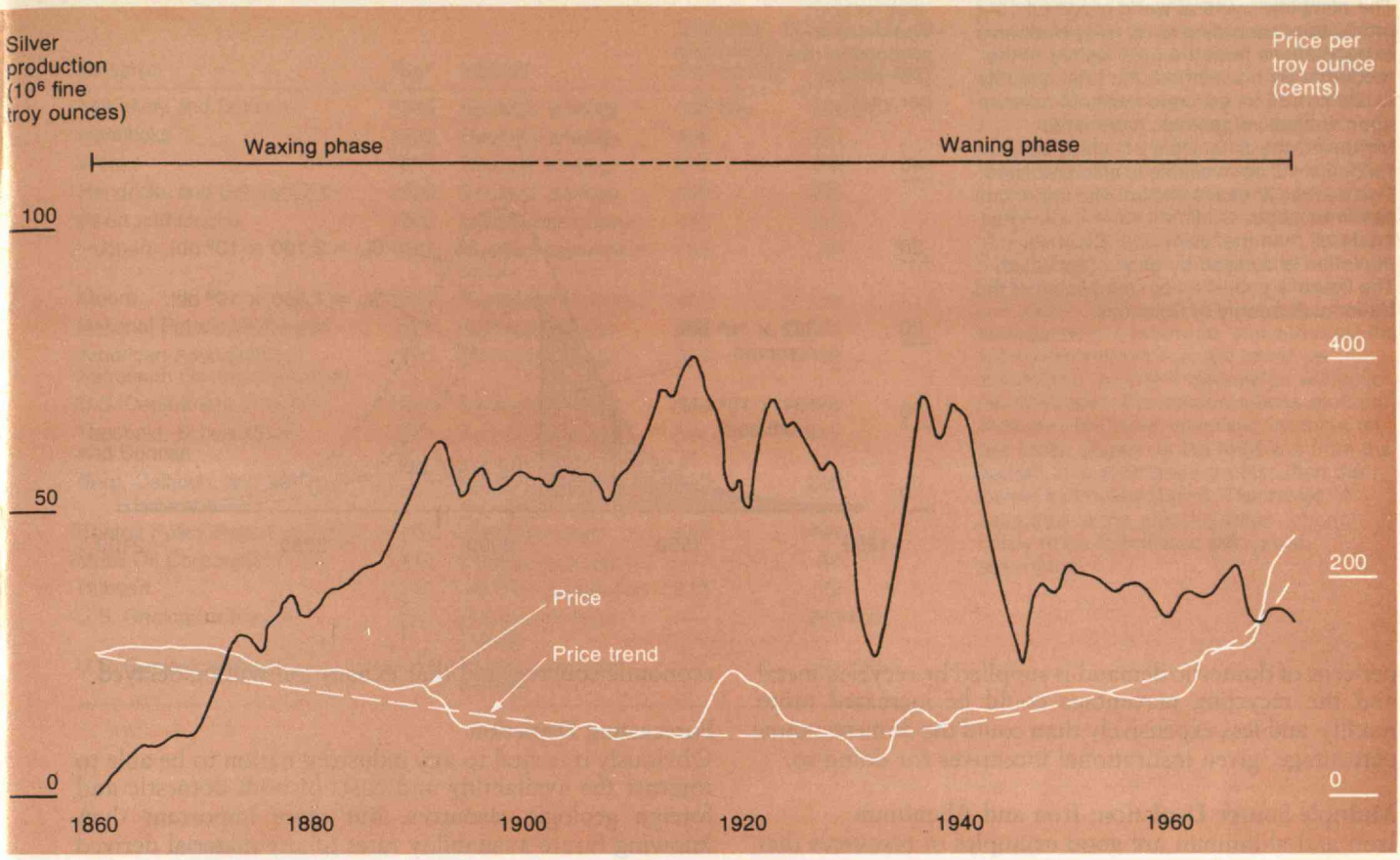
mines will be extended much by technological advances. Only if the price of copper rises faster than the cost of the energy and labor required for production will reserves be extended, and then only downward in the narrowing necks of the mineralized zones.

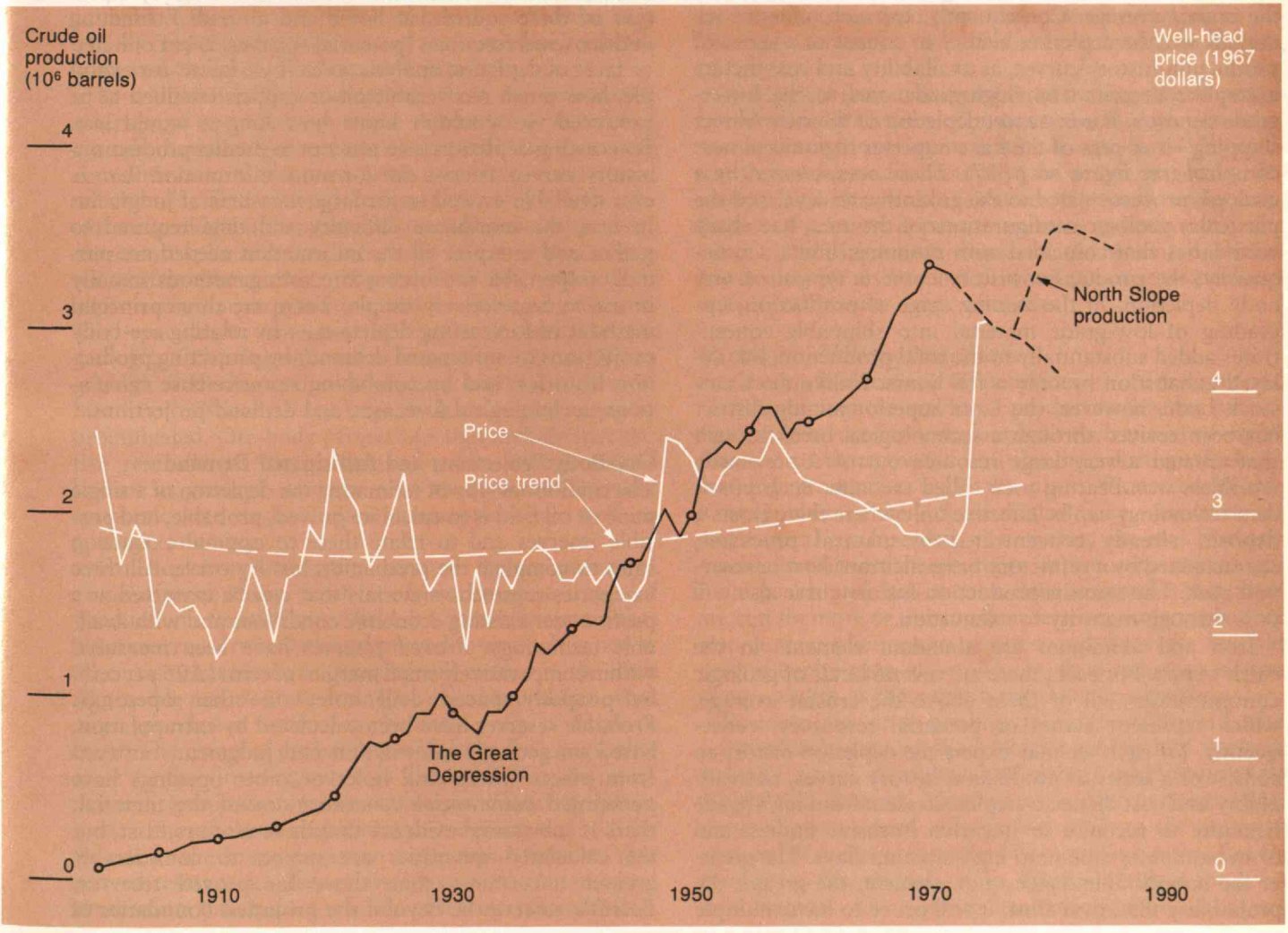
Not all copper deposits are like those which I have described, but enough *are* to throw a gray shadow of doubt over the rosy projections of the Council of Economic Advisors, which published a chart in 1970 indicating that the volume of copper ore increases geometrically as the grade drops arithmetically, and that the tonnage of recoverable copper is approximately proportional to price. That such relations can hold only for a restricted range of ores above some lowest grade limit is accepted by most students of ore deposits. It appears that this lowest limit for copper already has been reached, or nearly so.

There is currently an oversupply of copper in the world, the result of a recent major expansion of productive capacity, which in turn stemmed from: competition among the major consuming nations for foreign reserves and production; the thirst of major copper-exporting nations for increased income with which to finance economic development; a decline in the rate of increase in primary consumption in the industrialized nations as high prices stimulated secondary recovery and recycling; and a faltering of the worldwide economic boom that had been powering copper demand. Such temporary excesses in demand are characteristic of world production histories for non-renewable resources. Demand always catches up.

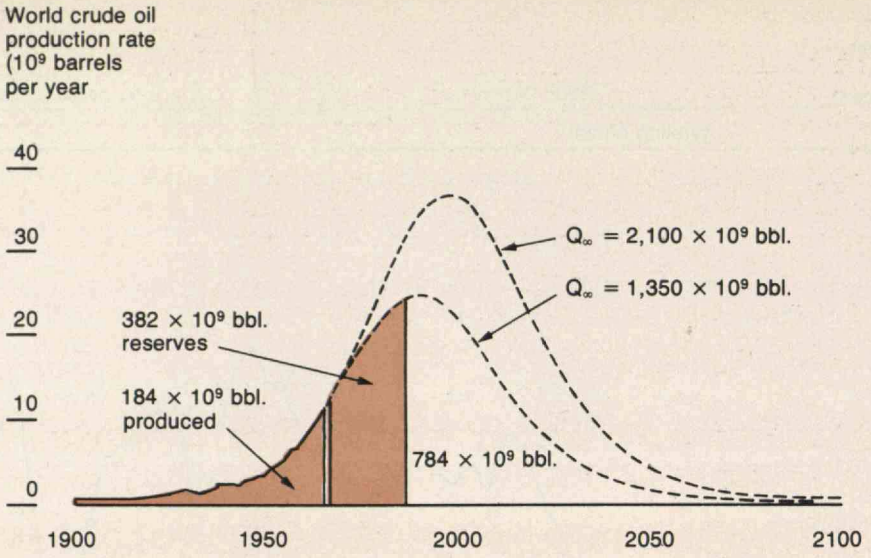
In fact, extrapolation from the consumption curve of recent years would lead one to conclude that there'll be no minable copper left by the year 2000. But that won't be the case. Primary demand will be depressed by higher energy costs, by higher production costs, and by increased recycling. By the year 2000, considerable amounts of copper will remain in known reserves, but they will be less than half as rich as the present world average. And the steep geochemical gradients at the outer limits of the major ore bodies probably will have slowed greatly the rate of additions to known reserves. Copper will be considerably more expensive than it is today, but will still play a major role in the structures and communications of industrialized society because of the large amount that will be available in the recycling system.

Indeed recycling appears to offer the main hope of slowing copper depletion — by reducing consumptive demand for newly-mined ore. The beauty of recycling is its positive feedback effect: the more metal that accumulates in the recycling system, the more primary production is displaced, not just once but many times. A whopping 30


Silver production (10^6 fine troy ounces)
Price per troy ounce (cents)
Waxing phase
Waning phase
100
50
0
400
200
0
Price
Price trend
1860
1880
1900
1920
1940
1960


Crude oil production (10^6 barrels)
Well-head price (1967 dollars)
4
3
2
1
0
4
3
2
1
0
North Slope production
Price
Price trend
The Great Depression
1910
1930
1950
1970
1990

The complete cycle of world crude-oil production, according to M. King Hubbert's extrapolations from the past history of the resource. By his method, the total quantity available can be estimated without reliance upon subjective geologic judgments. Moreover, the time-scale on which the resource will be available is also predicted. Two dashed lines are shown. The upper one assumes about 1.5 times more exploitable crude oil than the lower one. Even so, depletion is delayed by only a few years. The figure is published by permission of the National Academy of Sciences.



per cent of domestic demand is supplied by recycled metal and the recycling percentage could be increased more readily and less expensively than could the domestic-mine percentage, given institutional incentives for doing so.

Multiple-Source Depletion: Iron and Aluminum

Iron and aluminum are good examples of resources that occur in several kinds of geologic concentrations above the crustal average. Consequently, for such minerals we may expect the depletion history to consist of a series of production-history curves, as availability and cost dictate a steplike descent from high-grade ores to the lower-grade deposits. For instance, depletion of the rich "direct shipping" iron ores of the Lake Superior region is almost complete (see figure on p. 27). These ores, created by a geologic process related to the groundwater level and the particular geologic configurations of the area, had sharp boundaries that coincided with economic limits. Consequently, the production history curve is typical of ore-body depletion. In the waning stage of production, upgrading of low-grade material into shippable concentrates added substantially to the total production, but delayed exhaustion by only a few years. Unlike the Comstock Lode, however, the Lake Superior mining district has been revived through a technological breakthrough that created a very large resource out of a previously worthless iron-bearing rock called taconite. Such provident technology can be effective only where there exists a deposit, already concentrated by natural processes, characterized by a refractory or recalcitrant host or reservoir rock. The taconite production-history curve also will pass through maturity to exhaustion.

Iron and aluminum are abundant elements in the earth's crust. For each, there are several kinds of geologic concentrations, all of them above the crustal average, which represent actual or potential resources; consequently, for each we may expect the depletion history to consist of a series of production-history curves, as availability and cost dictate a steplike descent from high-grade hematite to taconite to iron-rich intrusive bodies, and from bauxite to alunite to high-alumina clays. The greater the natural abundance of an element, the greater the probability that, over time, it will prove to have multiple economic sources, and that exhaustion will be delayed.

Forecasting Depletion

Obviously it is vital to any industrial nation to be able to forecast the availability and costs of both domestic and foreign geologic resources. But more important than knowing future availability rates of any material derived from nonrenewable sources is knowing the *stage of depletion* of these sources, at home and abroad. Estimating undiscovered resources (potential reserves) is but one step or facet of depletion analysis; even if we knew, for example, how much recoverable oil or copper remained to be produced we wouldn't know how long it would last. Forecasting depletion is an attempt to predict production-history curves. It cries out for more information than is ever available as well as for large measures of judgment. In fact, the inordinate difficulty and time required to gather and interpret all the information needed are partially responsible for forcing forecasting methods actually in use to be relatively simple. There are three principal methods of forecasting depletion — by relating ore-body projections to anticipated demand; by projecting production histories; and by combining resource-base calculations, technological forecasts, and demand projections.

Ore-Body Projections and Anticipated Demand

The traditional way of estimating the depletion of a single mine or oil field is to calculate proved, probable, and possible reserves and to relate these to optimal extraction rates to complete the production history curve. All three categories represent materials that can be extracted at a profit under existing economic conditions and with available technology. *Proved* reserves have been measured within comparatively small margins of error (±25 per cent) by properly-spaced drill holes or other openings. *Probable* reserves have been calculated by extrapolation, based on geologic information and judgment, outward from places where drill holes or other openings have penetrated commercial concentrations of the material; there is substantial evidence that these reserves exist, but the calculated quantities are subject to considerably greater uncertainty than those for proved reserves. *Possible* reserves lie beyond the projected boundaries of

Author(s)	Year	Method	Ultimately recoverable (10^9 barrels)	Recoverable beyond known reserves (10^9 barrels)
McKelvey and Duncan	1965	Geologic analogy	320-660	180-520
Hendricks	1965	Geologic analogy	400	260
Weeks	1965	Geologic analogy	270	130
Hendricks and Schweinfurth	1966	Geologic analogy	500	360
Elliott and Linden	1968	Exploitation history	450	310
Hubbert	1969	Modified exploitation history	190	50
Moore	1971	Exploitation history	353	213
National Petroleum Council	1971	Geologic analogy	242	102
American Association of Petroleum Geologists (Cram)	1971	Geologic analogy	432	292
U.S. Department of Interior	1972	Geologic analogy	549	409
Theobald, Schweinfurth, and Duncan	1972	Geologic analogy	596	435
Berg, Calhoun, and Whiting	1974	Modified geologic analogy	400	260
Energy Policy Report (R.F.F.)	1974	Resource base	682	466
Mobil Oil Corporation	1974	Geologic analogy	—	88
Hubbert	1974	Modified exploitation	213	73
U.S. Geological Survey	1974	Modified geologic analogy	—	240-450
U.S. Geological Survey	1975	Modified geologic analogy	—	50-127

Estimates of U.S. crude oil resources. Several methods were used to produce the figures in the fifth column — predictions of the amount of hidden crude oil that will be recoverable when and if it is discovered. The most popular method is "geologic analogy," which extrapolates from known reserves to speculative ones. On the other hand, the "exploitation history" method extrapolates from the history of exploitation of a resource to predict its future, without making any judgment about putative reserves. Finally, the "resource base" calculation begins with the average crustal abundance of a resource, and subtracts the estimated amount that will never be discovered, or that if discovered will never be recovered. The resource base method produced the most optimistic estimate on this table; shown on the third line from the bottom, it is nine times greater than the lowest estimates shown. The range of estimates is too great to allow national policy to be formulated with great assurance.

probable reserves in areas of established production; they usually represent undiscovered or undelineated ore bodies and oil pools in favorable environments.

In addition to these categories, there are *speculative* reserves, of two kinds: *geologic,* representing material of a grade that could be extracted at a profit under existing economic conditions and with available technology, which may exist in unexploited areas for which little subsurface geologic information is available; and *economic,* representing known concentrations of material too lean, too far from the market, or in reservoirs too refractory to allow economic exploitation under existing conditions. The speculative category allows wide latitude for geologic, technological, and economic judgment. When geologic inference and technological forecasts are combined optimistically, very large "reserve" figures may be promulgated. Ore-body projections that include speculative reserves are the product of a forecasting method known as *geologic analogy* — a method that includes economic and technological assumptions as well as geologic inferences.

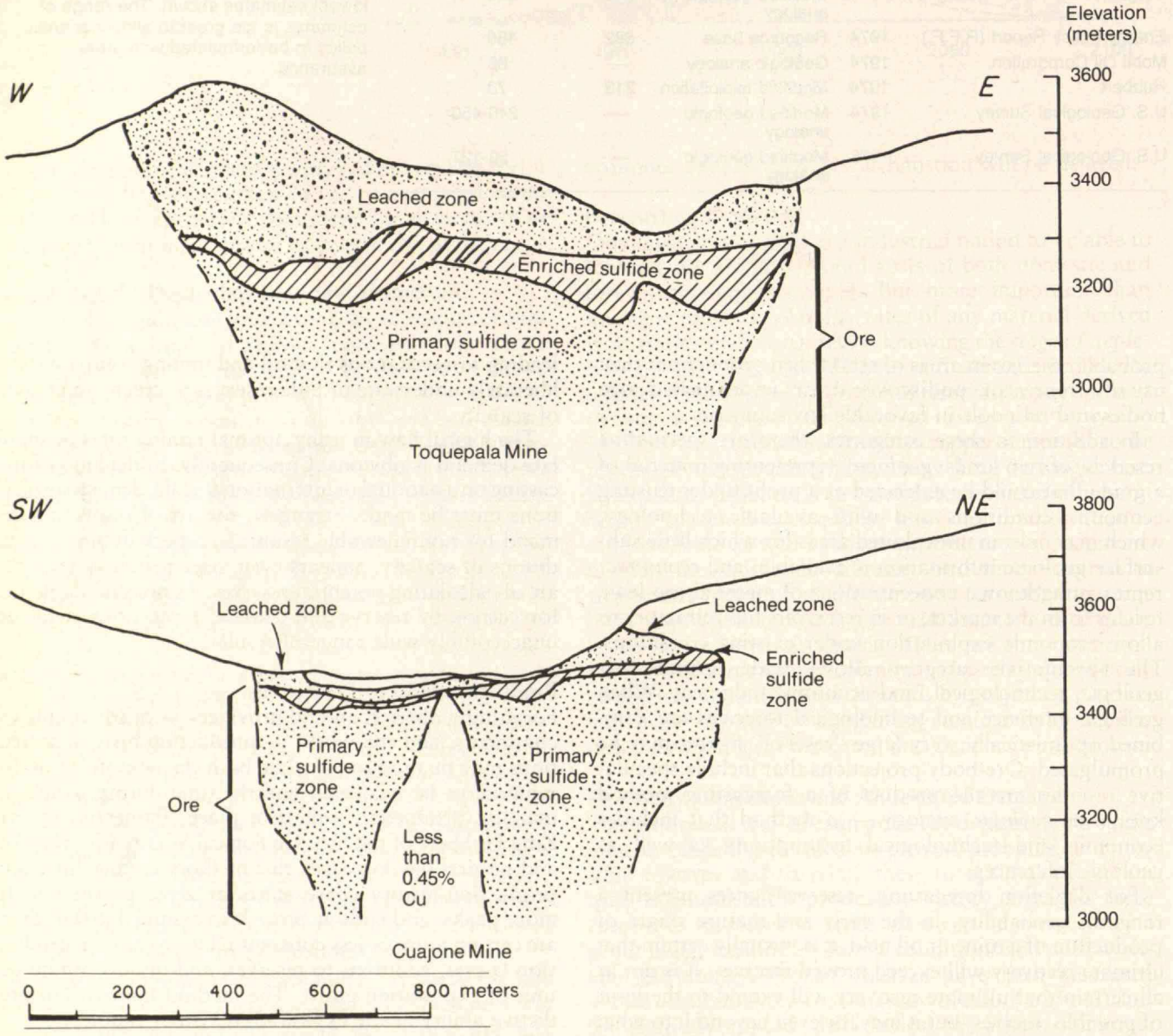
For depletion forecasting, reserve figures present a range of probability. In the early and mature stages of production of a mine or oil field, it is virtually certain that ultimate recovery will exceed proved reserves. It is not at all certain that ultimate recovery will extend to the limit of possible reserves, but it may, or even beyond into what were speculative reserves in the early years of development. The range of probability widens as the geographic scale or the time trajectory is increased. For major investment purposes, however, only proved reserves can be used, although land acquisition and exploration will be based on the more uncertain categories. The fact that proved reserves are almost always exceeded by ultimate production has caused considerable misunderstanding, leading to accusations that oil and mining companies deliberately understate or hide reserves to create an illusion of scarcity.

The logical flaw in using optimal mining rates to simulate demand is obvious. Consequently, in depletion forecasting on a national or international scale, demand projections must be made. Strangely, the art of projecting demand for nonrenewable resources, especially under conditions of scarcity, appears even more primitive than the art of calculating potential reserves. At present, depletion forecasting by reserve and demand projections yields an unacceptably wide range of results.

Production-History Projections

For mining districts and oil provinces — or for countries, continents, and the world — production-history projections may be used to calculate both the amount of useful material to be recovered and the time during which remaining production will take place. Pioneered by M. King Hubbert of the U.S. Geological Survey for crude oil and natural gas forecasts, this method assumes that any production-history curve starts at zero, passes one or more peaks, and ends at zero. Also assumed is that there are certain more or less constant relations among production curves, additions to reserves, and discovery rate per unit of exploration effort. The method improves in predictive ability as the exploitation history unfolds.

Economists and geologists have criticized the production-history method for not taking into account political, social, economic, and technological impacts on supply and demand. Most critics appear to believe that these impacts would enlarge and prolong the recovery and use of geologic resources beyond ranges forecast by production-history projection. But such faith in the positive impacts of evolving technology and changing



Cross-sections through two copper mines in Peru, the Toquepala Mine (top drawing) and the Cuajone Mine (bottom drawing). Copper ore in each mine takes the form of an inverted cone, but the grade of ore is not uniform throughout. At the top of the cone is overburden whose copper content is extremely low. Nevertheless, the overburden must be removed, so it is being stored for eventual leaching by sulfuric acid. Beneath this "leached zone" is a zone of high-grade ore, whose copper content averages 1.32 per cent. Then comes the primary deposit — ore containing perhaps one per cent copper. Deeper into the mine, the grade of ore decreases, and the amount decreases sharply as the grade declines. (Chart: Southern Peru Copper Corp.)

economic conditions may be unwarranted, in view of rising energy costs, exponential increases in drilling costs with depth, and abrupt decreases in geochemical concentrations in deposits of some important metals. This method has given remarkably accurate forecasts of crude oil and natural gas production peaks in the United States; moreover, it contains none of the great temptations to self-interest inherent in both the reserve-demand projection method and the method to be discussed below.

Resource-Base Calculations, Technological Forecasts, and Demand Projections

Economists of Resources for the Future, Inc. (R.F.F.), and geologists of the U.S. Geological Survey have promoted the use of the resource-base concept. According to Schurr and Netschert of R.F.F., the "resource base" includes "the sum total of a mineral raw material present in the earth's crust within a given geographical area." It is, in other words, the crustal content of crude oil, copper, or any other geologic resource. Because estimates, based on considerable sampling, exist of the crustal abundance of all elements and some compounds, this "resource base" can be calculated. From this is subtracted an estimate of the amount of the material that will never be discovered, a second estimate of the amount that will not be recovered if discovered, and the cumulative production to the date of estimation, in order to derive a number corresponding to the remaining recoverable resource. Then, as in the first method described, a demand curve can be fitted to this total to forecast depletion.

This method is not the same as calculating speculative reserves, although both methods tend to yield large numbers compared to the production-history method. The resource-base concept may easily mislead the unwary, as shown by a 1968 publication of the U.S. Department of the Interior. On the first page of that report's "Summary and Conclusion" — and clearly aimed at the interested layperson — was an estimate of crude oil, natural gas liquids, and natural gas *originally in place* within the exploitable jurisdiction of the United States, compared to cumulative domestic production of oil and gas through 1967. According to the chart, there were, for example, 2 trillion barrels of oil "originally in place" in the United States and its continental shelf to a water depth of 600 ft., and of this total only 84 billion barrels, or four per cent, had been "withdrawn" as of January 1, 1968. The first sentence below the table hammers home the point: "The remaining petroleum resources of the United States," it reads, "are obviously adequate to support consumption for many years into the future." But there is a contradiction in the next sentence, which states that: "The real question is whether [these resources] can be located and produced at costs which permit them to compete with other energy sources." This "real question" — whether the so-called resources will ever become true resources — is not obvious to the nonprofessional reader, who might never reach the passage on page 12 of the same report, which reads: "The fact that we have X billion barrels of oil and Y trillion cubic feet of gas in the ground, however, says nothing at all about how much of these quantities will eventually be found and put to use."

Early in 1974, the Energy Policy Project of the Ford Foundation published its first report, which contained a table of U.S. energy resources prepared by Resources for the Future. It is in resource-base format; when converted to barrels from the heat equivalents given, the figures for petroleum are seen to represent new highs for estimates of oil originally in place ($3{,}680 \times 10^9$ barrels) and in "recoverable resources" (520×10^9 barrels). Not surprisingly, the report states (p. 44) that "The work done for the project by R.F.F. suggests that energy resources are at least sufficient to meet the year 2000 requirements with major reliance on oil and gas supply."

The statistical basis for rejecting the resource-base model as a guide to estimation of future recovery of crude oil has been thoroughly presented by Hubbert in his 1974 report to the Senate Interior Committee, in which he points out the "leverage" represented by changes in estimates of the base or of the ultimate recovery ratio. The recovery ratio, as a manipulable factor of technological forecasting in projections based on oil-in-place estimates, may unbridle the technological optimist and allow estimates that put extreme demands on the technological cavalry to come riding over the hill in the nick of time to rescue the nation from scarcity.

The Importance of Depletion Forecasting

The importance of depletion forecasting may be illustrated by estimates of ultimately recoverable crude oil in the United States published within the past ten years (see table on p. 23) that state or imply a range of undiscovered but recoverable crude oil of nine times, from the lowest to the highest estimate. Such a range is almost useless for formulating national energy policy, because national strategies based on the lowest estimate would be quite different from those based on the highest. Believing a small estimate may lead to national strategies for:

— subsidized development of coal, nuclear fuels, and

The production history of a single iron district — the Lake Superior District. Depletion of this district has twice been delayed, first by economic technology, which made possible the exploitation of low-grade ore, and then by provident technology, which made possible the exploitation of a different and previously worthless form of iron-bearing rock. The data are shown as five-year running averages of iron content, plotted at the midpoint of the five-year period.

shale oil;
— conservation incentives and controls;
— creation of a strategic-economic reserve or stockpile;
— continued efforts to secure foreign resources at costs lower than those of domestic reserves.

Believing a large estimate, on the other hand, might lead to:
— incentives for domestic exploration and production;
— relaxation of environmental constraints on such activities;
— import restrictions.

Geologic analogy itself produces a wide range of estimates, a consequence of differences in the optimism with which individual authors or groups have calculated speculative reserves. Yet even if the larger estimates should be verified by production, the additional time during which the resource will be available may be small. A resource that is available will be used. If availability increases, consumption will increase; when consumption increases, depletion increases.

Because knowledge of the duration of abundant supply is more critical to national welfare than knowledge of the quantity ultimately available, the production-history method of forecasting depletion may be a better guide to national policy than are the geologic-economic methods, for it yields a direct and continuous forecast of supply rates. In addition, its errors will fall on the side of prudence rather than on the side of flatulent optimism.

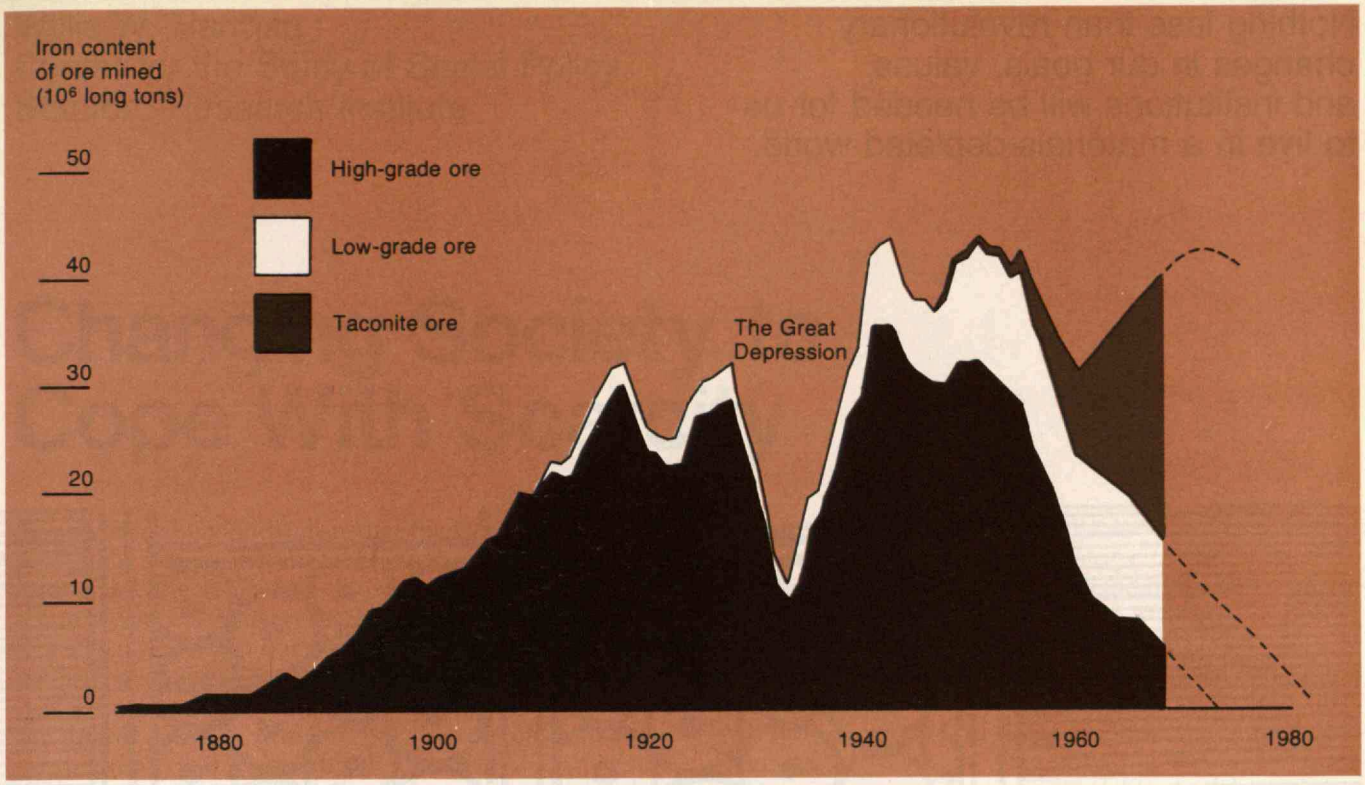
Managing Depletion

Geochemical concentrations of useful mineral substances are far from uniformly distributed throughout the world; almost 70 per cent of proved crude oil reserves are in the Middle East, for example, and five countries produce more than 65 per cent of the world's copper. These nonuniform distributions are real, and do not merely reflect differences in exploration effort. Geologists have long known that metallogenic as well as petroleum provinces exist and that the world's coal deposits are strikingly concentrated in the temperate belt of the northern hemisphere; physicist Herman Kahn once astonished them with the statement that the geology in forested Latin America is the same as it is in the barren highlands where most of the mineral resources have been discovered, and that the lack of discovery in the other parts of Latin America is because "people just have not looked . . ." In fact, the search for geologic resources has been unremitting and increasingly sophisticated throughout the world. Yet the persistent dream of vast, undiscovered resources is told again by John C. Fisher in his recent book, *Energy Crises in Perspective:* "I expect," he writes, "that as better data become available, the energy resources of the world will prove to be more or less uniformly distributed." Such hopeful ignorance of the facts of the earth's constitution and history might be harmless were it not used as the basis for recommended national energy and minerals policy.

Not only are geologic resources distributed unevenly over the surface of the globe, but they appear strikingly concentrated in the outermost part of our planet. This is because natural mechanisms that concentrate chemical elements operate most effectively on and near the earth's surface: weathering, erosion, sorting during transport, and groundwater leaching are effective only in the upper few hundred feet of the earth's crust. Conditions favoring the maintenance of open fractures and the abrupt deposition of mineral materials from rising emanations exist only in the upper few thousand feet of the crust. And finally, oil and gas formation, migration, and entrapment take place within the sedimentary skin of the continents, at depths of 50,000 feet or less. Several conclusions emerge: many geochemical concentrations have been destroyed by erosion; uplift and erosion have made many deposits of geologic resources more accessible than they otherwise would have been; and geochemical concentrations (ore bodies, ore pools) are not likely to exist below levels almost within range of current drilling technology.

Thus, in view of the geologic and geochemical constraints on the occurrence of economic deposits of minerals and energy resources, and the advanced nature of present exploration techniques, we must conclude that our resources are economically finite. There is no "endlessly retreating interface" between ore and almost-ore which some optimists have described. On the other hand, the question "When will we run out?" bespeaks a misunderstanding of geologic resource limits. The voracious exploitation of geologic resources on a global scale will draw to a close "with a whimper, not a bang." The world will not run out of inanimate energy or other geologic resources. But expenditure of the major part of mankind's natural subsidy of fossil fuels by the early part of the coming century will make energy and other geologic resources more expensive than they are today. Just how expensive will depend, as always, on a combination of geologic and technological factors. Depletion of geologic resources is real. It is swift for those materials found mainly in sharply-bounded, highly concentrated deposits — especially swift if they cannot be recycled after use. It is slow for abundant materials found mainly in deposits of relatively low geochemical concentration with gradational boundaries — especially slow if they can be recycled after use.

Our society and economy are growth- and production-oriented. Goods and services are produced but do not accumulate indefinitely; coincident with production is waste or entropy increase (the dispersion of materials and



the degradation of energy toward useless heat), which *does* accumulate indefinitely. The ultimate constraint on a growth society is entropic.

Mineral and energy deposits have low entropy relative to average rock. At considerable energy cost, their entropy is further lowered by concentration and refining. No energy profit can be made by reducing entropy; when we do it, we save human energy at the expense of fossil energy. In application or use, most geologic resources are degraded: their entropy increases. The fossil fuels, the agricultural chemicals, many of the construction minerals, and some of the metals are degraded beyond energetic recall. On the other hand, the low entropy of metals used in structures, machines, pipes, wires, and batteries may be conserved for recycling.

Two critical elements in the conservation of geologic resources as they become scarce and costly will be the development of economic ways to reduce or delay entropy increase; and the social rationing of depletion. The first subject has been treated in evocative fashion by Nicholas Georgescu-Roegen, while the latter has been explored by Herman Daly. Because actual recycling and reforming of materials can be done with only a relatively small fraction of the material used by an industrial society, increased attention is likely to be given to forming structural elements so that they can be rehabilitated in place or recovered for use elsewhere; and, of course, common materials will be used wherever practicable in place of scarce ones. Eventually, dissatisfaction with the market as the allocating mechanism for the social benefits of resource use is apt to bring depletion rationing of those resources which can be neither recycled nor reused and for which demand exceeds supply. Barring a breakthrough in the technology of energy, the present industrialized nations will have severe readjustments to make in the next 50 years.

If we neglect to conserve the remaining natural subsidy of the fossil fuels, there may be little hope for the nonindustrialized countries, except through luck or aggression, to supply their citizens with needed minerals, for without a substantial energy surplus that can be allocated to their exploitation, the nonenergy mineral resources do not exist, no matter how much mineral is in the ground. Industrialized nations may be compelled to uncommon ingenuity in use of common materials to avoid devolution into a retrograde agricultural society.

The dynamics and ethics of our production-oriented society will make thermodynamic thrift very difficult to achieve. The government now proposes tax cuts and other incentives to stimulate the U.S. public to buy more things, in order to "get America rolling again." High on the list of things we are urged to buy is the automobile, a machine that merits inclusion in *The Guinness Book of World Records* as the champion resource wastrel of the modern era. In the push to get workers back to the assembly line, government has not taken into account the realistic *need* for the product or the cost to future generations in nonrenewable resources depleted and entropy irrevocably increased by the production of unneeded machines. I consider most new cars unneeded because it is patent that the majority of citizens can get by with the cars they now have, perhaps for several years, with no decrease in actual transport utility.

Sometime in the not-too-distant future, Americans will look back with astonishment at our ignorance of the world we live in. Because of diminishing resources and continued population growth, we are heading for a planned, managed society. Just how restraining or undemocratic that society will become may depend in large measure on how quickly and successfully we move to minimize entropy increase and resource depletion — which, after all, are the same thing.

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Nothing less than revolutionary changes in our goals, values, and institutions will be needed for us to live in a materials-depleted world.

Willis W. Harman
Center for the Study of Social Policy
Stanford Research Institute

Changing Society to Cope With Scarcity

By now it is abundantly clear that the United States faces potentially serious materials shortages, and that both the causes and effects of these shortages are complex. Government reports and even the daily newspapers tell us that the gap between our needs for raw materials and the remaining easily accessible world supplies is widening. And even if there are still plentiful supplies of minerals, the rapidly growing demands of other nations make importing more and more difficult and costly.

Materials policies are intricately intertwined with other aspects of our society — transportation, balance of trade, industrial production, economic stability and unemployment — and these factors in turn deeply affect materials needs. In fact, so complex are these interactions that policymakers are frankly unsure of the ultimate effects of any of their decisions on materials procurement, distribution, or recycling.

The eight propositions summarized on page 34 are an attempt to deal with this complexity. These evolved out of extensive research on alternative futures for the nation and the world. Like any other interpretation of the future, they are not demonstrable. However there is enough evidence of at least plausibility to warrant their serious consideration. If these propositions do indeed turn out to be true in any sense, they have momentous implications for national and world policy. Now, to the first proposition:

Imminent revolutionary changes toward a "post-industrial" society will affect materials policy.
It is quite clear that our country, as well as other technically advanced nations, is rapidly proceeding beyond the traditional industrial age. This post-industrial economy is marked by a decrease in the number of industrial workers, an increase in service workers, and, perhaps most important, an increased concern over "quality of life" as opposed to quantity of goods.

Opinions vary as to how rapid and extreme this change in our economy will be, but it will be more rapid than any major historic social change — modern transportation and communication make rapid spread certain.

We probably cannot control this massive transformation of our social institutions, but we can produce policies to reduce the accompanying social chaos and disruption.

Current materials policies cannot be sustained more than a few decades without serious social disruption — radical policies are needed.
Regardless of whether we achieve zero population growth, current materials policies (indifference and noninterference are policies, too) cannot be continued for more than a few decades without:
— Shortages of key materials, including fossil fuels, topsoil, and some minerals
— Energy demand outracing supply
— Severe interference with natural biological and ecological cycles
— Impoverishment and degradation of the human environment
— Deterioration of the quality of life, health, and possibly of genetic stock
— Possible ultimate ecological catastrophe

Certainly when we look at materials problems in isolation there appear to be no insurmountable difficulties for some time to come. We can substitute one material for another, exploit low-grade ores, develop new technologies for resource use, and import ores and crude oil (although at a high political and economic price). Our massive coal deposits can be used as such, or converted to synthetic oil and gas, and nuclear, solar, geothermal, and other energy sources can be developed. And, of course, we can recycle our solid wastes and clean up our pollution.

However, when we consider all these problems in the aggregate and study their interaction, the profound nature of our crisis begins to emerge. For example, *materials* limitations affect *energy* production. Fossil fuels will run out, high-grade uranium ores will be depleted, and solar energy farms would require enormous amounts of scarce metals. But, we are told, when such materials become scarce, the price goes up and it becomes economical to develop methods to extract low-grade ores, mine from the sea, convert from one material to another, and so on. However, these are highly energy-consumptive processes, and we now begin to encounter *energy* limitations on *materials* production.

Our nation could urge a world policy of beginning to level off both materials and energy consumption. But such a policy risks economic decline and unemployment, and also invites hostility from nations whose material standard of living falls far below the average American's.

And if our corporations did cooperate with plans to use materials and energy economically, and to voluntarily minimize deleterious effects on the environment, it would endanger their survival, as long as they had to compete with other corporations here and abroad which might not adopt these more expensive practices.

In sum, the period from the Industrial Revolution to the early part of the 21st century — about 250 years — is

An increased interest in and tolerance of the "ecological ethic" has arisen, and with it a sense that the nature of man is both physical and spiritual. As a result groups as far removed as students and corporate executives have evidenced an increasing interest in humanistic and spiritual values, quality of life, community, and the person-centeredness of social institutions. (Photo by J. Albertson, Stock, Boston)

unique in man's history. During this period man has been living on a prodigal scale using a legacy of virtually non-replenishable minerals and fossil fuels. Before this period man's consumption from this storehouse, and his consequent environmental impact, were small. After this period there will be an indefinite time during which the storehouse's limitations will be patently evident, and humans will have to learn to fit their activities to a new set of ecological relationships. Nature's recycling processes will have to be supplemented with new ones engineered by man.

Materials policy is intimately intertwined with social and economic policy.

The beginning of the Industrial Revolution marked extensive changes in the behavior of individuals, societies, and institutions; so it is with the transitional period we are now entering. So we cannot expect even the most prudent materials policy alone to resolve our materials predicament. Certainly it may be wise to build the nuclear breeder reactor; to tax fossil fuel, and apply the revenue to development of alternative energy sources; to cut down on materials and energy usage; and to substitute materials. But unless we work large changes in how our society and our economy operate, these will only buy time until an ultimate showdown with our planet.

Some examples of the interconnectedness of the materials-economic-social-political complex: if we try to further raise economic productivity, an admirable end, we are likely to lower environmental quality, a not-so-admirable result. Land-use policies, perfectly reasonable in earlier days, have extravagantly wasted one of our more critical materials — topsoil, mainly by building cities over it. Massive importing of minerals to sustain our economy has given rise to international charges of exploitation.

Although seemingly basic, the fact has been often overlooked that our materials problems, in fact all our serious problems, have resulted from or been aggravated by the fantastic successes of the Industrial Revolution. Thus, it seems unlikely that continuing to think in "industrial" terms will now make these problems go away. Rather, we must aim towards a whole-systems approach to social transformation — a task which we are so far ill-equipped to undertake.

Resolving our materials-related problems requires policies insupportable by our present institutions and behavior. There are countless examples illustrating how our institutions work against adequate materials policy. For instance, what happens when large-scale recycling is ecologically or strategically desirable, but economically disadvantageous (*e.g.* returning urban wastes to the land or recycling scarce metals)? The system decision-making rules force us to eschew such recycling and to evade the spirit of government-imposed regulations when profitable to do so. Everyone has heard of the industrialist who, upon learning that government fines for pollution will be less than pollution control costs, opts for the former.

And even if it were economically feasible to recycle wastes, urban and rural political organizations have great difficulty cooperating to carry it out.

How about the many industrial policies, sound in materials use, but unsound economically and in terms of productivity? Industry is unlikely — indeed unable — to adopt them until we can resolve the conflict between economic gain and social good by:

— Substituting materials when long-term future shortages are indicated

— Developing long-term advantageous processes uneconomical in the short run

— Redesigning a product to be repaired rather than thrown away to make recycling easier or reduce usage of non-biodegradable materials

— Depressing consumer demand for a product when its social good is questionable.

This serious conflict between economics and social good evolved as a result of a number of dilemmas confronting the industrial society. The dilemmas listed here might be described as multiple intolerable tradeoffs, and collectively amount to a fundamental challenge to our free-enterprise, democratic system:

We must continue to grow economically and technologically, but the consequences of this growth are intolerable. This is popularly known as the "limits to growth," which argues that we must shift to a "steady-state economy." While we experience all the energy and environmental problems associated with growth, we fear stopping it, because of the possibility of unemployment and economic depression. Should growth slow, there will also be increased pressure for a "bigger piece of the economic pie" that was less evident when the pie was expanding more rapidly.

We must guide technological innovation, but the consequences of centralized control are disquieting. While technology does increase in its power to affect our physical, social, political, and psychological environment, we cannot be sure that a democratic society can anticipate

technological impacts, protect the interests of the whole society, and yet preserve the basic characteristics of a free-enterprise system.

Individuals will almost certainly become ever more governed by organizations, but this appears to reduce our liberties and make our systems more fragile. Modern transportation and communication and growing interdependencies of specialists make persons and systems more closely interconnected. This places the individual's freedoms in jeopardy — the modern astronaut's actions are more circumscribed than those of the old-time cowboy. This interdependence means more and more government regulation to reinforce the faltering "invisible hand" of free enterprise — entailing price regulation, environmental restrictions, controls over safety of food and drugs. Such regulation interferes with industrial responses to market pressures and contributes to such dislocations as shortages of fuel and other commodities. Internationally, this interdependence has become so intense that depression or inflation in one or a few countries becomes "contagious." At the same time, universal commitments to full employment increase inflation, and individual nations' trade barriers and price controls make the one-world of today even more unstable. Politics aside, the sheer complexity of national and international systems — economic, transportation, electric power — makes them more vulnerable to breakdowns, accidental or deliberate.

Enough work to go around seems essential to a healthy society, yet our industrialized economy seems increasingly unable to provide these opportunities. Employment statistics and opinion polls fail to indicate the seriousness of unemployment and worker discontents. But there are indications that our citizens fear meaningful work will become an endangered species. These indications take the

Division of labor, specialization, and cybernation are "anti-human" processes, consequences of the industrial era, and have worked to counteract human ends — enriched work roles, resource conservation, and environmental enhancement. The challenges to our institutions from consumers, minorities, environmentalists, and workers have been efforts to reclaim these human ends. (Photo by Daniel Brody, Stock, Boston)

form of widespread fear of unemployment and foreign industry's "exporting" jobs; inflated job-entry requirements; forced early retirement policies; featherbedding and make-work practices.

Psychologists have made it clear that lack of a satisfactory work role — as employee, self-employed, housewife, or student — can result in personal disintegration. And competition for scarce jobs can exacerbate racial and intergroup conflict — blacks competing with whites, and youth with their elders. Further, people worried about their jobs cannot contribute as creatively to problems of environmental pollution or natural resource waste. One remedy has been government welfare or unemployment payments, a solution that ignores the psychological aspects of employment and the person's need for a satisfying and valued role in society.

The industrialized nations will find it costly to share the earth's resources more equitably with less-developed nations. But not sharing may prove even more costly. As the less developed nations modernize they will begin to demand their share of scarce materials, perhaps at a pace that can be met only by a lowering of the rich nations' standard of living. If unheeded, however, this pressure could become a major threat to world stability, not only political but environmental. Continued worldwide economic growth is necessary to afford the world's three billion poor a decent standard of living, yet, as our past record shows, such economic growth poses an undeniable threat to the environment and to the health of man.

These five dilemmas confronting the United States are also dilemmas of the rest of the industrialized world, and they appear just as insoluble to the other nations. They are essentially unresolvable without fundamental systemic change.

We can identify institutional changes to support needed materials policies.

To do this, however, we must first recognize a more basic anomaly than even the ones we have heretofore discussed. This anomaly is based on the fact that the industrial era's basic goals — material progress, private ownership of capital, maximum return on investment, free enterprise — have been approached through a series of subgoals. These subgoals — efficiency, economic productivity, continued growth of production and consumption, continued growth of technological-manipulative power — have caused processes and states which counteract human ends. These "antihuman" processes and states include an extreme division of labor and specialization, cybernation, stimulated consumption, planned obsolescence, and exploitation of common resources. The human ends that they counteract include enriched work roles, resource conservation, and environmental enhancement. We see the powerful impetus to reclaim these human ends in the intensifying challenges to our institutions from consumers, minorities, environmentalists, workers, and civil libertarians. In fact, this "anti-humanistic" consequence of the technological-industrial thrust presages increasing turmoil, followed by some sort of major restructuring because of the strength of the growing challenge to the legitimacy of the present system. This restructuring will be largely completed within the next 15 to 20 years, if it occurs at all. The new structure, because of the magnitude of the problems facing it, might be a highly authoritarian state, an unstable system held together by force of a centralized control, with concomitant reduction of individual liberties. Or, if the post-industrial transformation is more successfully undergone, there is a possibility of a synthesis of high technology and humanism.

The key to making it successfully to post-industrialism is whether we can resolve all these dilemmas compatibly with the free-enterprise, democratic system. And the resolution must be a whole-system one, involving changes in the culture, society's perceptions of its goals and problems, its guiding ethic, value commitments, and implicitly cultural premises. We must also redefine our underlying image of man-in-the-universe and of the "good society." Such a massive change has happened but rarely — the fall of Rome, the Protestant Reformation — and has never happened in the space of only a few decades. Basically, a successful outcome requires that we transform our goals. Instead of material progress, limited private ownership of capital, maximum return on capital investment, and unrestricted freedom of enterprise, there must be substituted human growth and development, widespread ownership of capital, fair return on capital investment, freedom and responsibility of private enterprise, and care of the planet and environmental quality. Such a transformation is undoubtedly far more plausible now than it would have seemed even ten years ago. Significant changes in entrepreneurship, in corporate social responsibility, and in corporate management have already taken place. The challenge to legitimacy of present economic institutions, noted earlier, could become as powerful a transforming force to business as was the democratic challenge to governments that did not derive "their just powers from the consent of the governed." Large business corporations

Eight Propositions Implied by a Systemic View of Materials Policies

1. Imminent revolutionary changes toward a "post-industrial" society will affect materials policy.
2. Current materials policies cannot be sustained more than a few decades without serious social disruption — radical policies are needed.
3. Materials policy is intimately intertwined with social and economic policy.
4. Resolving our materials-related problems requires policies insupportable by our present institutions and behavior.
5. We can identify institutional changes to support needed materials policies.
6. Only changes in cultural values will make these institutional changes feasible.
7. These needed value changes may be taking place and may be sustained.
8. Fostering changes in values and institutions is necessary to achieve an adequate materials policy.

are as vulnerable as were monarchical, imperialist governments in the past; the contemporary challenge will be that business must be responsible to and derive "its just powers from the consent of" all affected by it.

Only changes in cultural values will make these institutional changes feasible.

Environmentalist Lynton Caldwell has defined an environmental ethic which, he argues, is essential to the massive change needed to preserve the habitability of the earth. His credo holds that man is an integral part of the natural world and hence inseparable from it, and that humanity has no extraordinary moral claim over the natural world. Man may in some measure control nature, Caldwell contends, but he can do so safely only within nature's laws; however, punishment for violations do not necessarily fall upon the perpetrators of an offense. Finally, Caldwell recognizes that the world continually changes, but asserts that if it is to support life and human society its self-renewing capabilities must be maintained.

This ethic is not new, but implies behavior advocated in a variety of ethical systems, from the legendary Chinese philosopher Lao Tse, through St. Francis of Assisi, to Mahatma Ghandi. Its basic assumptions correspond to the pre-scientific assumptions of many so-called "primitive" peoples. Thus, this ecological ethic finds support, not only in modern scientific knowledge, but also in practically any known past cultural or religious system.

But if the dilemmas I have discussed are all of a piece — such an ecological ethic requires a complementary human ethic — for example, satisfactory materials and energy policies must be compatible with a resolution of the work dilemma. I shall call this human ethic the "self-realization ethic." It places the highest value on development of selfhood and holds that an appropriate function of all social institutions is to create an environment fostering the highest development of human potential.

These two ethics are contrasting sides of the same coin. Together they leave room for both competition and wholesome cooperation, for love and for self-concern, for community and for individuality. Each is a corrective against excesses or misapplication of the other.

These needed value changes may be taking place and may be sustained.

A new "ecological ethic" does seem to be emerging. Surveys and polls of certain elite groups such as students and corporate executives show an increasing emphasis by these people on humanistic and spiritual values, quality of life, community, and the person-centeredness of social institutions. Simultaneously the polls show decreased emphasis on materialism, status, and unqualified economic growth.

And there does appear to be increased interest in and tolerance of the transcendental, religious, mystical, and spiritual views which traditionally underlay the "ecological ethic," wherever it was found — at least this interest is evidenced in such cultural indicators as books read, associations developed, and coverage by the media. Developing scientific interest in formerly lightly dismissed "altered states of consciousness" is particularly significant. Scientists' objective probing of these states via galvanic skin response, electroencephalograms, body electric fields, etc., are resulting in a new legitimacy for studies of religious beliefs, psychic phenomena, mystical experience, and meditative states. In any deep probings of the nature of man the duality of his experience emerges — he is both physical and spiritual, biologically determined but in a sense freely choosing, separate yet bound to nature.

Interestingly the new task-orientation in business also reflects the new ethic. Jobs in the larger and high-

technology corporations particularly, place high values on knowledge, broad perspective, individual responsibility, and on interdependence, cooperative trust, honesty, and openness. In other words, the values needed to develop and operate a highly complex socio-technological task are very close to those required to support a national quality of life and continued habitability of earth.

As many have pointed out, our society is approaching the point where producing the commodities necessary for life does not require the full effort of more than a small fraction of the population. In such a society the distinction between work and play will become less sharp, because those that do work will likely be engaged in creative activities they enjoy. If our cultural values continue to shift, public pressure will be put on the corporation — through selective stock and product purchasing, selective job-seeking, and consumer and political action — to become more socially responsible. Fortunately, solutions to the dilemma of being socially responsible yet competitive can be found in a thorough-going cultural value shift.

In sum, fostering changes in values and institutions is necessary to achieve an adequate materials policy. Planning toward this future is the prime requirement, and it cannot be manipulative planning by an elite group, but rather the collective forming of images of desired directions, educating ourselves to appreciate the actions necessary for survival as humans. Because of this diffuseness of planning, we need an intercommunicating and coordinating network of local, regional, national, and planetary planners. These units will delineate alternatives, weigh their value, and broker their implementation. These planning units represent one of many kinds of partnerships among government, business, and the "third sector" — foundations, environmental groups, civic organizations, etc. Analysing economics, designing policy and legislation, and educating the public represent other opportunities for collaborations.

Corporations must broaden their goals to include authentic social responsibility — not as an image-improving, public relations program, but as part of the profit-making and institutional security motives. The beginnings of social accounting by large corporations are visible, but this is only a first step. Changes in tax laws, antitrust laws, corporate charter conditions, and so on could encourage further steps. Multinational corporations will play a particularly vital role in planetary materials policy, at least as important as national governments and international agencies. These corporations are especially influential, not only because they are as powerful as many national governments, but also because political boundaries are especially permeable to them. They will be the key actors in resolving the distribution of materials among nations, including persuading nations to sell their resources preferentially. They can also assist less-developed nations in adopting policies which are environmentally sound and materials-conserving, but which might slow their economic growth.

This nation's principal obligation is to maintain high standards of responsibility, in both its materials policy and its political-economic policies. At present, these requirements appear to conflict. The solution is clearly not to jump to a simplistic "zero growth" policy, nor is it to proceed blindly with outmoded politics and economics and unrealistically hopeful environmental and materials policies.

Thus, it would be misleading to propose even the best materials policies that can be devised, without warning that radical changes in our goals, values, and institutions will be needed for the policies to succeed. "Business as usual" plus technological advance will not be adequate for the future.

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Educating Engineers to Deal With Materials Shortages

Changes in how we use materials are coming rapidly now, and the accelerating rate of change is one of the distinguishing features of our new world. In the old days, as recently as last year, the patterns of materials utilization and processing were evolving slowly, with several long-term trends in evidence: plastics were replacing metals and wood in the consumer market; the aluminum industry was growing steadily, taking over products formerly made of steel, copper and wood; the new field of electronic materials had established itself and replaced a whole generation of devices. On the whole, these developments occurred at a controlled pace, largely determined by the reactions in the marketplace. In the electronics field the rate of change has been somewhat more rapid than in the others because of the concentration of high technology and the relatively low capital requirements. In the older industries — automobiles, farm equipment, bearings, machine tools, and hand tools — changes have progressed at an ordered pace. The capital requirements to make any significant change are massive and, consequently, the rate of technological development has been deliberate.

The technology in some mature capital-intensive industries has been stable indeed. A hammerman who had retired from a forge shop fifty years ago could probably return to his old shop (the body willing), pick up his tongs, step up to his old hammer, which is probably still in place, and go to work. Moreover, he would be well-received, because experienced hammermen are scarce. A foundryman might find that the equipment looks different, but little of substance has changed. This is not meant to point the finger of scorn at these industries, for there have been substantial advances in the technology in all of these areas, but the basic practice in most shops has changed very little. It is these industries, however, which are now being most affected by the present shocks. Substantial, solid, and conservative basic industries are being forced to change at an unaccustomed pace, and the consequences are felt on a national scale.

In what follows we examine some of the reasons for these multishocks in the field of materials utilization and processing. We will try to identify some of the long-term trends and discuss approaches being used to deal with these problems. Finally, we will look at the engineer, particularly the materials engineer, and consider how well he is able to handle these problems.

We conclude, unfortunately, that the materials engineer is not functioning decisively in this arena, and that instead of leading, he is following, with others making the important decisions. A reassessment of engineering education is in order, and we consider what might be done.

Motivations for Changing an Industry

The stimuli for change in a mature, successful operating unit usually come from the outside. Existing operations are difficult to change without serious intervention. Equipment is in place, processes have been established, work practices have been negotiated, and a market has been built. Furthermore, there are massive capital and psychological barriers to change. Management will look at a discounted cash-flow rate of return, or a return on capital investment, very carefully before a new approach is tried. Furthermore, the market has well-nurtured expectations which cannot be easily changed, and a long acceptance time is required for anything which is different. Finally we have the engineer, who may be even more conservative than the management. The engineer likes to have orderly procedures; logical improvements come on an incremental basis. Even when production is expanded, it is easier to multiply the existing technology than to justify something new and unfamiliar. Thus, if external shocks are absent, the practice changes slowly at a well-controlled pace.

The new shocks, however, are different. They are coming at an accelerating rate, and the management, the market, and the engineer have little control of how they come. Let us look at a few cases.

Materials Shortages Forcing Change

In 1974 we were suddenly faced with shortages, allocations, and supply situations which were reminiscent of wartime. But the underlying causes were fundamentally different, and there may not be a reversion to the old order. For example, there was a worldwide shortage of the steel tubing usually used in high-precision ball bearings. There were two reasons for this. First, we had a steadily rising demand for bearings. This might have strained the existing capacity of bearing plants, but the capacity would have been expanded as the market warranted. There was never any question of getting enough tubing. Secondly, several tube mills had decided to stop the production of this particular tubing because their resources could be used more profitably on other lines. The price of tubing could have been raised, but this did not happen rapidly enough to keep these mills in this business. The mills faced their own economic problems and simply abandoned the field.

Acceptable alternatives were available. The bearing

"Not only do we have to make good products, but also good wastes which we can eliminate safely."

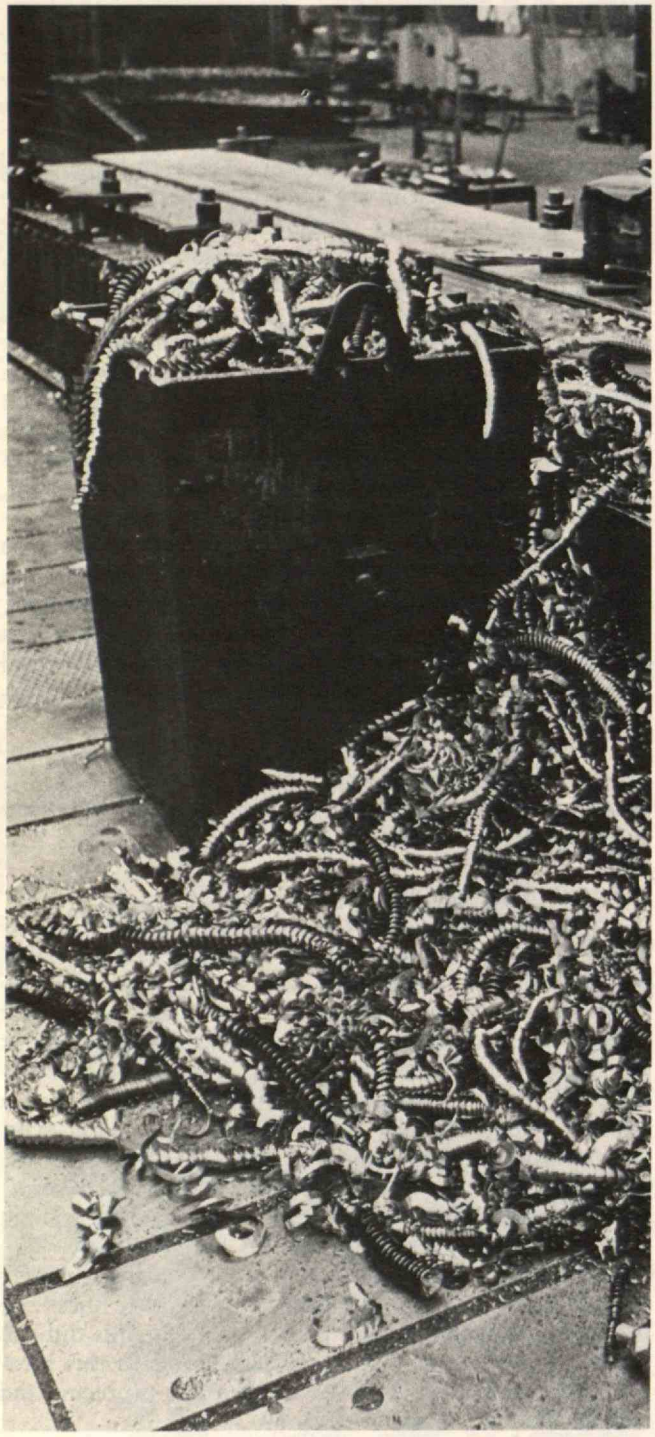


Photo by Owen Franken, Stock, Boston

manufacturer could use bar stock of the same bearing steel, and forge rings, instead of using tubing. This was not a good alternative, however, because one mill had just left the bar stock business. Also, if a plant is set up to use tubing, it will not have the forging equipment, the skilled labor, or the finishing equipment required to go the forging route. On the short term, manufacturers could only consider using other available tubing material. There was little point in considering another high carbon steel because this type of tubing was not available, but tubing of several carburizing steels was available. This meant that a bearing ring would be hardened no longer through its entire thickness but only through a predetermined case depth. This approach was feasible, and performance tests showed that bearings satisfactory for very many applications can be made this way. But such a change was not just a materials change. Machining practices were different. Heat treating techniques were different, and furnace capacity for carburizing became a problem. Furthermore, there was a whole new metallurgical control system which had to be established because carburized rings and through-hardened rings were to be processed side-by-side. But there was no real choice; some bearings had to be made by a new process or the availability of precision bearings was to be reduced.

The impact of such a decision in the marketplace had to be considered. The consumer fully expects that every good ball bearing will be made of vacuum-treated bearing-quality through-hardened steel. Can he be persuaded that his requirements can be met with these new materials? Ordinarily this would be a slow and difficult task, but at this point the consumer had his own problems, originating in these same shocks. He was scrambling for all types of supplies and bearing manufacturers found that expectations in the market were now not so rigid as they had been. The user was quite prepared to listen to alternatives.

But this was not the end of the changes. By 1975, the price of the usual bearing steel tubing has been adjusted sufficiently that one of the tubing mills reentered the field. In addition, the demand for bearings eased, and there was suddenly enough bearing steel for everyone. But the practice has not reverted. There is a cost advantage in making some types of carburized bearings and they have performed well in the field. Furthermore, it may be necessary to change again and to use a much wider variety of materials and processes to make bearings as cost, availability and competitive processes rise and fall. In the present climate we have an unparalleled opportunity to expand the technology and to rationalize some long-held taboos.

The next bottleneck for the bearing industry, however, may not be steel, but energy. At the peak of shortages in 1974, it was apparent that natural gas and fuel oil were in short supply in some parts of the country and that production could well be limited by this factor. If we were to sustain an energy shortage for a prolonged period there would be another reordering of processes on quite another basis and our entire industry could be changed by such a shock. For example, in 1974 the type of coke used in the cupolas for melting cast iron became critically short. In one particular instance there was a wild scramble to locate another source. One was found, in England, at a considerable increase in cost. No sooner had this problem been solved, when the foundry was told that the allocation for the resin used in their shell-molding process had been reduced by 30 per cent. In this case there was no way out except to face a sequence of irate customers. The smaller plants are severely affected by these shocks. They do not have the resources to devise and introduce alternative technologies and this important segment of our industry will suffer badly in the next round of shortages.

New Processes, Safety Standards and Environmental Protection

The introduction of new methods of processing materials has moved along reasonably well in an expanding economy. With the rising cost of materials and labor, however, there has been much more emphasis on processes which save materials and are easily automated. For example, cold and warm forming — which consists of pushing metal into a desired shape rather than cutting it from bars — are finding increasing utilization in making large volumes of deep sockets, roller bearing rings, fasteners and a variety of automotive parts. The production of waste chips, as was the case with machining, is avoided, and the savings in materials are substantial. Such processes as friction welding, forge-casting and vacuum heat treating were coming to the production line at the usual slow pace. Now, however, there are some external factors which are changing this rate, and the introduction of new technology will be accelerated.

The Occupational Safety and Health Act and the requirements of the Environmental Protection Act are affecting every industry in the country. For instance, rules prohibiting the introduction of the operator's hands within the pinch area of a steel press will accelerate the introduction of industrial robots and mechanical transfer devices. Such changes do not alter the nature of the operation in principle, but, if the costs of these changes are substantial, it will be logical to rethink the entire process, and there will be then the opportunity of making wholesale changes in technology. For example, foundries are under considerable pressure to limit exhaust fumes from their coke-fired cupolas, which are used to melt cast iron. This can be done with careful control and a substantial amount of equipment. But, it is also possible to scrap the cupola and use an electric induction furnace, but if an induction furnace is used it becomes possible to produce a wide variety of irons and steels, and the technological horizon as well as the market can be expanded. This has happened in a number of cases and may well lead to a rejuvenated foundry industry.

In the case of the E.P.A. requirements, the changes may be even more evident to the consumer. For example, federal regulations require that the discharge of cyanides and hexavalent chromium be essentially eliminated. This can be done chemically, but the costs of doing it are so substantial that the plating of copper and chromium by the usual methods may not be economical. Furthermore, the limits on nickel, cadmium and zinc are also quite low, and plating operations may be feasible only for very special applications. A glance at automotive trim, household plumbing, tools and appliances indicates how the elimination of plating could change the look of things. There will be other protective processes but it is only a matter of time before the metal coating industry will be forced to make fundamental changes.

In another instance, the E.P.A. has ruled that water discharges can contain no more than 15 parts per million of oil. Every plant with machining and grinding operations must treat the used cutting fluids to this level before they can be discharged. This can be done by a variety of physical and chemical methods, but for these treatments to work reliably there must be careful control of the constituents in these cutting fluids. Indeed, we have found that there is some uncertainty in the response of various cutting fluids to the disposal methods, and several types of synthetic detergents in these oils have resisted our best efforts. We are forced to a new realization. We have to make not only good products but also good wastes which we can eliminate safely.

Making the Change

The general procedures for dealing with these new shocks of materials shortages are emerging, and while considerable flexibility is required, we may list a few guidelines:

— The function of the product must be clearly understood. A screwdriver may actually be used more often for opening paint cans than for driving screws.

— The performance and the expectations in the market

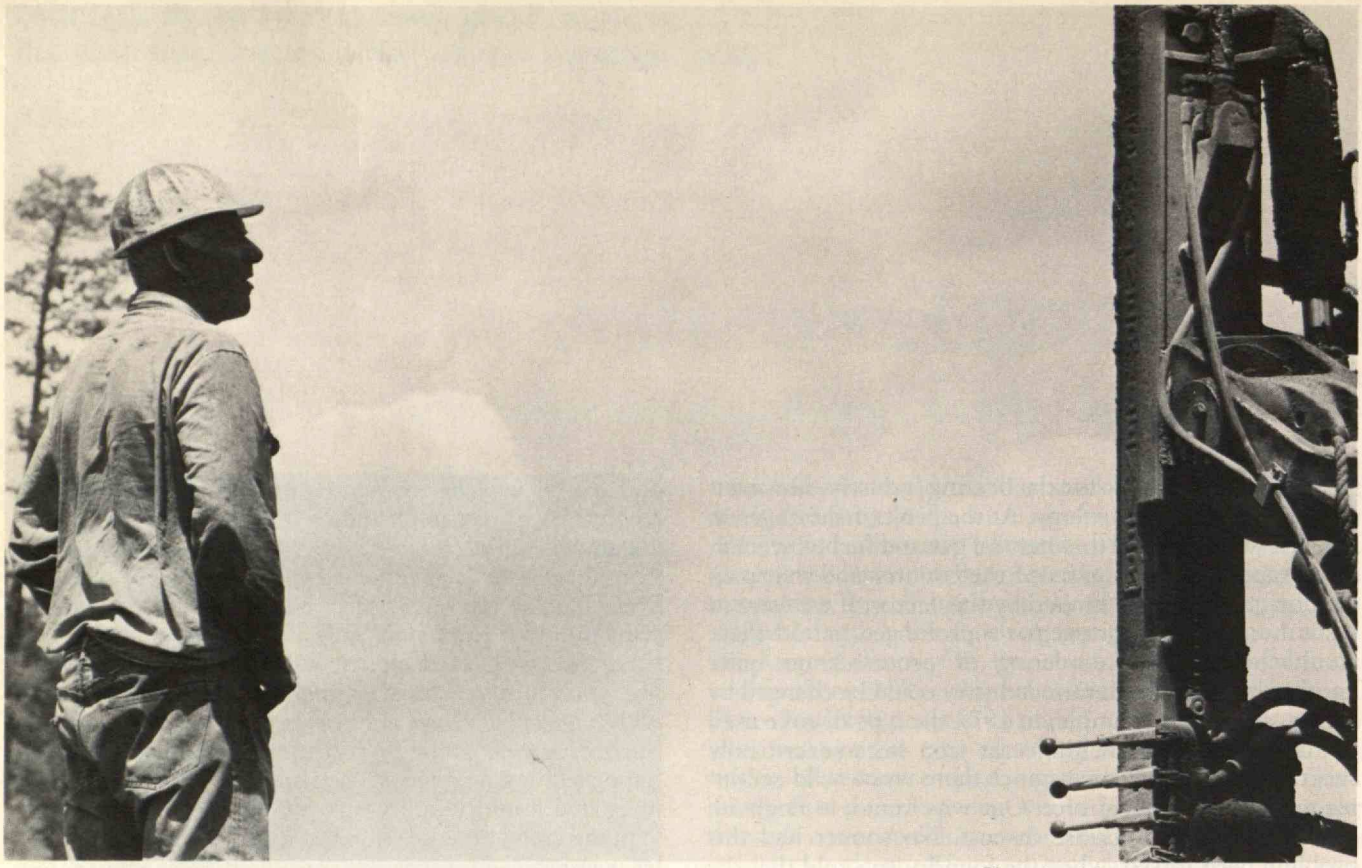


Photo by John Running, Stock, Boston

"The materials engineer . . . does not try to discover why something is being done, but thinks only of what happens in a particular physical or chemical reaction."

must be taken into account. It is not enough to know what is needed; we must know what is expected. A carving knife should not dull halfway through the roast.

— Changes in materials usually require changes in processing, and these must be evaluated.

— A technology must be fully available if it is to be introduced into production. Experimental processes and experimental materials cannot be used without a long period of acceptance testing. The technology and its control must be on the shelf before it can be considered as an immediate replacement.

— The consequences of a change must be evaluated in a way which allows a decision to be made. This will involve an economic yardstick, such as a rate of return, or it may be the cost of staying in business.

— There must be a list of alternatives. The relative positions of these alternatives must be kept in mind and reevaluated as the situation changes. We may no longer be able to use a single material and a single process for a given product.

Educating Engineers for Shortages

It would be comforting to tell you that our modern industrial materials engineer is thriving under these new and challenging conditions, but he is having a difficult time. Instead of leading, he is following; the big decisions on process changes are being made for him, and he is then called upon to implement the changes and to troubleshoot the failures. This is not a universally bleak picture, and some individuals are very successful in meeting these new challenges. But this is being achieved by the individual engineer's force of personality, rather than by his professional preparation.

This lack of engineering leadership is a consequence of our current philosophy of engineering education. A materials engineer's viewpoint is almost entirely microscopic; he has been drilled in the basic concept that properties are related to structure, or that processing is related to thermodynamics, and told that if he understands these relationships and can apply them, he has executed his task. His thinking does not extend to function and performance of a process and to the macroscopic economic, social, and technological factors which lead to the fundamental decision of whether the process should be carried out at all. He does not try to discover why something is being done, but thinks only of what happens in a particular physical or chemical reaction.

The typical undergraduate engineering education is now a suitable preparation for graduate school and for the research laboratory, but not necessarily for industry. We teach a logical progression of fundamental concepts on an atomic scale and a systematic approach to the analysis of problems. Not only do we continue to emphasize this orientation toward research, but we have fa-

vored research which is fundamental rather than applied. Thus, even if the engineer we have educated does not go on to graduate school and enters industrial practice, he tends to think in microscopic terms, and he gravitates to the laboratory. He does not understand the macroscopic viewpoint, and, not having much to contribute, he is removed from the decision-making areas.

We have struggled with the question of how to teach engineering, as distinct from how to teach science, and while there is no widespread agreement among educators, we can offer a few proposals as a focus for discussion.

Teach Engineering Backwards

That is, backwards from the current method. We would still like to use the first two years of an engineer's education for selected fundamentals in science and in general engineering. The second two years would consist of a series of professional courses which would begin with applications and work backward to the basic engineering decisions and to the relevant fundamentals used to develop that application. We would not systematically cover all of the fundamentals, but would emphasize how to get to the fundamentals relevant in each case. We would leave a deeper study of the fundamentals to the graduate schools for those who elect research careers. The basic concept in this approach is to begin with the macroscopic picture and to provide the motivation for the deeper fundamental study which will eventually emerge.

Give a Four-Year Master of Science Degree

Most of our students accumulate enough credits to graduate in three-and-a-half years, and some in three. If we add a summer term, preferably at an industrial practice school under the supervision of a faculty member, we should be able to grant a combined bachelor of science and master of science degree within a four-year period. In such a program we would still begin with two years of fundamentals and follow with professional courses which start with the macroscopic viewpoint and then proceed to the relevant fundamentals. But this curriculum would be supplemented with an exposure to industrial operations and problems at industrial sites, the solution of one of these problems constituting the student's master's thesis. Such a four-year M.S. degree would require the cooperation of industry and an expansion of the school year, but the results might be gratifying.

An alternative to taking students into the plant is to bring the plant into the classroom using videotapes. We have proposed that case studies on specific processes and on entire plants be prepared to serve a two-fold purpose. The tapes would be used to develop student courses of study on industrial operations emphasizing the factors which influence productivity. In addition, there would be taped detailed studies of new processes, and these tapes would be provided to industry to increase their exposure to new technology. The preparation of video programs requires special skills, and it is expensive. The Center for Advanced Studies at M.I.T. already has excellent equipment and personnel for the preparation of such programs, and we are seeking the sponsorship from government and industry to get such a program underway.

Allow a Mid-Course Correction

This master of science program could also be a refresher for engineers who have been through the old system or who have been out in practice for a few years. We could assume that they already understood the fundamentals and start with the macroscopic professional viewpoint, emphasizing the pathways to the decision points. A case study method could be very suitable here along with techniques of modeling and computer simulation.

We should end the presentation of these alternatives by discussing the principal difficulties in implementing such changes in engineering education. First there are professional problems. The members of an engineering faculty have been chosen for their research abilities and for their abilities to teach fundamentals. They may feel rather diffident about teaching such a new more applied curriculum. This reluctance could be remedied in several ways. Some faculty members might enjoy a sabbatical, or at least a series of summers with an industry. In addition, industry could send some of their people, not necessarily engineers, to work with a professor and his students on topics specific to his industry. These arrangements would restore some of the traditional ties between industry and the university and would provide the mechanism for a very healthy interchange between the two groups. A few of these mutual sabbaticals have been undertaken in several instances at M.I.T. and elsewhere, but many more are needed.

Another problem has been the insulation of students from industry. In implementing a more applied curriculum it would be useful to take small teams of students to a plant to study a particular process, or an operation, or the plant itself. They could follow a product from the market to the raw materials, and study processing, materials, and cost. They could evaluate feasibility of new approaches and could study and model the entire operation as a whole. Such a student-run study was recently carried out at a small forging plant with considerable benefits to both the students and the plant management.

A number of interesting educational experiments along these lines are now underway at M.I.T. and at other universities, but the rate of development is very slow. We need a bold new approach to capturing the essence of engineering education. The approach should preferably be interdisciplinary, with a gathering of existing staff with technological experience, and with the active participation of industry. We need a new curriculum which produces engineers who can see the big picture first, thread back to the necessary fundamentals, and then have a logical approach to making the big decisions.

The price is high, but we ought to do it. If we continue as we are, we will all become technicians with some bean-counter telling us what to do.

B. L. Averbach received his Ph.D. degree from M.I.T. in 1947 and is now Professor of Materials Science there. A Fellow of the American Society for Metals and a member of the American Physical Society, he is currently President of the International Conference on Fracture. His principal research has been concerned with the structure and properties of metals and amorphous materials.

The Helium Conservation Question

H. Richard Howland
Westinghouse Research Laboratories

The resources of the earth are finite. But exhaustible resources are still being carelessly wasted. As you read this, excess production of helium from natural gas wells in the U.S. is being vented into the air for want of an immediate market — helium that will probably be essential in future technologies for energy generation and transmission. Should this helium be conserved in the expectation that future demand will make such storage profitable? Or should we expect future generations to rely upon uncertain reserves in as yet undiscovered gas fields, find substitutes for helium, or find means to economically extract helium from the atmosphere — its only other source besides natural gas?

The unique properties of helium — its chemical inertness, its super-cold liquifying temperature, and its nonreactivity when exposed to radiation — make it unlikely that substitutes will soon be found. These characteristics make helium vital to energy generation, storage, and transmission technologies now under development.

Our legislated attempt at conservation has already failed, as we shall see later, leaving the problem of how to manage helium open to examination. In itself, the helium question is important, but it also represents an example of the false starts, inefficiencies, and economic pitfalls we must avoid to wisely preserve our exhaustible resources.

Why Helium?

Helium is a chemically inert, low-density gas. It diffuses readily, has good heat transfer properties, and does not become radioactive. It liquifies at the lowest temperature (4.2° K.) of any gas. Helium is used as a source of cold in low-temperature devices, as a heat transfer agent in nuclear reactors, and furnishes a protective or inert atmosphere for purging and pressurizing in welding and chromatography. Helium appears to be an essential material to magnetic-pinch fusion reactors, superconducting electrical machinery and transmission lines, and gas-cooled fission reactors.

Helium is found in natural gas in concentrations ranging from a trace to over 8 per cent, and in air at five parts per million. Most of the helium in natural gas is contained in fuel-quality natural gas, which is sought and sold for its heating value. If not extracted first, helium in fuel gas dissipates into the atmosphere at the time of combustion. The U.S. has the world's largest proved reserves of helium, but most of these are in one fuel gas field which is committed to market. In addition, the U.S. government has stored a large amount of helium in a depleted gas field, and there are significant but uncertain reserves of helium in unmarketable natural gas.

The Department of the Interior administered a program for the purchase and storage of helium from 1961 to 1973, when the Secretary of the Interior terminated the purchase contracts. Termination of the contracts has led to controversy both within and outside the government. The official position of the Department of the Interior is that the purposes of the enabling legislation have been accomplished, and that enough helium has been stored. Unofficially some feel that the program is a boondoggle which has already wasted too much of the taxpayers' money. Others, particularly those who foresee widespread use of helium in high-technology energy areas, think that the U.S. will run out of helium early in the next century, when these new energy technologies will multiply the need for helium, and that termination of a storage program is a short-sighted fiscal measure.

The helium program is now being reassessed. The immediate choice is whether or not to store more helium, and if so, under what arrangement. Since helium in fuel natural gas is a dissipating resource, the decision not to store helium is irreversible. Managing the conserved helium for the greatest benefit is an equally significant long-term choice which must be made.

The federal helium conservation program was judged a failure, but it provides an example of the issues which confront us in setting policies for managing other exhaustible resources.

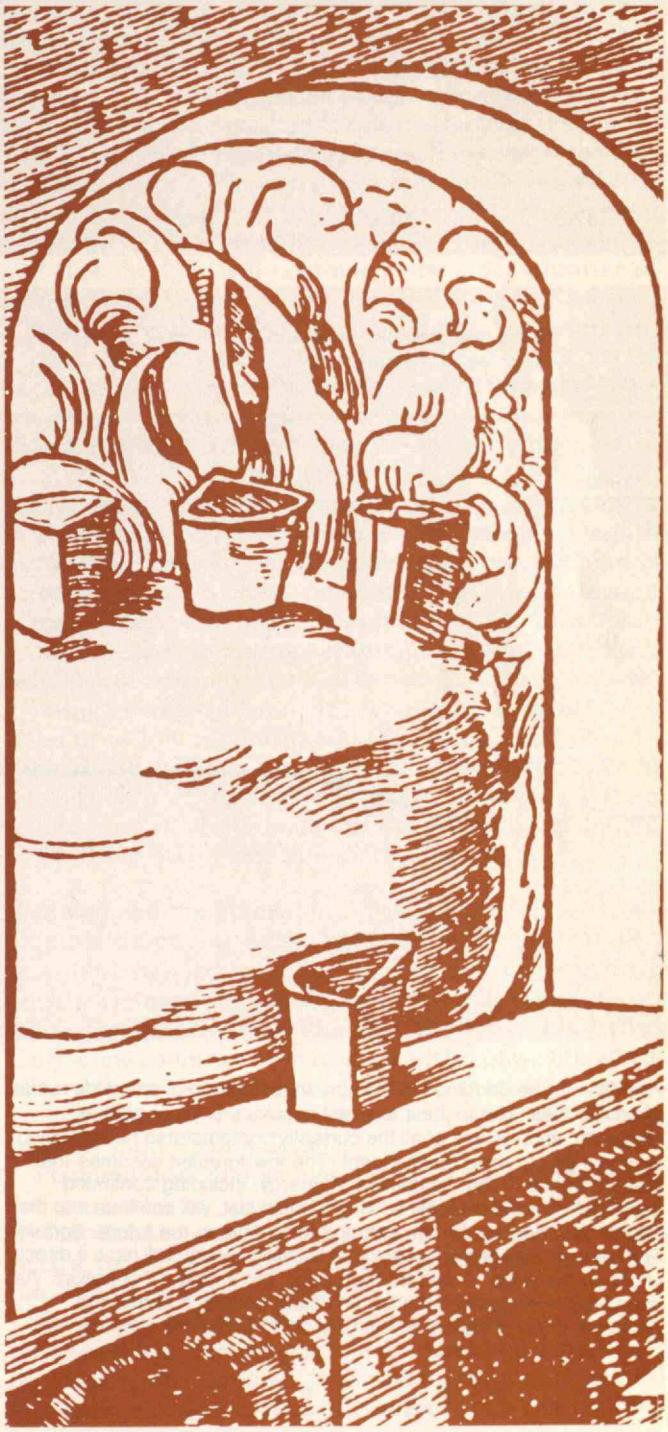
Helium: Unique and Exhaustible

Both the current and projected uses of helium depend on helium's unique properties. Helium was first used as a nonflammable substitute for hydrogen in blimps and balloons. Until the end of World War II, its chief use was as a lifting gas. During World War II helium began to be used as an inert sheath for welding — welding is still the fourth largest application of helium. Purging, pressurizing, and controlled atmospheres, which depend on helium's nonreactivity with other elements, are the largest use for helium; for example, some semiconductor fabrication is carried out in a helium atmosphere. Its inert properties also make helium a necessary material for gas chromatography and synthetic breathing mixtures. Because helium has the greatest diffusivity of any gas, it is widely used in leak detection.

New uses for helium still in the research or development stage also depend on its inertness, good heat transfer characteristics, and above all, the low temperature at which it liquifies. Helium-cooled fission reactors are already commercial; problems of contamination are reduced since helium does not become radioactive. Helium can also be used directly as a working fluid for gas turbines.

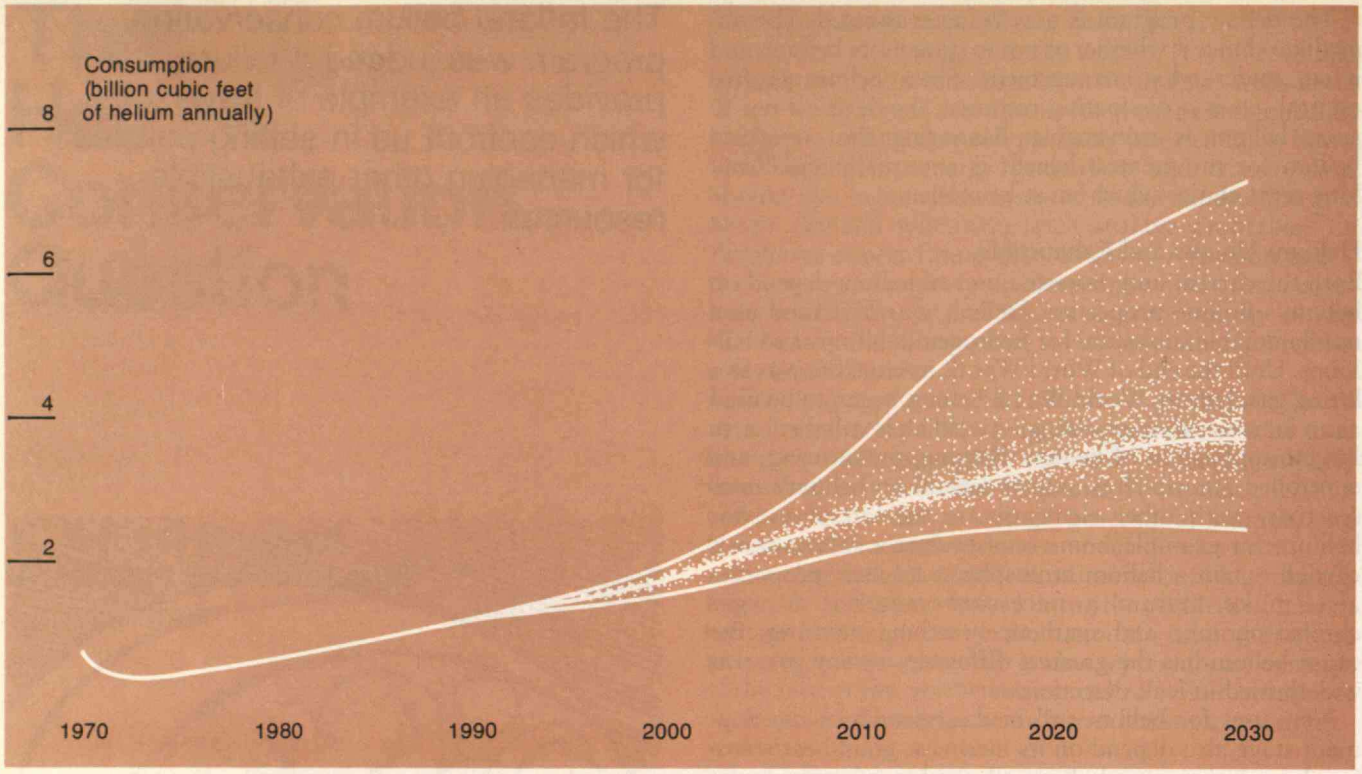
At liquid helium temperatures some substances lose all resistance to the passage of electricity and become superconductors. Development is now underway to make superconducting transmission lines using helium, and commercial operation may begin by 1985. Superconducting generators and motors, also currently in the development stage, should come into use in a few decades.

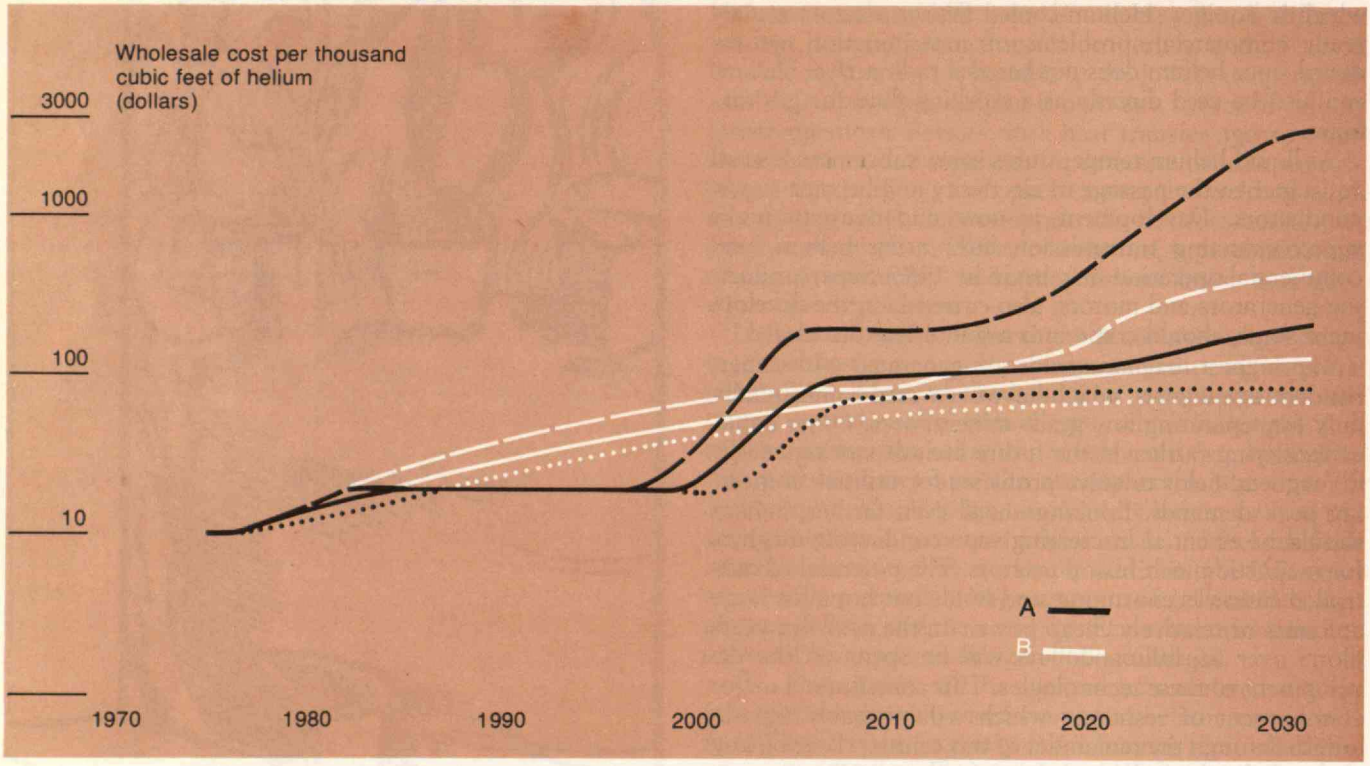
The highest magnetic fields are generated with superconducting magnets, which have been used commercially only for separating low-grade mineral ores. Other applications lying farther in the future include storing energy in magnetic fields to solve problems for utilities in meeting peak demands. Looking ahead even farther, helium should be essential in creating superconducting magnets for magnetic-pinch fusion reactors. The potential of controlled fusion is enormous, and holds out hope for large amounts of relatively cheap power. In the next five years alone over $6 billion dollars will be spent on the development of these technologies. This constitutes a major commitment of resources which will probably not diminish through the remainder of this century. Barring any major technological breakthrough, these will most certainly hinge on a continuing and dependable source of helium.



Why Save Helium Now?

The single most uncertain factor in the helium conservation question is the total extent of U.S. helium reserves. The U.S. has the world's largest and richest reserves of helium, but they are dwindling. About 100 billion cubic feet of the known reserves of 230 billion cubic feet are found in the Hugoton Field, which extends from Kansas to the Texas Panhandle, and which contains 0.5 per cent helium.





Top: The future demands for helium are estimated over a wide range of possibilities. The highest forecast assumes a major shift to electricity, and the use of all the currently contemplated helium-using technologies to their fullest extent. The low forecast assumes that present trends in the distribution of energy, including continued dependence on fossil fuels as long as they last, will continue into the future, thus decreasing the demand for helium in the future. *Bottom:* The helium management policy that is finally chosen will have a direct effect on the price — and through price, the supply — of helium. As measured in constant (inflation-adjusted) dollars, A shows the projected price of helium to the year 2030 under the present management policy. The assumptions governing A are that the prices of stockpiled helium will remain lower than the cost of extracting helium from air or natural gas until the time when the stockpile is depleted. This would discourage the entry of new private producers until the stockpile is depleted, and affect those now in operation. One alternative to this, shown as B, is to raise the administered price of stockpiled helium gradually in order to stabilize prices over the long run and extend the life of the stockpile.

These calculations assume a medium growth in demand; the price uncertainty results from different assumptions about future helium supplies.

Nearly all these proved reserves will be exhausted by the turn of the century. An estimated 300 to 940 billion cubic feet of helium, based on potential reserves of natural gas from 690 to 2,000 trillion cubic feet, is contained in as yet undiscovered natural gas fields.

Potential availability of helium from fuel quality natural gas at any time depends largely on the rate of natural gas consumption. This in turn is related to the rate of economic growth, the availability of other energy sources such as coal and petroleum, and on government policy toward the usage of fossil fuels.

Besides the depleting reserves of natural gas mentioned above, from 31 to 87 billion cubic feet of helium can be found in non-marketable, low-B.t.u. gas fields which have no value except for helium. The extent of these fields is not well known because the drillers, who are searching for fuel-quality gas, close and leave the wells; with no production history the total contents of the fields cannot be accurately assessed.

If the low estimates of helium in fuel natural gas are correct, then helium will have to be extracted from low-B.t.u. gas by as early as 2010. If the more optimistic estimates are correct, the date could be as late as 2040. In any case, extraction costs will be higher because future natural gas streams will be less rich than present ones.

Human factors, too, cause variations in the estimates of the quantities of helium in these non-fuel quality reserves: the experts disagree among themselves as to the best method of reserve estimation, geological data are sometimes scanty and, unfortunately, confirmation is after the fact; the prospect of profit seems to affect the amounts of resources that can be lured from the ground; and institutional pressures may produce an official estimate shaded high or low to coincide with organizational objectives.

Regardless of the estimates of helium reserves, the fact remains that the least costly sources of helium will be depleted by the turn of the century, future supplies will be less rich while they last, and we will eventually be forced to the costly process of extracting helium from the atmosphere.

The atmosphere contains about 5,000 cubic miles of helium, but in a concentration of only five parts per million. Air separation plants for commercial oxygen and nitrogen emit waste streams which are relatively rich (0.01 per cent) in helium. As a by-product of air separation, from 140 to 450 million cubic feet per year of helium could be available in the year 2000 from this source.

Foreign sources of helium are much less rich than U.S. domestic sources. Concentrations of helium in fuel natural gas in Europe are at most 0.1 per cent. Helium from outside the U.S. would be available mostly as a by-product either of liquefaction of natural gas for transport, or as a result of upgrading low-B.t.u. fuel gas. However, little is known of supply-demand relationships abroad, or the price at which imported helium would be sold in the U.S. It seems likely that nations at a level of development similar to the U.S. would have similar needs for helium, and that the U.S. will continue to be a net exporter of helium.

Not only is the availability of helium in the future uncertain, but the cost of extracting helium is also uncertain. This cost is governed by the investment and operating costs of plants which sit astride gas pipeline streams. Existing plants extract helium at an operating cost of $2.50 to $4.00 per thousand cubic feet; they operate on the richest streams of fuel natural gas. Future streams of fuel natural gas can be expected to contain only one-fifth as much helium. At that lower concentration the market price necessary to attract investment into an extraction plant has been estimated at from $80 to $135 per thousand cubic feet. But using any estimate, future supplies of helium will certainly be more expensive than at present.

Helium extracted from air is even more expensive, because of its low concentrations. As a by-product of commercial air separation processes, the cost of helium would range from $150 to $300 per thousand cubic feet. As a sole product of air, estimates of the extraction cost jump to $1600 to $3500 per thousand cubic feet.

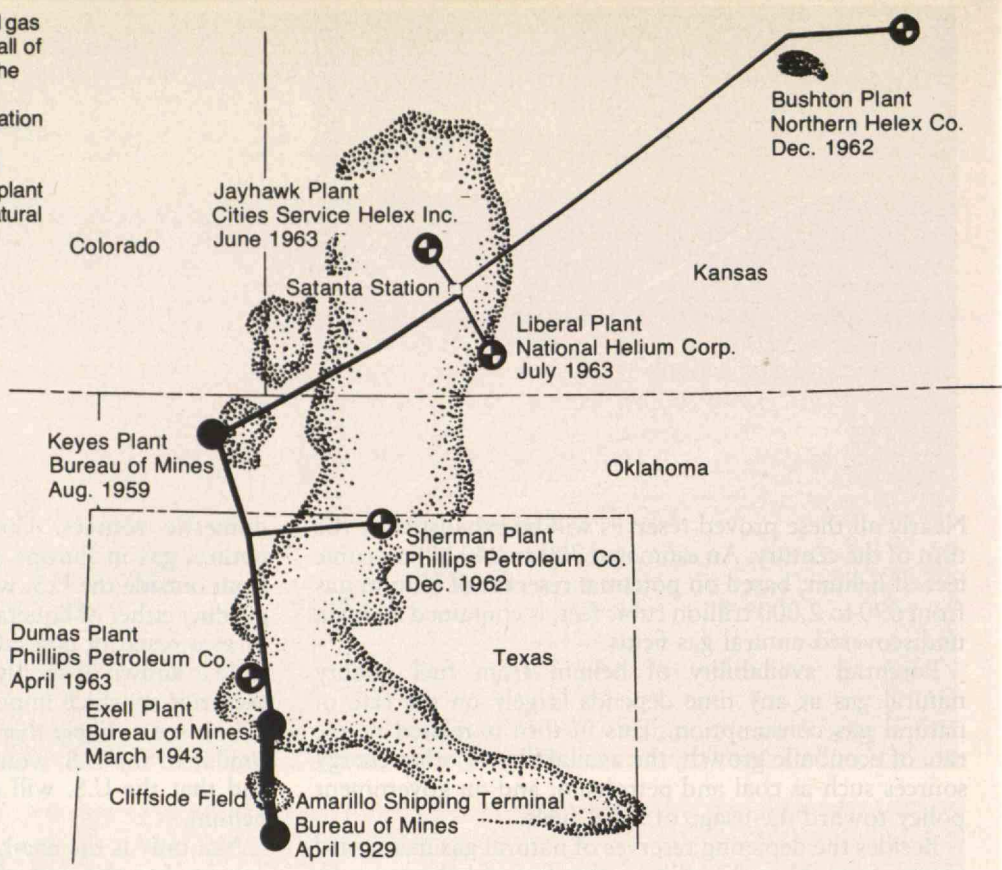
Planning and the Future

One philosophy of future planning holds that the best way to do well for one's children is to do well for oneself. Such a view may be unrealistic if natural resources become significantly more scarce in the forseeable future. Only a few countries have reached a level of wealth which allows them to plan ahead for more than a few years. Even in the U.S. the planning horizon does not often extend for more than a decade.

Planning does and should include some consideration for those who are alive now — a child born today has a life expectancy of about 70 years, so that decisions with regard to today's natural resources directly affect "future" generations alive today.

Predictions of future technologies, particularly those associated with energy, point to an increasing dependence on helium. The national policy formulated now toward U.S. helium resources thus affects the means our children

Helium extraction plants sit astride natural gas pipelines. The five private plants shown, all of which have sent helium to be stored in the Cliffside storage field, are owned by contractors to the federal helium conservation program. The stippled area outlines the Hugoton field, the richest U.S. source of helium in fuel natural gas. The Bushton plant was built at the confluence of several natural gas pipelines.



will use to generate and distribute energy.

The original justification of the federal helium conservation program was to store helium until a later time when it would be more essential and less available. At that time, the need was stated primarily in terms of national defense; now it appears that peaceful uses related to energy will predominate. The economic rationale of the federal helium conservation program thus was to foster economic efficiency by saving a natural resource now for future generations.

Helium Conservation: A Hindsight

The U.S. government and its contractors have always been the principal users of helium. From 1917 to 1961 the federal government had a monopoly on the production and sale of helium, with trivial exceptions. Production facilities were operated first by the U.S. Navy and later by the Bureau of Mines. During World Wars I and II, large quantities were used for blimps and dirigibles. Production between wars fluctuated, following closely congressional attitudes toward lighter-than-air craft.

During World War II, the technical feasibility of storing helium was established. The Bureau of Mines leased the gas rights to the Bush Dome structure of the Cliffside field near Amarillo, Texas, in order to extract the helium contained in the natural gas there. After World War II, the Cliffside field was used successfully to store excess helium production for later recovery.

Private commercial uses for helium, mainly for shielded arc welding, grew after World War II. By the late 1950s the growing uses for helium in guided missiles, research, and industry taxed the capacity of the Bureau of Mines to produce it, even after they restarted and expanded the plants which were shut down at the end of World War II. Helium was even rationed to non-federal users at times during the period 1956 to 1959.

The inadequacy of Bureau of Mines' capacity to meet demand, the rapid growth in demand, and the prospect of its expanded use for defense and aerospace applications prompted a federal government interagency study of the feasibility of a conservation program. Other groups, including physical scientists who used helium in their work, and conservationists, had already recommended conservation of helium.

The interagency study recommended that helium be conserved on a massive scale. The report noted that the free world's largest reserves of helium are in the U.S., centered around the Texas Panhandle, Oklahoma, and Kansas, and recommended that:

— additional helium extraction plants be built on fuel natural gas streams and the helium conserved in the Cliffside field;

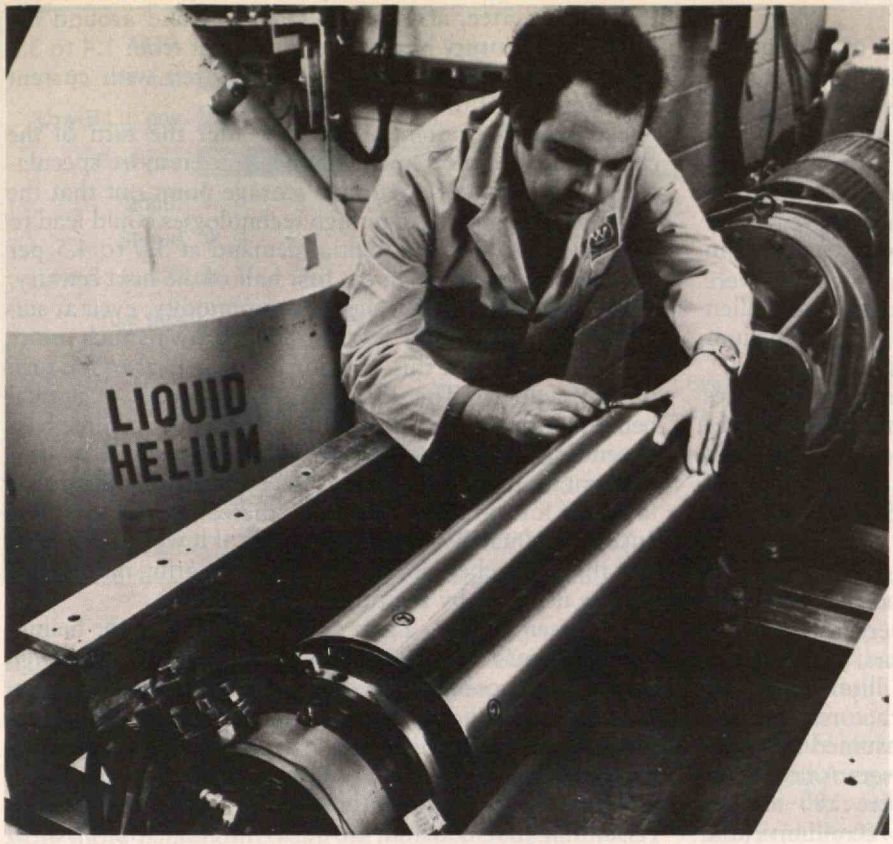
— private industry be invited to participate;

— the Bureau of Mines and newly constructed plants be interconnected by a pipeline network to facilitate conservation;

— appropriate legislation be passed, including an authority for the Secretary of the Interior to enter into long-term helium purchase contracts;

— the price of helium be set high enough to cover the cost of the conservation program.

Legislation embodying these recommendations was prepared and sent to the Congress in 1959. The stated purpose of the legislation was to implement a long-range conservation program for the "defense, security, and welfare" of the nation. At that time federal agencies, mainly D.O.D., A.E.C., and N.A.S.A., and their contractors used over 90 per cent of the helium consumed. The justification of the program rested as much on defense and security as on the general welfare. Since Congress



Liquid helium is used to refrigerate the inside of this experimental rotor to -452.2°F. At this temperature, the electromagnetic coils of niobium-titanium alloy wire act as superconductors — they carry a current density 50 times greater than conventional conductors at conventional temperatures. The result is a compact, lightweight generator which will be suitable for powering equipment in sophisticated laboratory aircraft; the weight of conventional generators makes capacities of 1,000 kw. and above prohibitive for such applications.

had previously shown itself amenable to stockpiling critical materials for wartime, a favorable response was expected. The assumptions, explicit or implicit, presented to the lawmakers were:

— the Bureau of Mines would continue to have a monopoly on the sale of helium;

— demand for helium would grow as forecast;

— users of helium would not alter the amount purchased if the price were increased.

Though a legislated monopoly was considered, an encouragement to private enterprise was added to the law. The federal agencies were required to buy helium from the Bureau of Mines; but their contractors were not specifically mentioned. With some other minor amendments the bill, known as the "Helium Act," was passed by the House and Senate in September, 1960.

By an appropriations act of 1961, the Secretary of the Interior was authorized to enter into long-term contracts for the purchase of helium, with authority to borrow up to $47.5 million per annum from the U.S. Treasury for payment to contractors. It was contemplated that the Bureau of Mines would purchase 78 billion cubic feet of helium over the period 1961-1983 and sell 36, leaving 42 billion cubic feet conserved by the government. The Helium Act requires that the price of helium be set to repay, with interest, any sums borrowed from the U.S. Treasury by the end of the contract period, so that the 42 billion cubic feet of conserved helium would be fully paid for by 1983.

In late 1961, the Department of the Interior entered into 22-year contracts with four private companies. Under the contracts, the Department of the Interior bought crude helium (about half helium, half nitrogen) at fixed prices varying from $10.30 to $11.78 per thousand cubic feet (helium), depending on the contract, with mild escalation provisions based on wholesale price indices. The contracts could be cancelled if demand should fall substantially or if large new helium resources should be discovered, though exact definitions for these events were not written in the contracts. In order to fulfill the requirement that the program be self-amortizing, the Secretary of the Interior raised the wholesale price of high-purity helium from $12 to $35 per thousand cubic feet.

The assumptions on which the program was founded — of government monopoly, growing demand, and demand inelasticity — were contradicted almost immediately, though the results did not become apparent for several years. At first demand grew with the missile and space programs as expected. But the three-fold increase in the sale price of helium (from $12 to $35 per thousand cubic feet) attracted the attention of private industry; by 1966, five private producers had built or were constructing helium extraction plants. By undercutting the price of government helium and offering delivery of it as a liquid instead of as gas, the private operators took away the Bureau of Mines' market as fast as new plants were built. Contractors to federal agencies, who in most cases were under no obligation to buy from the Bureau of Mines, were a major market for the private producers. The government monopoly on helium had been broken.

The government's loss of a helium monopoly caused no difficulty initially, because the total market for helium rose rapidly from 1961 to 1967, peaking at 929 million cubic feet in 1968. But federally-related consumption of helium waned as solid-fuel replaced liquid fuel military missiles, and as testing for the Apollo program was completed. Total consumption of helium in the U.S. began to fall in 1969, while new and inexpensive private production increased, and both the forecasts of constantly growing demand and user insensitivity to price were dis-

proved.

Three results stemmed from the private operators' encroachment in the helium market: Bureau of Mines' sales fell below expectations; more helium was stored than expected; and borrowings from the Treasury were not repaid. The last was fatal to the program.

The Secretary of the Interior attempted to cancel the helium purchase contracts in 1971, but was prevented by litigation from doing so. The contracts were cancelled in January, 1973, after those initial legal difficulties were overcome, on the grounds that helium demand had fallen substantially, and that significant new reserves of helium had been discovered in a field containing non-fuel gas.

Though current revenues now exceed current expenses since the contracts have been cancelled, the program has a large debt and significant liabilities concerning royalties and breach of contract contingent on the outcome of litigation; $379 million was owed the U.S. Treasury as of year-end 1973.

As the situation stands now, total consumption of helium is far below original forecasts, and the Bureau of Mines Helium Activity retains as customers only the federal agencies and a few federal contractors. In 1973, the total consumption of helium was 682 million cubic feet. U.S. government agencies and its contractors were the largest single group of users, having consumed 300 million cubic feet. Domestic commercial users followed at 202 million cubic feet, and exports were 180 million cubic feet. Bureau of Mines' sales were 170 million cubic feet, about 25 per cent of the total market.

Total production capacity in the U.S. is now over 3.5 billion cubic feet, or about five times current consumption. With the termination of the government contracts, most of this is on the open market at distress prices. Excess production is being vented into the air.

By year-end 1974, 38 billion cubic feet of helium had been injected into the Cliffside storage field, 10 per cent less than the amount which had been expected for 1983. In addition, one billion cubic feet had been stored by the contractors under an interim storage agreement. At current rates of consumption, the U.S. has a 50-year supply of helium on hand.

On the face of it, the helium conservation program appears to be a failure; certainly the fiscal status is poor at present. Though hindsight reveals a number of changes which might have enhanced the chances for success of the program, the question is where to go from here. In particular, are these difficulties temporary or permanent, and is there a case for continued storage of helium? And how should the helium already stored be managed?

How Much Will Be Needed?

Forecasting future demand for a commodity is always a chancy business. Past estimates of helium usage have been shown wrong, and there is much room for error. Some prediction is necessary, though, in order to make decisions now. Conventional uses of helium cycle it through once and allow it to dissipate; these uses will grow about as G.N.P. through 2000. The new technologies charactistically require an initial fill with only makeup thereafter. Few of the new technologies will become widespread before the turn of the century — the usage rate will depend then on how rapidly these technologies are introduced and the extent to which they penetrate their markets.

Estimates of future demand for helium have been performed by the Bureau of Mines, S.R.I., Inc., by an N.S.F. study committee, and by E.R.D.A. Demand around the turn of the century has been estimated at from 1.4 to 3.6 billion cubic feet annually (as contrasted with current consumption of 0.68 billion cubic feet).

Estimates for potential demand after the turn of the century are more interesting but also even more speculative. Proponents of continued storage point out that the multiple uses of helium in high technologies could lead to continued growth in potential demand at 3.0 to 4.5 per cent per annum through the first half of the next century. Others point out that usage of a commodity, even at stable prices, eventually levels off or grows much more slowly, and predict this levelling off shortly after the turn of the century. The E.R.D.A. study forecasts annual helium usage by 2030 at from 2.4 to 7.2 billion cubic feet, depending on energy usage and new technology implementation for that time. Other estimates differ by a factor of four in 2030, and more thereafter. These differences in estimates would be academic if it were not for the fact that the richest sources of helium-bearing natural gas will be depleted by the turn of the century.

At present there is a glut of helium, because the helium formerly sent to storage is now on the open market. Even taking into account a rebound in the demand for helium, with present capacity the glut will continue until 1985. The operators with higher costs will probably close down much sooner, lowering future production capacities.

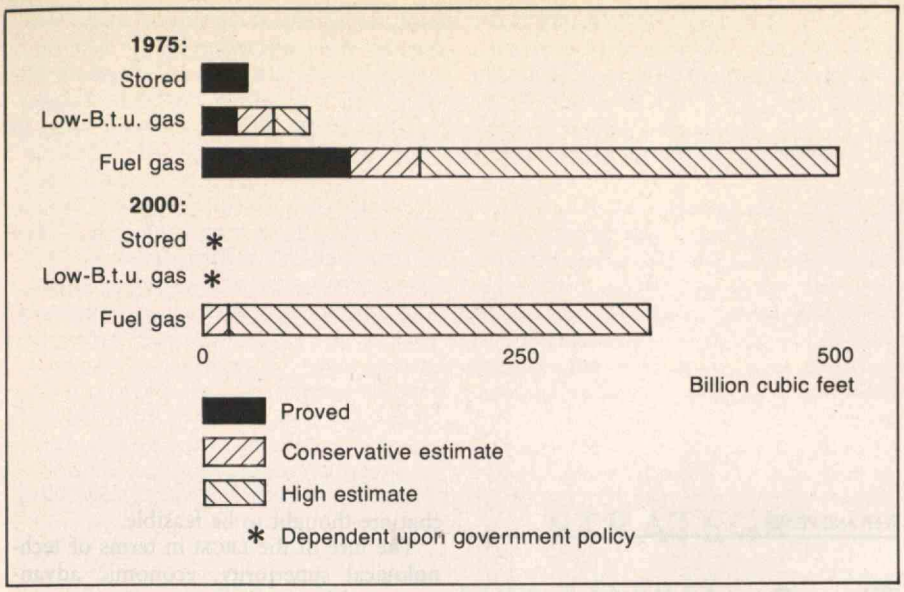
What would happen if there were no helium stockpile? Assuming that demand grows as forecast, the price of helium will rise rapidly after the Hugoton field depletes in 1990-95. The price of helium will stabilize after the turn of the century at prices consistent with concentrations in natural gas then available, approximately $100 per thousand cubic feet. Prices will stay at that level till fuel natural gas supplies begin to dwindle. Non-depleting gas fields can be tapped then, but eventually it will be necessary to turn to helium from air.

The U.S. government owns a large quantity of helium which can be produced at a low cost. To date, the government's administered price for helium has acted as an umbrella over the private operators. In theory, the government can get any share of the market it chooses, though there would probably be political repercussions if prices were lowered drastically. If the administered price is maintained at its present level, inflation and increasing costs of helium from other sources will combine to make the stockpiled helium competitive after 1985. Should the price be maintained at that lower level, the government would once again have a monopoly on helium sales. Under such a pricing policy, the stockpile would be exhausted shortly after the turn of the century.

The administered price can be changed to reflect conditions suitable at the time. In such a case the management can be varied to encourage or discourage private producers to any desired degree. Even if helium does become relatively more expensive, the stockpile can be made to last an indefinitely long period by raising the price. Only the most socially-useful applications could then be serviced; gas-cooled fission reactors and fusion reactors could probably pay the enormous price of helium extracted from air.

The Politics of Helium Conservation

Who is to decide the policy for management of the nation's helium resources? The current helium stockpile has been bought with the taxpayers' money, and a



The government has 38 billion cubic feet of helium in storage at this time, but the remainder of the U.S. helium reserves are contained in natural gas. Since fuel gas is more valuable as an energy source than as a source of helium, these reserves will shrink whether or not the contained helium is extracted. Because of the distribution of the helium recovery plants, only about half of the helium in natural gas can be recovered. This chart refers to the amounts recoverable. However, the total reserves of natural gas are uncertain, as shown by the striped section of the graph. Regardless of the number, helium reserves will have decreased through the burning of fuel gas by the year 2000. The amounts of helium remaining in storage and in low-B.t.u. natural gas will depend on the policy chosen to manage them.

significant fraction of the non-depleting helium reserves are on public lands. Though technologists and economists can contribute useful advice on estimates of supply, future uses, and the likely consequences of various policies, the resources are in the public domain. The disposition of them, and any decision whether or how to store more helium, are subjects for public debate.

The public preference involved with the helium conservation question is the trade-off between benefits now and benefits later. To the physical scientist working on one of the new technologies, 1985 is tomorrow, 2000 the day after. But for most businesses, this year's profit comes first and 10 years hence is long range planning. In the case of leasing and stockpile management, the trade-off then is between lower prices for the helium in the relatively near future and price escalation over the long run.

The past history of the helium conservation program puts any proposal to spend more of the taxpayers' money for further helium storage at a disadvantage, since the previous program did not meet expectations. The social question of benefits now versus benefits later becomes most obvious for such a proposal, however. The benefits of further storage at public risk occur at least 25 years into the future, and are subject to forecasting error and changes in the assumed environment. The costs of further storage, on the other hand, are immediate and calculable, and numerous social programs which have more immediate benefits compete for the allocation of public funds. The social issue of further helium storage at the public risk is whether, in view of shrinking natural resources, society chooses to value long-term benefits enough to justify storage.

The Economics of Further Storage

These considerations bring us back to the present choice of whether to store more helium from the existing plants, most of whose production is being vented into the air. Any extra benefit from further storage at the public risk would come only after the helium currently stockpiled is used up, which, depending on the policy chosen, is 25 years or more into the future. The benefits then are uncertain because of the uncertainties in future supply, demand, and cost. Calculations with the computer model show a return of from four to nine per cent per year, depending on the stockpile management policy; these figures assume the higher estimate for helium in fuel gas and an intermediate demand.

If further storage at the public risk is excluded, the private companies can be given the choice of whether to vent or store their helium by offering free storage in the Cliffside field. A different cost/benefit calculation applies because the benefits of storage to these companies would occur before depletion of the government stockpile. The benefits would still depend indirectly on the government leasing and stockpile management policy.

Suggested Readings

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H. Richard Howland has been Senior Research Engineer for the Westinghouse Research Laboratories since 1969. A 1962 graduate of M.I.T., he received his M.S. and Ph.D. degrees from the University of Pennsylvania. He recently served as a consultant to E.R.D.A. on helium conservation.

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Trend of Affairs

Trends This Month

WAR AND PEACE

The Casual Nuclear Weapon

Technical advances in weaponry, like the furies that stormed out of Pandora's box, cannot be restrained until the world is made ready for them. One such development has dropped from General Dynamics into the willing lap of the Defense Department recently, and its implementation threatens to upset the precarious balance between technical superiority and so-called strategic stability between nations that the U.S. has tried to maintain since World War I.

General Dynamics, under contract to the U.S. Navy and Air Force, is planning 1977 tests of a Long-Range Cruise Missile (LRCM), a highly-evolved descendant of the World War II "buzz bombs" that Germany launched against Britain. Like the V-1, the LCRM is a small, winged, subsonic missile — about 20 ft. long and 20 in. in diameter.

Advances in microelectronics, computers, and electromagnetic sensors have enabled the LRCMs to be equipped with "intelligent" guidance systems, which can constantly monitor and correct the missile's path by scanning the ground and consulting digital terrain maps in its computer memory. Upon reaching its target, the missile will be able to recognize it and land with an error of a few meters.

In addition to this deadly accuracy, this missile will probably cost only about a tenth that of the standard ICBM to build and maintain. Launching and delivery will be no problem for the LRCM — it could be launched from the standard submarine torpedo tube, dropped from a bomber, or out the door of a non-military cargo plane. A 747 jet could carry a hundred of these small missiles. And, say its developers, the LRCM will be capable of tactical battlefield or shipboard use with a conventional warhead, or strategic use fitted with a nuclear warhead.

These missiles are expected to have a range of about 1,500 mi., but ranges twice that are thought to be feasible.

The lure of the LRCM in terms of technological superiority, economic advantage, and bureaucratic expedience is understandable. But, argues Kosta Tsipis of M.I.T.'s Center for International Studies, the LRCM should not be deployed.

Writing in the April *Bulletin of the Atomic Scientists,* Dr. Tsipis explains his apprehension:

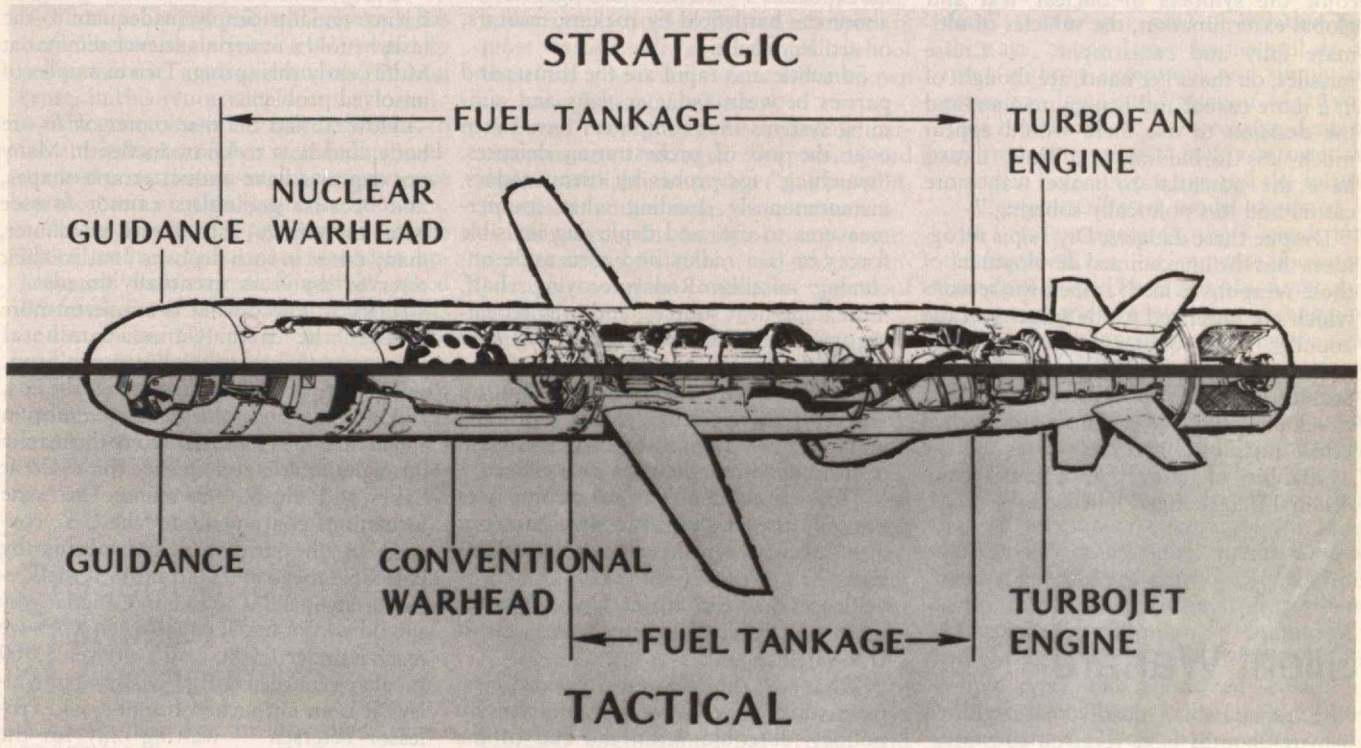
— If the U.S. integrates the missile into its defense plan, other nuclear countries will hasten to develop their own missiles to match the expanded delivery capacities of the U.S. New defense measures taken in an attempt to reinstate the semblance of balance that existed before the LRCM was introduced may trigger another arms race.

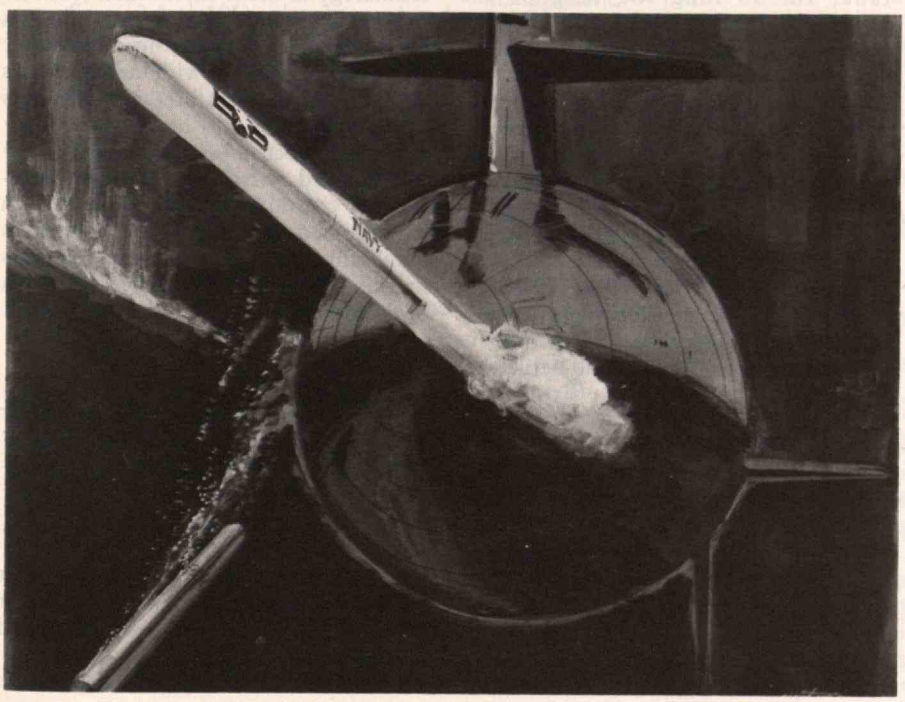
— In addition to initiating an arms race between nuclear nations, non-nuclear nations may be spurred to develop nuclear weapons once they know that a cost-effective delivery system for the weapons is available.

— Cruise missiles, because of their potential numbers and dispersed deployment, will be harder to command and control, increasing the possibility of accidental launches.

— Nations under the shadow of LRCMs would be more likely to launch their ballistic missiles upon warning, rather than proof, that enemy missiles are approaching. Too, since the missiles will probably be installed on all submarines, the practices of anti-submarine warfare would change so that any interference with a submarine could trigger nuclear war. The possibility of accidental nuclear war would be greatly increased.

— Arms limitations treaties require some form of non-intrusive verification — a relatively easy task with ICBMs due to observation satellites and remote detection of radiation. But "the submarine-launched cruise missile as now being developed includes two versions — one strategic with a nuclear warhead and one tactical with a conventional warhead — which are externally identical," writes Dr. Tsipis. "Since both weapons will be encapsulated in a canister for firing from a torpedo tube, it will be physically impossible to distinguish between the two ver-





The Long-Range Cruise Missile can be fitted with a conventional warhead and used as a tactical weapon, or fitted with a nuclear warhead and used as a strategic weapon. Both could be launched, as shown in the artist's depiction, from the torpedo tube of a submarine. Since both would be encased in a protective stainless steel capsule (shown ejected to the left in the drawing), it would be "literally impossible to distinguish between the two versions without dismantling the weapon," according to Kosta Tsipis, member of M.I.T.'s Center for International Studies. This, he feels creates a situation which would seriously hinder international arms limitation agreements. (Illustrations courtesy of General Dynamics)

sions without literally dismantling the weapons." This prospect is unacceptable to both the U.S. and the Soviet military establishments. The inability of conventional monitoring methods to distinguish between the two missiles would render the proposed ceiling of 2,400 ballistic missile launchers, established in the S.A.L.T. II agreement, meaningless.

In summary, Dr. Tsipis thinks these factors point to a dangerous diminution of the inhibitions against nuclear war that have protected us thus far: "Cruise missiles do not have the psychological barrier of ballistic missiles," he writes. "[Intercontinental and submarine-launched ballistic missiles] . . . have become the symbols of nuclear war and global extermination, the vehicles of ultimate folly and catastrophe . . . Cruise missiles, on the other hand, are thought of in a more casual and benign manner, and the decision to use them would appear much less forbidding . . . Thus, LRCMs have the potential to make war more casual and less politically sobering."

Despite these dangers, Dr. Tsipis recognizes that the unexamined development of these weapons is likely, albeit for reasons which are unrelated to the security of the country. He quotes one incredibly contingency-laden statement by former Secretary of Defense Melvin Laird: "The development of the [submarine-launched cruise missile] is necessary to assure the availability of future U.S. options for additional U.S. strength, if needed." — *D.M.*

Silent Warfare

The remarkable, deadly, laser-guided "smart" bombs have received considerable publicity lately, perhaps overshadowing another technological development sure to have profound effects on both armed conflict and politics — electronic warfare.

As described in a special issue of *Aviation Week and Space Technology* (January 27), electronic warfare has blossomed since the Air Force discovered it had saved over 200 bombers from destruction over Viet Nam by effectively jamming North Vietnamese missile-directing radars. In the recent conflagration in the Mideast, Arab ground forces scored telling victories with their ability to electronically confuse Israeli communications and home-in on Israeli forces with electronically-directed weapons.

Electronic warfare will consume about one-half billion dollars in defense funds next year, the magazine reported, and this doesn't even include the radar-killing aerial strike force called Wild Weasels, or the sophisticated electronic warfare capabilities of the B-1 bomber, the Trident submarine, or the F-15 fighter.

This funding is despite Pentagon critics who, like the public, may feel that "weapons that make a bang are more substantial than the ethereal jamming, deception, and counterdeception in the invisible electromagnetic spectrum," says Robert Hotz, Editor-in-Chief of *Aviation Week and Space Technology*.

Electronic warfare consists basically of complex and sophisticated methods to jam enemy radars, intercept and disrupt communications, decoy enemy aircraft and missiles, and even degrade the enemy's vision. Equipment may be used on board fighting ground vehicles, ships, or aircraft, on special electronic warfare manned and unmanned craft, or may be on expendable electronic packages strewn about the battlefield by rockets, mortars, or artillery shells.

So subtle and rapid are the thrusts and parries between radar systems and jamming systems that computers have taken over the job of orchestrating defenses, "watching" for probes by enemy radars, instantaneously deciding what countermeasures to use, and deploying invisible forces to jam radars and turn aside oncoming missiles. Radar-decoying chaff, misleading heat sources, and even repeating spurious radar echoes are among these countermeasures.

And radars must consequently shift up and down the spectrum, changing probing methods like a running back on a football team to penetrate defenses.

This new arena of warfare encompasses not only air, ground, and sea warfare, but also space, where satellite-satellite jamming has already been used — there is evidence that the Soviet Union has directed electronic countermeasures against U.S. satellites.

What will the effect of expanded electronic dueling be on warfare, and thus on politics? It could mean the end of the tank, for so long the king of the battlefield. Tanks are easy to locate because of unintentional electronic emissions of motors, etc., and because they are so prominent on the landscape. And with inexpensive and sophisticated missiles, they are easy to destroy. Similarly, effective radar and sophisticated missiles are making the powerful U.S. cruise ships vulnerable to destruction by small, sophisticated missile-firing ships.

Apparently, the see-saw of electronic warfare is currently oscillating so rapidly that strategists have little notion of the future balance of power on the battlefield. — *D.M.*

MATERIALS

Ample Ores, if We Can Find Them

Is the U.S., whose prosperity has been built on plentiful supplies of rich ores and fuels, becoming a have-not nation, making do with ever-poorer ores and ever-colder homes? Don't jump to such an unappealing conclusion, says Ulrich Petersen, Professor of Mining Engineering at Harvard University.

It's true, of course, that every country in the world chooses to first use the richest, most accessible ores it can identify — and as time passes and these first-choice resources are exhausted, the same process of choice operates again and again in the exploitation of leaner, more distant deposits.

But Professor Petersen finds estimating reserves — the question of how to predict the course of this process into the future — a very hazardous enterprise. Geological science remains simply inadequate to the task, he told a materials science seminar at M.I.T. early this spring. Two examples of unsolved problems:

— How to find the true center of an ore body, and how to know its depth. Many ore deposits have exotic, erratic shapes, and because geologists cannot foresee what the miners' shovels will encounter, many mines in such deposits "outlive their reserves" by years, eventually decades.

— How to know what is a mile or more beneath the earth. Canada's mineral riches — chromatz, sedimentary iron, nickel, copper, cobalt, uranium, asbestos, and more — are in the great Precambrian Shield that lies exposed from the Arctic through Ontario and Quebec to the Great Lakes and the St. Lawrence. The same formations continue under the U.S., covered in the midwest and plains by Paleozoic rocks and glacial till. If the Precambrian Shield is so rich in Canada, why should we not find it equally rich when we reach it under 1,500, 2,500, or even 5,000 ft. of overburden in the Mississippi Valley? It is an untouched frontier, said Professor Petersen — waiting only for the technology to make exploration feasible.

A problem, he thinks, because there is now a gap in the earth sciences. Economic geologists are familiar with the techniques which reveal the rich ore concentrations which have historically been their primary goal. And geochemists have become very sophisticated at tracing small concentrations of crustal materials. There remain the intermediate concentrations, and it's "high time" we devoted some serious scientific study to how moderately-rich ores can best be found and used. — *J.M.*

OCEANS AND LANDS

Earthquakes: A Stitch in Time . . .

Remember the famous letter from Albert Einstein to Franklin Delano Roosevelt which set the nation on the course toward an atom bomb?

It's time now for another such letter to

the Chief Executive, thinks Frank Press, Head of the Department of Earth and Planetary Sciences at M.I.T. The subject: earthquakes.

Our understanding of plate tectonics, earth physics, and volcanism are now so advanced that predicting earthquakes and volcanic eruptions "are achievable goals," Dr. Press said at a recent dedication of the U.S. Geological Survey's new National Center in Reston, Va. "It is as if the etiology of 90 per cent of cancers was understood for the first time," he said.

The next stage is a whole new approach to risk analysis which will show the time, probability, and damage-mitigating strategies in every threatened, predicted earthquake. Two problems:

— Financial support for this research has been "below the critical level needed to achieve these goals, in an operational sense, in this century."

— The government has failed, thus far, to use the influences it has to mandate land-use and construction-engineering practice on the basis of what is already known.

"How does one sell preventive medicine for a future affliction to agencies beleaguered with current illnesses?" asked Professor Press. His answer: let scientists and engineers "assume a role of advocate and even special pleader." Let them point to housing tracts being placed in fault zones, let them "show how a research dollar invested today can yield an enormous return in lives saved and property preserved tomorrow." — *J.M.*

Present and Promise of Aquaculture

A one million kw. nuclear plant raises 60,000 ft.^{3} of water by 15° F. every minute. Some 3.6×10^{12} gal. of treated and untreated sewage enters U.S. coastal waters every year. These two waste products — heat and fertilizer — are the key ingredients for the growth of plants, crustacea, and fish. But despite these immense resources, and despite the rising price of food and the threat of its scarcity, aquaculture remains essentially unknown in the U.S. Why?

Professor Judith Kildow of the M.I.T. Department of Ocean Engineering and John E. Huguenin of Woods Hole Oceanographic Institution suggest a series of answers in a new report of the M.I.T. Sea Grant Program:

— Heated water is an auspicious environment for fish, oysters, and plants — and also for parasites, predators, and disease. "Diseases once introduced into such a favorable environment can sometimes produce a virtually instantaneous and complete loss of culture stocks," says the report.

— Meat grown in warm water may have texture, color, or taste very different from that of naturally-grown fish.

— No one knows what may be the long-term effects on organisms living where natural, seasonal water temperature variations are suppressed.

— Power plants expel — routinely or by accident — toxic and dangerous substances and almost without exception trace quantities of metals eroded from the plant's piping. How much of these will be concentrated in organisms, and with what effects are unknown.

— Both bacteria and viruses appear in treated and untreated waste, and the vulnerability of organisms, and their ability to pass infections on to human consumers, is unknown.

— Organic chemicals — notably pesticides and hydrocarbons — are present in most waste water, and harmful levels of these and other carcinogens are unknown for most fish and shellfish.

— Some marine organisms create carcinogens from nitrogen compounds and amines available in sewage; this possibility raises another series of unknowns.

— Monitoring the levels of many potential hazards is difficult — and perhaps impossible — under conditions typical of aquaculture.

— Large flows of water are characteristically required in aquaculture; so are large numbers of animals in confined spaces. The former is a difficult hydrodynamic problem, and the latter results in "huge" problems of solid waste disposal.

— Most favorable aquaculture sites are in coastal waters, where competition among users is high and jurisdictions uncertain.

Though all these difficulties seem "significant" but "surmountable," the M.I.T. report concludes that the potential for aquaculture is "tremendous." To realize it requires only a major thrust of research on a broad range of topics in biology, engineering, marketing, and management. — *J.M.*

ENERGY

Who Will Have Dimmed the Lights?

If shortages of electricity darken American homes and still factories in the 1980s, the villain will have been the archaic, politicized regulation of the electric power industry in the 1970s.

Archaic, says Professor Paul W. MacAvoy of M.I.T.'s Sloan School of Management, because regulatory bodies are continuing to make decisions about the future on the basis of the past — using historical data to fix future prices.

It works this way, Professor MacAvoy told members of the M.I.T. Club of Boston last winter: seeking a fair price for a public utility to charge for electricity, a regulatory agency typically studies that utility's performance during a previous period — its costs, depreciation, expenditures, profits, payments to stockholders.

In the 1950s and early 1960s inflation was slow, markets and costs were predictable, and technological progress was fast enough so that companies could "keep ahead of the regulators." But the present and future are very different from the past. The rate of inflation is far exceeding the rate at which new technology can reduce costs, and there are unprecedented constraints on fuel supplies, on environmental impact, and — because of high interest rates — on capital. Looking at the future in terms of the past is suddenly very unrealistic.

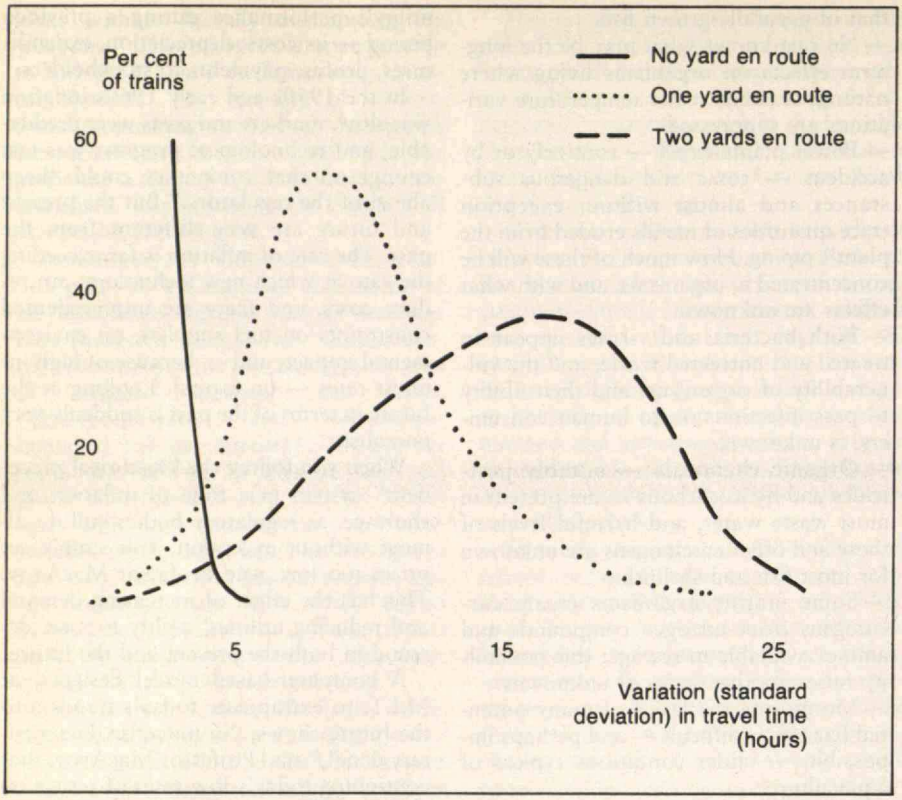
When you follow the "historical precedent" system in a time of inflation and shortage, as regulatory bodies still do almost without exception, you simply set prices too low, said Professor MacAvoy. This has the effect of increasing demand and reducing utilities' ability to meet demand in both the present and the future.

A computer-based model designed at M.I.T. to extrapolate today's trends into the future shows, "in immense documentary detail," said Professor MacAvoy, that continuing today's low rates of return on electric utility investment during the next five years can have but two related effects: At least seven of the 12 largest utilities in the U.S. will be operating with deficits by 1980, and brown-outs will be unavoidable.

Utilities need rates of return on their capital investment comparable to those achieved by other capital-intensive industries in years of prosperity — 15 to 17 per cent. But in today's environment any Massachusetts regulatory commission proposing to allow such a rate of return would precipitate politicized screams of protest "from every kitchen in the Commonwealth." (The only exception to the system of regulation by looking at the future backwards is the fuel adjustment privilege of Massachusetts utilities, by which they pass on to consumers the full burden of that element of inflation. And even that is the focus of strong political and consumer protest.)

What about the alternative of public power commissions — the plan for state-owned generating facilities which could supply power to commercial utilities for distribution to individual customers? The advantage, of course, is that new capital for new capacity could be obtained through low-interest, tax-free, guaranteed government bonds.

But the plan has no appeal for Professor MacAvoy. There is nothing so unregulated — and unregulatable — as government, he said. The proposed new commissions would be vast, inexperienced agencies; he thinks their chances of saving money would be "very slim." It is a matter of resorting to political processes to avert a shortage created by other political processes, and that to Professor MacAvoy looks unproductive. — *J.M.*



Why are freight cars late and railroad deliveries unreliable? The problems appear to center in the yards. Carl D. Martland of the M.I.T. Department of Civil Engineering has shown that variability in total line-haul time (i.e., the time between a car's departure from the original yard and its arrival at its destination yard) increases generally as the number of intermediate yards handling the car increases, and that this effect in fact has more influence than total distance travelled on the reliability of freight car arrivals. The chart above shows Mr. Martland's results when analyzing freight car deliveries over distances of 600 mi. or less.

TRANSPORTATION

How to Make a Railroad Run on Time

For thirty years the American railroads' share of the freight transportation market has been falling, with sharp losses of high-value freight to trucks and airlines. Why?

Because the railroads have a well-earned reputation for unreliability, think members of the Transportation Systems Division of the M.I.T. Department of Civil Engineering after a three-year study for the Federal Railroad Administration.

At the beginning of the project, Carl D. Martland, analyzing data on the movement of freight between 253 origin-destination cities on two large railroads, found that less than 30 per cent of the movements were made within "the widely-sought goal of 90 per cent within three days."

Railroad operations represent a complex network system through which units move in many ways and at many times — a tough analysis assignment; and no single problem seemed to be the obvious cause of this poor record. At first glance, line-haul performance seemed reasonable: Most trains arrived at their destinations with deviations from schedule of only one to three hours, and most of these were caused by deviations in departure time rather than by problems en route. One sample traffic study showed one en-route delay caused by mechanical or electrical (not engine) failure for each 1,300 train miles; 42 per cent of these delays were longer than one hour, 9 per cent longer than three hours. Taken by itself, not a bad record — and surely not enough to explain the overall poor performance of rail freight.

Mr. Martland soon discovered that unreliability correlated at least in a general way with the number of freight yards involved in a movement. One problem turned out to be connections: "At most yards of any size," wrote Mr. Martland and A. Scheffer Lang, formerly Professor of Civil Engineering at M.I.T. who is now Special Assistant to the President of American Railroads, "a substantial share of the traffic misses its connections and thus incurs delays of up to 24 hours." Indeed, they said, 30 per cent or more of scheduled connections may in fact be missed. And outbound trains were completely cancelled often enough to have "a significant effect on yard performance."

Corrective measures seemed obvious from this analysis, and M.I.T. in 1973 joined with the Southern Railway to test a common-sense strategy described by W. Graham Claytor, Jr., President of the Southern, in *Railway Age:* "Don't handle cars in as many yards. Run more trains or change train schedules or both to cut yard time and missed connections. Increase the reliability of each yard operation. And have enough motive power available . . . so you won't have to cancel trains or reduce their size."

M.I.T. predicted improved performance and monthly cost savings of $430,000 from a five-point program to test this strategy over a small section of the Southern system for six months. Joseph M. Sussman, Associate Professor of Civil Engineering who supervised the railroad reliability study through most of its life, is satisfied: Savings of $300,000 were realized, and "results show that both reliability and mean trip times can indeed be improved in the short run without increasing costs," he writes. Mr. Claytor agrees: the changes "improved reliability to a clearly-measurable degree," he told *Railway Age.—J.M.*

A Yellow Light for Mass Transit

He sits stubbornly amid the warning cries of environmentalists and economists, happily committed to his car and his suburban house. Planners had better allow for this commitment of the American transportation consumer, says Dr. Alan Altshuler, former Massachusetts Secretary of Transportation and Construction who has now returned to a joint appointment in the M.I.T. Departments of Political Science and Urban Studies Planning.

Dr. Altshuler foresees no total transformation in American transportation in the immediate future, despite a shift in government policy to emphasize environmental protection, energy conservation, safety, democracy of mobility, and citizen participation in decision-making. Investment in highways and aviation has changed, too, away from new facilities toward modernization and improved safety. But this also will leave Americans' travel behavior intact, Dr. Altshuler told the Alumni Advisory Council meeting in January.

Most Americans want to live in a single-family free-standing house — a heritage of the American rural tradition. This majority will has shaped our social structure, including tax policies, credit patterns, and land-use planning policies. The incentives to conform are so powerful that if most people move to single family suburban homes, a personal decision to stay in the city is likely to mean some loss of status as well as greater exposure to

crime, poorer public schools, and generally more dilapidated surroundings.

Changing incentives to encourage travel by public transit would involve changing patterns of land use as well as day-to-day consumer choice. Only some major national decisions can change the environment in ways strong enough to begin to affect our basic motivations.

Elected officials have not been willing to change policy contradictions: first they encourage urban sprawl and auto dependence; then they pass environmental and citizen participation laws which effectively halt highway construction and necessitate new transit systems. Reversal of our auto dependence has just barely begun, spurred by the energy issue. But in spite of the extremely severe economic and national security threats posed by our dependence on imported oil — a frightening dollar drain out of the economy and loss of international standing because of vulnerability to blackmail by embargo — elected officials still tremble at the thought of using strong means to reduce oil consumption.

Given the dispersion of American employment patterns, there is no way for the public to respond to energy conservation pleas strongly enough to save two million barrels of gasoline a day. But they can respond in ways that are worth working for: People can move closer to work; forego certain vacation trips; increase their use of car-pooling. Dr. Altshuler feels that van-pooling is the most promising new idea: the employer buys a vehicle; one employee picks up eight or ten fellow employees as he commutes. The driver is paid by having a free ride plus the use of the vehicle evenings and weekends; the riders' fare pretty well supports the van. The program began at 3M Corp. in St. Paul, where about 1,000 people van-pool in a plant of 10,000 to 12,000 workers, and there are long waiting lists for new vans.

Americans could drive less, according to a Gallup Poll in the *Boston Globe* this January: six of ten driving commuters say that they could find other means of getting to work if they had no car (walking would be the alternative for one quarter of this group); four of ten Americans say they would not find it difficult to reduce by 25 per cent the number of miles they drive. (If Americans drove 20 per cent fewer miles, about one million barrels of oil a day would be saved.)

Dr. Altshuler sees safer, cleaner, smaller, and more efficient cars in the future — but we will still have lots of automobiles. We will see few new airports and new expressways; and many fewer new transit systems than you might expect from reading the papers. And if we as a nation are smart, we shall also see dramatic moves to cut energy consumption for transportation. — *M.L.*

SOLAR SYSTEM

An Inorganic Spot in an Organic Cloud

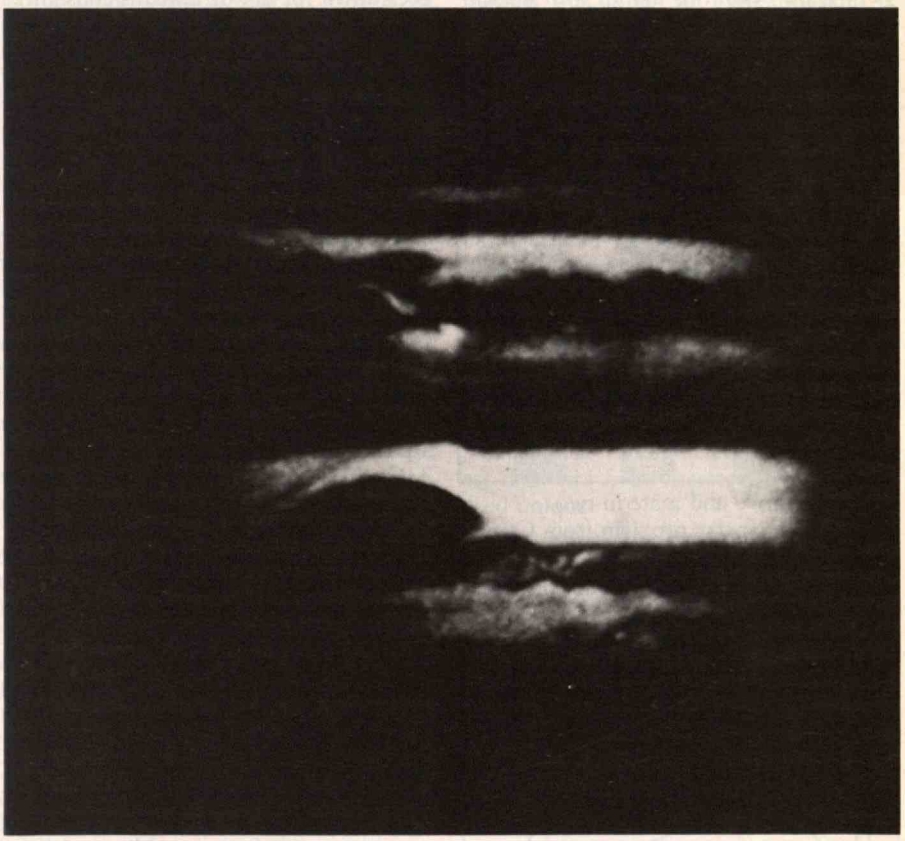
Giant Jupiter, presumed to be closer to its primordial state than any other planet, is beginning to yield its secrets. But the evidence remains so fragmentary that its meaning is unclear and even controversial. Even before the new results from Pioneer 11's close approach late last year were fully documented, two earthbound observations excited astronomers:

— University of Arizona scientists, using N.A.S.A.'s Airborne Infrared Observatory flying 50,000 ft. above the earth, discovered water vapor in boiling, opaque clouds which cover the planet Jupiter. Though it was "the first oxygen-bearing molecule identified in the outer planets," finding water on Jupiter was hardly a surprise: oxygen was the third most available element when the solar system was being formed.

— The great red spot which is the most prominent and curious feature of Jupiter's gaseous atmosphere, "is almost certainly red phosphorus," Professors John S. Lewis and Ronald G. Prinn of M.I.T. told the American Astronomical Society. This conclusion results from the finding that ultraviolet irradiation of phosphine, compounds of phosphorus and hydrogen well known in the atmosphere of Jupiter, produces "great quantities" of red phosphorus.

Earlier hypotheses suggested that organic precursors of life were responsible for the varied colors in Jupiter's atmosphere, including the red spot. But Professors Lewis and Prinn say their proposed inorganic process would produce red phosphorus 10,000 times faster than the hypothesized organic reactions. Even given the presence of water on Jupiter, Professor Lewis told Robert Cooke, science writer for the *Boston Globe*, "there is no known mechanism for making organic material that can possibly compete with the photolysis of inorganic gases for producing the colored material."

But Professor Harold Larson of the University of Arizona remains an advocate of the earlier theory. "Water is a medium that permits other substances to combine and can also be an active participant in chemical reactions," he said in the N.A.S.A. announcement of the Arizona work, and the discovery of water on Jupiter seemed to him to "add confidence" to speculation that organic compounds, precursors to life, are formed in Jupiter's atmosphere and may account for the coloring of its clouds. — *J.M.*



Speculation about an organic source for the mysterious great red spot in Jupiter's atmosphere (lower left of the Pioneer 10 photograph above) should now end, think Professors John S. Lewis and Ronald G. Prinn of M.I.T.; they are convinced that the spot has an inorganic origin and that it does not represent evidence — as commonly believed — for organic processes on Jupiter. Now they think Titan, Saturn's largest moon, is the most likely place to search for organic material in the outer solar system. (Photo: N.A.S.A.)

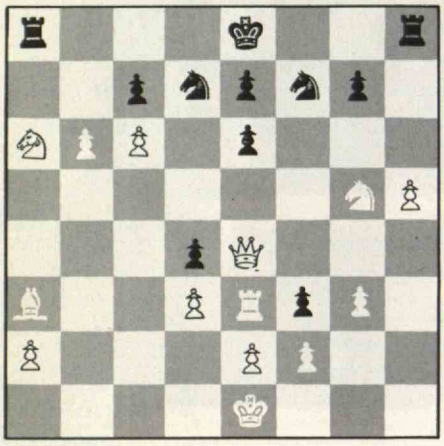
Start at the Gallows (Which Is Missing)

Puzzle Corner
by
Allan J. Gottlieb

A few months ago I asked about reversing camera lenses for magnification ratios exceeding 1:1. Many readers responded. I am pleased to say that there is scientific justification for the practice. Briefly, lenses are optimized for the usual case where object size exceeds image size. When the opposite is true, reversing the lens causes the front of the lens to face the larger "thing" (the image) while the rear faces the smaller (the object), effectively returning us to the usual case. Many thanks to all who responded.

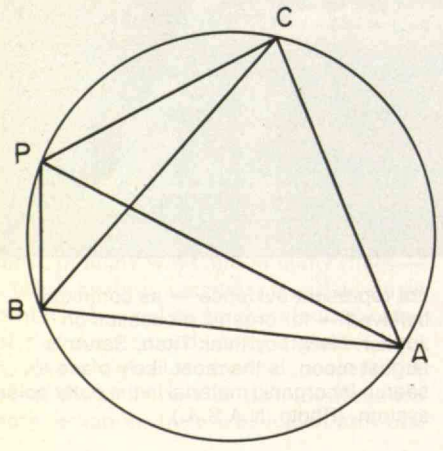
Problems

JUN 1 We begin this month with a chess problem from Harry Nelson:



White to move and mate in two.

JUN 2 A geometry problem from George Marcov:



ABC is an equilateral triangle inscribed in a circle, and P is a point chosen on arc BC. Prove that AP = BP + PC.

JUN 3 The proposer, Edward Quilter, submitted the following as a speed problem, but I feel it is more appropriate as a regular problem:

Given: one local gas company's old-fashioned storage tank. It floats like a rigid balloon, open end down, on a water sump. Vertical guides restrain it sideways but let it move up and down as gas is pumped in or out. Problem in ten parts:

1. Serve up a proof without numbers that as the tank goes up the gas pressure inside goes down (or up, or remains constant).

2. Is the sump a cylindrical hole or an annular moat (and no fair asking anybody around the gas works; they have lost the blueprint)?

3. A. The tank is half full (or half empty), no gas is added or removed, but the barometer drops. Does the tank go up or down? (*Yes* is not an acceptable answer.)

B. What about the water level(s)?

4. Would it make any difference in *3* whether the hole was annular or cylindrical, or other?

5. Would it make any difference in *3, 9, 10,* if the hole was filled with mercury or olive oil instead of water?

6. Would the tank top be a good place for a penthouse? Or a heliport?

7. Could you employ an escalator to get there and back?

8. With a decorated tank that rotates for advertising purposes, what precautions are required against freezing?

9. If the tank never goes all the way to the top, was it built too large? Does evaporation let the gas company make money on vapor?

10. Same, if it never goes all the way to the bottom? How can the interior be checked out for corrosion?

JUN 4 John E. Prussing is looking for buried treasure: An M.I.T. student bought a treasure map from an old sea captain, who told him the coordinates of the small island on which the treasure was buried. The map showed a palm tree, a eucalyptus tree, and an old wooden gallows. The instructions said to walk from the gallows to the palm tree, counting the number of steps. At the palm, turn right by a right angle and take the same number of steps, placing a stake in the ground at the point reached. Start again at the gallows and walk to the eucalyptus, counting the number of steps. At the eucalyptus turn left by a right angle and take the same number of steps, placing a stake at the point reached. The treasure is to be found buried exactly half way between the two stakes. The sea captain told the student that the old gallows had completely disappeared, having rotted away; but the trees still stood. The student is attempting to devise a method for locating the treasure. Can you help him?

JUN 5 The following difficult problem from Frank Rubin was suggested by 1972 O/N SD2: Given any collection of straight streets $S_1, S_2, \ldots, S_k$ intersecting at points $I_1, I_2, \ldots, I_n$, describe a general method of finding the placement of a minimum number of policemen so that every intersection can be seen by at least one policeman.

Speed Department

SD 1 Our first speed problem is from W. D. Mohr: Three toggle switches may be manipulated, one at a time. A change in position of any of the three switches is called a move.

1. How many unique placements are there for the group of three switches?

2. How many moves are required to enter all possible placements?

3. From any given placement, how many moves can be made?

4. How many moves are required to make all possible moves?

5. Defining a "pair of moves" as two moves that can be made one right after the other, how many possible unique "pairs of moves" exist?

6. How many moves are required to make every possible "pair of moves"?

SD 2 We end with the following from Morry Markovitz: Take any two integers, either both odd or both even, whose sum is S, which is divisible by 3. Prove that the absolute value of the difference of the squares of these numbers is divisible by 2S/3.

Solutions

O/N 1 (as revised in February, 1975) Black and White are to cooperate to checkmate White *by discovery* in the fewest possible moves, starting from the standard beginning position. What are the moves if Black is constrained to move only one piece with which he may neither capture nor give check (he may, of course, mate with the piece)?

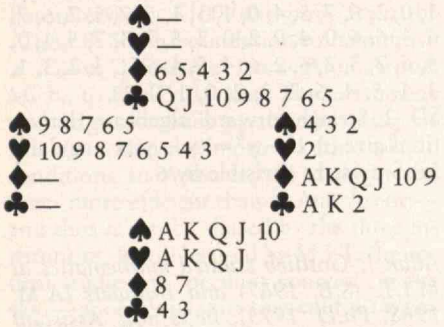
The shortest solution is the following, in ten moves, from Gerald Blum:

1	P-K3	N-KR3
2	B-Q3	N-N1
3	P-KN4	N-KR3
4	K-B1	N-N1
5	K-N2	N-KR3
6	K-N3	N-N1
7	BxP	N-KR3
8	B-K4	N-N1
9	B-N2	N-KR3
10	K-R3	N-B4

Also solved by Edward Ocampo, Paul Reeves, Stuart Schulman, and the proposer, Frank Rubin.

FEB 1 Can one deal a hand of bridge with which either side may make even two hearts?

Our best solution is from Daniel Pratt, who gives a hand where either side (but only one player from each side) can make three hearts against *any* defense:



With South as declarer, West leads either a heart or a spade, South wins in his hand, pulls East's trump (if still necessary), and takes all his spade and heart winners for his nine tricks. If West is declarer, North leads a diamond or club, West wins in Dummy with the ♦ A or ♣ A, leads the other ace, the two kings, and then the ♦ Q, discarding spades from his own hand on all five of these tricks. South can take only four tricks (his high trump), leaving the balance for West regardless of whether he trumps the ♦ Q lead.

Also solved by R. Robinson Rowe and Kenneth Lebensold.

FEB 2 Find the set of positive real numbers whose sum is 100 and whose product is maximal.

The following solution is from Allan Gottlieb (after reading everyone else's): Given n, it is fairly easy to show that the maximal value occurs when each number is 100/n (for $n = 2$ calculus, if $n > 2$ and $a_1 \neq a_2$, we can make the product larger by replacing a_1 and a_2 with $(a_1 + a_2)/2$. So the problem is to maximize $f(n) = (100/n)^n$ for *integral* n; if n is not integral, how can the set have n elements? We convert this to the problem of maximizing $(100/x)^x$ for real x. Again using calculus (differentiate and set the result equal to zero), one finds the solution to be $x = 100/e$. But we want the integral solution. Since x is between 36 and 37, most people tried each and chose 37 since it gives the larger result. To prove that this is the largest integral solution (which, in general, need not be near the largest real solution), one should point out that the above x is the *only* zero of f' and that $f''(100/e)$ is negative. Hence f decreases for $x > 100/e$ and increases for $x < 100/e$; and therefore the maximal integral solution must be either 36 or 37.

Solutions received from Gerald Blum, Sy Comwill, Daniel Feldman, Lionel Goulet, Winslow Hartford, Jerry Hedden, Eric Jamin, Jeff Jordan, Kenneth Kiesel, Zalten Mester, Charles Musselman, Randall Neff, Daniel Pratt, John Prussing, Paul Reeves, R. Robinson Rowe, Frank Rubin, John Rule, Alfredo Sadun, W. A. Schoenfeld, Stuart Schulman, and Harry Zaremba. Randy Merilatt gave an interesting application to probability theory.

FEB 3 If the numbers from 1 to 5,000 are listed in equivalence classes according to the number of written characters (including blanks and hyphens) needed to write them out in full in correct English, there are exactly 40 such non-empty classes. There is a class with exactly one number; what is it?

The following solution is from Kenneth Kiesel:

None of the one-digit numbers is unique. Of the numbers 10 through 19 only 17 is unique; it is equivalent to 51. So 1 through 19 are eliminated. Any two-digit number above 19 whose last digit is nonzero cannot be unique since no digit is unique (x4 is equivalent to x5 and x9, etc.). The remaining two-digit numbers 20, 30, . . ., 90 are not unique by inspection. Thus there is no unique number from 1 through 99. No three-digit number is unique because no digit is unique (3xx is equivalent to 7xx and 8xx, etc.). No four-digit number that is not an even thousand is unique because none of the digits 1, 0, 9, 9, or 9 is unique. The only possibilities remaining are the even thousands. 1,000 is equivalent to 2,000 and 4,000 is equivalent to 5,000. The only possible unique number is 3,000, with 14 characters. But is it unique? The other even thousands have 12 or 13 characters. The shortest remaining four-digit number (e.g., 1,001) has 16 characters. Thus there are no four-digit numbers equivalent to 3,000. The longest even hundred (e.g., 300) has 13 characters. The shortest of the remaining three-digit numbers (e.g., 101) has 15 characters. Thus there are no three-digit equivalents. The longest two-digit number (e.g., 77) has 13 characters, and the longest digit has five. Therefore 3,000 is indeed unique.

Also solved by Steven Baum, Gerald Blum, Daniel Feldman, Winslow Hartford, Eric Jamin, Jeff Jordan, Randall Neff, Daniel Pratt, John Prussing, Paul Reeves, R. Robinson Rowe, Frank Rubin, Stuart Schulman, Harry Zaremba, and the Green Phantom (again!).

FEB 4 In the programming language BASIC, each line is numbered and the subroutine call is called GOSUB. It transfers control to a specified line number, as in 10 GOSUB 20.

Control continues as usual from there until a RETURN instruction is read, when control is passed back to the line *following* the GOSUB. When several GOSUBs are executed without intervening RETURNs, they are *stacked*; that is, a RETURN returns to the line following the

latest pending GOSUB which is then removed from the stack. The next RETURN encountered refers to the previously pending GOSUB, which is then removed. And so on. Assuming a RETURN without pending GOSUB is illegal, can you prove the legality or illegality of this program:

```
10 GOSUB 20
20 GOSUB 30
30 GOSUB 40
40 GOSUB 50
50 GOSUB 60
60 GOSUB 70
70 GOSUB 80
80 GOSUB 90
90 RETURN
99 END
```

How many GOSUBs were executed?

A unanimous decision: the program is illegal! The following elegant proof is from Robert Mandl:

The program bombs out after $2^n - 1$ GOSUB executions, where n is the number of GOSUB statements in the program ($2^8 - 1$, or 255, in the case of the program given); it reaches the RETURN statement 2^n times, and the last time there is no GOSUB pending in the stack. The proof is by mathematical induction on the number of GOSUB statements. The induction starts at n = 0; the program is

```
90 RETURN
99 END
```

and it obviously bombs out the first time (thus the only time) the RETURN statement is reached. $1 = 2^0$. Suppose the program with k GOSUBs bombs out for lack of a pending GOSUB on the 2^kth time the RETURN statement is entered. After the first GOSUB statement of the program containing k + 1 GOSUB statements is executed, the sequence of events is identical to the execution sequence of the k-GOSUB program *except* for the fact that at all times there is an extra GOSUB return address at the bottom of the stack (corresponding to the extra GOSUB statement executed prior to entering the k-GOSUB portion). Thus the RETURN statement will be entered 2^k times. The original k-GOSUB program bombed out at this stage for lack of a pending GOSUB. The expanded program, however, still has one GOSUB in the stack; thus, rather than bombing out, it transfers control to the statement found in the line immediately below the line containing the stacked GOSUB — i.e., it is again at the beginning of the k-GOSUB program segment, but now with an *empty* stack of pending GOSUB requests. It will bomb out, therefore, just as the original k-GOSUB program did, after the RETURN statement is reached 2^k more times, for a total of 2^{k+1} times. Thus for all n (before the set of available statement numbers is exhausted), the n-GOSUB program bombs out after $2^n - 1$ instances of GOSUB transfer. (An additional solution could be based on the observation that the locus of control in the n-GOSUB program mimics closely enough the pattern of bit changes in an n-bit binary counter, where the 2^nth step results in an overflow.)

Also solved by Gerald Blum, Lionel Goulet, Jeff Kenton, Randall Neff, and Frank Rubin.

FEB 5 Can you build a 3 x 3 x 3 magic cube using the integers 1 through 27 once each? How about a magic hypercube using the integers 1 through 81 once each?

Again we have unanimous agreement: a magic cube is impossible, assuming that by magic cube we mean that each plane parallel to a face is a magic square. We proved several months ago that in a magic square the middle element must be one-third of the common sum. Since each plane will have the same sum, this one number would have to appear in many places. By weakening the hypotheses, several readers found solutions. The following is from Loren Dickerson:

The magic cube below is one of the entire set of possible 3 x 3 x 3 magic cubes described by W. S. Andrews (*Magic Squares and Cubes,* New York: Dover Books, 1960). All the rows, columns, "lines" (into the paper), and major diagonals have the magic sum, 42, except the two-dimensional diagonals of the outer squares. The cube also is "associated" in that all pairs of numbers diametrically equidistant from the central cell add up to 28, or twice the average of the series.

Top			*Middle*			*Bottom*		
1	17	24	23	3	16	18	22	2
15	19	8	7	14	21	20	9	13
26	6	10	12	25	5	4	11	27

The four-dimensional "hypercube" shown in the box at the bottom of this page was generated independently but is a variation of one attributed to Dr. C. Planck. The rules for its formation are as follows: The natural numbers 1 through 81 are divided into three series beginning with 1, 2, and 3. The series progress from these with intervals of four except immediately after multiples of 3, when the interval is 1. Placement from a series into cells of the squares is regular, moving to the corresponding cell in the square to the "northwest," except for three kinds of breakmoves corresponding to and occurring immediately after multiples of 3, 3^2, and 3^3, respectively, in the 1-series and after every third, ninth, and 27th numbers in the 2- and 3-series. The three series are shown with single, double, and triple virgules at the three respective kinds of breakmoves:

1, 5, 9 / 10, 14, 18 / 19, 23, 27 //
28, 32, 36 / 37, 41, 45 / 46, 50, 54 //
55, 59, 63 / 64, 68, 72 / 73, 77, 81 ///

2, 6, 7 / 11, 15, 16 / 20, 24, 25 //
29, 33, 34 / 38, 42, 43 / 47, 51, 52 //
56, 60, 61 / 65, 69, 70 / 74, 78, 79 ///

3, 4, 8 / 12, 13, 17 / 21, 22, 26 //
30, 31, 35 / 39, 40, 44 / 48, 49, 53 //
57, 58, 62, / 66, 67, 71 / 75, 76, 80 ///

The breakmoves are:
— After every third number: to the corresponding cell one square to the southwest, then one cell to the right of that square.
After every ninth number: to the corresponding cell one square to the south.
— After every 27th number: one cell up (north) in the same square.

Note that the squares may be imagined to "wrap around" vertically, horizontally, and diagonally, so that moving a number three cells in any direction confined to the same 3 x 3 square returns the number to its original cell. The resulting hypercube has the magic sum of 123 in all directions parallel to the four dimensions, in its eight hyperdiagonals, and in several other diagonals. The sums of the numbers in the cells of each square is 369. This is true also for many 3 x 3 groups of adjacent cells in the 9 x 9 square, chosen randomly. The pairs of numbers diametrically equidistant from the central cell total twice the central number, or 82. The 9 x 9 square is associated in addition to being magic.

Also solved by Gerald Blum, Winslow Hartford, Roger Lustig, Paul Reeves, R. Robinson Rowe, Frank Rubin, and the proposer, Eric Jamin.

34	74	15	20	42	61	39	7	47
23	45	55	72	1	50	28	77	18
66	4	53	31	80	12	26	39	58
65	6	52	33	79	11	25	38	60
36	73	14	19	41	63	58	9	46
22	44	57	71	3	49	30	76	17
24	43	56	70	2	51	29	78	16
64	5	54	32	81	10	27	37	59
35	75	13	21	40	62	67	8	48

Proposers' Solutions to Speed Problems

SD 1 *1.* $2^3 = 8$; *2.* 8 − 1 = 7 (One placement when it is handed to you, seven moves to get to the remaining seven placements. 0, 1, 3, 2, 6, 7, 5, 4.); *3.* Three — any one of the three switches could be manipulated; *4.* 8 × 3 = 24 (Eight placements, three moves from each placement. 0, 1, 3, 7, 3, 2, 0, 2, 6, 7, 6, 4, 0, 4, 5, 7, 5, 1, 5, 4, 6, 2, 3, 1, 0); *5.* 8 × 3 × 3 = 72; *6.* 72 + 1 = 73 (0, 1, 3, 7, 6, 2, 0, 4, 5, 7, 3, 1, 0, 2, 6, 7, 5, 4, 0, 1, 5, 1, 5, 7, 5, 7, 6, 7, 6, 4, 6, 4, 0, 4, 0, 2, 0, 2, 3, 7, 3, 7, 5, 1, 0, 4, 6, 7, 3, 2, 6, 2, 6, 4, 5, 4, 5, 1, 3, 2, 3, 1, 3, 1, 5, 4, 6, 2, 3, 2, 0, 1, 0, 1).

SD 2 Straightforward algebraic derivations give (i) $x^2 - y^2 = (x - y)(x + y)$; and (ii) S must be divisible by 6.

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics at York College of C. U. N. Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y., 11432.

An Institute Informant

Irradiating Sewage, Surveying Proteins . . .

New research assignments announced at M.I.T. during the spring:

— An experimental facility to **treat sewage sludge** by irradiating it with high-energy electrons is to be built at the Deer Island wastewater treatment plant of the Metropolitan (Boston) District Commission. The M.I.T. High Voltage Research Laboratory will design and test the pilot plant under a $198,000 grant from the National Science Foundation, and its advocates call the method "the most important new treatment method that has emerged in the last half century."

— A "far more sophisticated" **crystal growth experiment** will be aboard the Apollo spacecraft launched this summer to link up in earth orbit with the Russian Soyuz astronauts in the first international space flight. Crystals grown in the gravityless environment of Skylab III and IV a year ago turned out to be more perfectly uniform than any grown on earth, and the new experiment this summer will incorporate new features to record the rate of crystal growth and to extend the work to new materials.

— The University of Michigan, Dartmouth, and M.I.T. Astronomy Consortium has received a $100,000 grant from the Alfred P. Sloan Foundation to help move a 52-in. telescope from Ann Arbor, Mich., to Kitt Peak, Ariz. The instrument was originally built by the University of Michigan, and the improved atmospheric conditions in Arizona will make it ten times more efficient than in Ann Arbor — and thus it can be shared by the three institutions. It will be used by M.I.T. for optical studies of "peculiar sources" in the sky — anomalous stars that emit x-rays as well as visible light.

— A major study of the world's **nonconventional protein resources** is underway in the Department of Nutrition and Food Science under a $185,000 grant from the National Science Foundation. The goal, says Professor Nevin S. Scrimshaw, Head of the Department, is to produce "an agenda for high-priority research on protein sources that can make a significant contribution to enhancing world food resources."

— A low-density **housing complex relying largely on solar energy** for heating is being designed by a team of M.I.T. architecture faculty and students for a 70-acre site in the Pequannock River watershed in northern New Jersey. The property is owned by the city of Newark, and its Watershed Conservation and Development Corp. commissioned the project. Units to house some 1,000 people are being designed in a way to minimize ecological impact and to make maximum use of solar energy for heating, according to Tunney Lee, Associate Professor of Urban Design.

A Boom-Free S.S.T.

Sonic boom is probably not a serious constraint on the use of supersonic transports, thinks Wesley L. Harris, Associate Professor of Ocean Engineering and Aeronautics at M.I.T.; his research suggests that the effects of sonic boom at ground level can probably be eliminated by two simple characteristics of a redesigned first-generation S.S.T.:

— Plan an aircraft to fly at "transonic" speed, between Mach 1.05 and 1.25 — about 800 m.p.h. (The French-English Concorde is designed to fly at Mach 2, 1,400 m.p.h.)

— Give it a "waisted body" — a relatively new concept in aeronautical design which Professor Harris describes as a fuselage "pinched in the middle like a Coke bottle."

"We are convinced that these changes would prevent an S.S.T.'s boom from reaching the ground," says Professor Harris. And he proposes that "with experience from this first generation of aircraft, we could refine the design to produce a larger, faster second-generation S.S.T."

(But Professor Harris admits that the sonic boom problem may not be the controlling limitation on S.S.T. design; pollution of the stratosphere, he thinks, presents a more fundamental, serious constraint.)

Budget Weakness: How Does a Furnace Really Burn?

Nuclear engineers know precisely what is happening inside a nuclear reactor during fission, and they can control the process with great accuracy.

"But inside one of those oil-burning things — you just look in through a little window and say, 'Ah, that's a nice-looking flame.' "

"There has never been what you might call basic research on coal; and now, with our new needs, we find ourselves not knowing enough about it, and how it behaves."

Professors David J. Rose and Jack B. Howard of M.I.T. were among members of a special panel convened by the Office of Technology Assessment to study the 1976 budget proposal for the new Energy Research and Development Administration (E.R.D.A.) this spring. Though they used different words (Professor Rose first, Professor Howard second of the two paragraphs above), their conclusion was the same: in fiscal 1974 $73 million was budgeted for fossil fuel research; in 1975 the figure was $195 million; in 1976 it is proposed to be $311 million. "This is a very rapidly growing program," said Professor Howard at an M.I.T. seminar this spring, "but it is growing from a very small base, (from) . . . years of neglect."

Another need: more research on energy conservation. That budget for 1976 is $32 million — "way below what it ought to be," said Professor Rose. And end-use conservation — the ways of saving fuel where it is used — at $3 million "is being treated like the proverbial bastard at a family reunion."

Managers for the New World of Management

American industrial society is at the turning point, in the hands of "major dynamics" which may well change the patterns by which business is done throughout the world. Something as rev-

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olutionary in its way as the plate tectonics of modern geology is at work on the theory of the management of an enterprise, Howard W. Johnson, Chairman of the M.I.T. Corporation, told the Executives Club of Chicago meeting with members of the M.I.T. Club of Chicago late this winter; and "effective managers are the most crucial and complex of all the factors that relate to the wise and humane future development of our society."

What Mr. Johnson had in mind in today's industrial environment were a series of questions about the future:
— The shortage of energy and of natural resources of almost all kinds.
— The problems of the cities and their underachieving systems of housing, transportation, protection, and education.
— The shortage of capital, and the changes in the capital markets.
— The complex of human problems relating to population, food, and health.

An incomplete list, Mr. Johnson said, for "we have a surfeit of problems." But the problems themselves are not so worrisome; most of them will yield to imaginative science and engineering, and in technology we have a plenitude of resources.

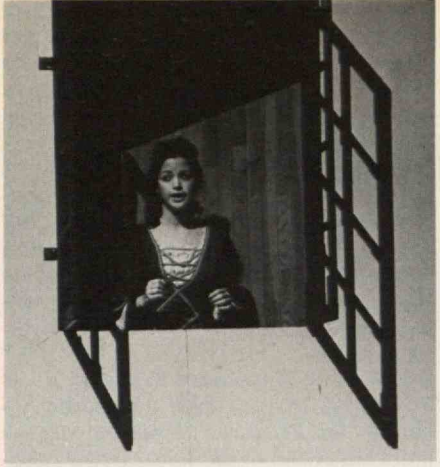
The real constraints in the future, said Mr. Johnson, will be "more human than technical." And the most difficult of these will be "the need for managers in all sectors of the society who can make the largest strategic judgments in positions that carry great visibility. . . . The crucial issue is not wealth itself but the uses we are able to make of it."

Solid Waste Management

An annotated bibliography of some 400 publications on solid waste management is now available from the M.I.T. Department of Civil Engineering (write for Report R74-56), where it has been assembled under the direction of Professor David H. Marks, Director of the Civil Engineering Systems Laboratory.

There are lots of publications on solid waste management, resulting from a large amount of research in the past decade. But the effects of all this on the actual operation of solid waste systems has been very small, thinks Professor Marks; hence the bibliography — "an effort to prepare a synthesis of useful findings which could be of value to local systems managers." One of Professor Marks' colleagues on the project calls it "a kind of encyclopedia on the subject for people at the local level."

Institute Review



"For God's sake, John, sit down!" is the first song in "1776," the musical by Peter Stone and Sherman Edwards which records – with some license – the story of the first Continental Congress and the Declaration of Independence. But John Adams never does, and Daniel T. McGillicuddy, '73 (top left), who had the part in the M.I.T. Musical Theater Guild's spring production of "1776," was the powerful focus of a thoroughly delightful evening. Carol J. Livingston, '75, who directed the show, was a novice, but she says the cast was "friendly, helpful, and talented," and "what might have been a nightmare turned into a delight." The audience found it so, too, with special plaudits for Gayle E. Ehrenhalt, '78, as Martha Jefferson (top right) and John T. Nichols as Benjamin Franklin (center right), the senior statesman of independence. (Photos: Scott D. Tobias, '77, and Ephrain M. Vishniac, '78, from Technique)

In This Section

Financial Aid: More Costs, and More Help

Every undergraduate at M.I.T. who needs financial aid for tuition and living expenses will be asked to earn in a term-time job and/or borrow a total of $2,100 before he or she receives any scholarship aid. That "equity level" will be $350 higher than this year's $1,750.

But scholarship aid for undergraduates will be up next year, too — a total of $3.85 million is budgeted. To achieve that level, the income from M.I.T. funds designated for scholarship endowment will have to be supplemented by $800,000 from other, unrestricted funds; this year only $350,000 of such funds have been required.

The pressure of costs is unrelenting. The Student Financial Aid Office expects the average student to spend $6,800 at M.I.T. next year (not including travel) — $3,700 in tuition, $3,100 for room, board, and other expenses.

Recognizing the effect of inflation on other aspects of family budgets, the College Scholarship Service last fall recommended a series of changes to the formula by which colleges calculate the contribution which parents should make to a student's college expenses. But M.I.T. — and a number of other eastern universities and colleges — took exception to some aspects of the revised formula, and they have together adopted a plan which provides for 1975-76 somewhat less aid than that recommended by C.S.S. — but more than suggested by previous C.S.S. formulas.

The result is that — at least in M.I.T.'s case — more aid will be available than ever before, and Jack H. Frailey, '44, Director of Student Financial Aid, is satisfied that no student who wishes to come to the Institute will be prevented from doing so for financial reasons.

Financial aid awards from M.I.T. in 1975-76 will depend solely on financial considerations. There will be no special scholarship grants based on outstanding academic or athletic credentials — just as there have been none in the past half-decade.

An Example: If the Need Is $3,400

The "aid package" which the Student Financial Aid Office would offer an undergraduate whose need for 1975-76 was determined to be $3,400 — just half of the student budget for the year — would include three elements:

— $900 of self-help, earned in a term-time campus job. At current wage levels, that represents about 12 hours of work per week of the term, and Mr. Frailey is satisfied that most M.I.T. students can earn that much without jeopardizing their academic work. (Students who wish to earn less can obtain the difference in a loan.)

— $1,200 of additional self-help in the form of a loan probably from the National Direct Student Loan Program, or at a somewhat higher interest rate through the Technology Loan Fund.

— $1,350 of scholarship aid.

Applying to a different "Ivy League" college, the same student would probably receive aid similarly totaling $3,400. But he would almost surely be offered more scholarship help than the Institute can provide and be asked to earn and take as a loan less than the $2,100 which is M.I.T.'s "equity."

A minority student — black, American Indian, or Spanish American — at M.I.T. with $3,400 of need would receive $2,150 in scholarship aid and be asked to take only $1,250 of loan and work obligation. This lower "equity" level is designed to reduce the apparent risk to such a student tackling M.I.T.'s rigorous academic programs. □

Default Rate: Low

Loans are a major factor in the program of financial aid to M.I.T. undergraduate and graduate students (see above), and M.I.T.'s experience in their repayment is far better than the national average.

The default rate on loans made at M.I.T is about 2.5 per cent, according to John R. Rogers, Accounting Officer for Student Loans. That's less than half the national average of 5.7 per cent reported by the U.S. Office of Education, Mr. Rogers told Roger J. Cogswell, '78, of *The Tech,* this spring.

Several loan sources are involved, and in all cases interest rates are more favorable than standard commercial terms. Repayment typically begins six to nine months after graduation, but the start of repayment may be deferred in the cases of students entering graduate schools or the armed forces.

Buy "Points" for Meals

Board and room in the Institute houses will be up next year — an increase of just over 9 per cent in room rents, 9½ per cent in meal costs.

Room rents (two terms) will range from $863 in Senior House to $1,111 in MacGregor House.

For 19 meals a week, both terms, the cost will be $1,190; for a 15-meals-a-week plan, $930. But now, in addition, students can choose to buy dining hall "points" to use as they like — 268 points for $230. Breakfast will cost one point, lunch three points, dinner four points. Unlimited seconds? Still available on all plans.

New Studies of Science In Its Social Contexts

How is a society related to, and affected by, its science and technology — and by changes in these?

A central question for scientists and engineers, and now it will be a topic of special concentration in the School of Humanities and Social Science. Beginning next fall, a wide variety of electives will be offered under a new Technology Studies Program whose purpose is to study the values, goals, and contexts of science and engineering, says Harold J. Hanham, Dean.

Louis L. Bucciarelli, Jr., Associate Professor of Engineering and of Technology Studies, explains it this way: "We are entering a period of technological maturity that requires constant examination of the social and experiential contexts of such fields as nuclear engineering, molecular biology, and urban planning." Professor Bucciarelli will head a core faculty of seven whose goal will be "to bring skills from a variety of disciplines to bear on present-day science and engineering and on future options for their relations to society and the individual."

Several approaches are planned:

— The use of history to focus on and examine enduring issues between science and society.

— The use of "oral history" — sounds of voices and events — in conjunction with written sources to study more recent changes in science and engineering.

— Studies of current problems in which technology, social issues, and disciplinary frameworks come together.

Among courses scheduled for next fall: "The Role of Blacks in American Science and Technology," "The History of Nuclear Engineering," "Value, Risk, and Choice in Modern Technology," "Social Responsibility of the Scientist and Engineer: Contemporary Issues and Historical Perspectives," "Science, Technology, and Ritual," "Chinese Science and Natural Philosophy," and "Theories of Technological Society and Politics."

The goal? If the Technology Studies Program helps students to appreciate the constant interaction between their work, their professions, the values of their society, and their experience as individuals, thinks Dean Hanham, the Program will have succeeded markedly in stimulating skillful thinking about the humanistic content of scientific and engineering activity. And if, through seminars and colloquia, the Program can similarly stimulate faculty in science and engineering, then its goals will have been even more fully met. □

The 117th portrait in the Institute's collection of distinguished scientists, engineers, and educators — perhaps the last one whose whereabouts was unknown — came to light this spring, just in time to be restored (left) and exhibited to Class Secretaries (above) at the M.I.T. Historical Collections in April. The subject is Alfred E. Burton, an adventuresome scientist who was M.I.T.'s first Dean; the artist, Mary Hazelton; the date, in the early 1920s.

The story of the Burton portrait is typical of those Warren Seamans, Director of the M.I.T. Historical Collections, can tell about many of the Institute's important artifacts. It disappeared from Burton House in 1970 during refurbishing, having been hung there in 1951 when the building was dedicated to Dean Burton's memory. Finally Mr. Seamans found it behind a pile of equipment in Building N52 — just downstairs from the Historical Collections themselves.

Assembling the History of a "Historical Force"

M.I.T. is so busy looking toward the future that it seldom looks at the past — "a historical force in the country that has neglected its own history," says Howard W. Johnson, Chairman of the Corporation. But now that delinquency is being overcome by "an absolutely superb job" in the M.I.T. Historical Collections, where literally thousands of artifacts from M.I.T.'s past have been brought together and catalogued by Warren A. Seamans.

By "conservative estimate," the collection now includes more than 300,000 photographs; a "staggering number" (130) of portraits — 117 oils and water colors, 13 portrait busts; a complete collection of theses done by students in the Department of Architecture which is achieving national recognition as a unique resource in architectural history; a large group of scientific instruments, including a collection which traces the history of the telephone; and countless dance programs, trays, favors, and other pieces of historical hardware.

But in the success of this effort lie problems, Mr. Johnson told a group of Class Secretaries assembled at the Historical Collections early this spring. The activity has literally grown of its own momentum from a part-time effort by Mr. Seamans when he was Administrative Officer of the Department of Humanities. Now it is an enterprise which absorbs his — and several others' — full-time effort. It needs "more sureness and stability," Mr. Johnson told the Secretaries — more certain future funding (the present budget is only $30,000 a year) and better quarters from which to communicate to students, faculty, and alumni "a sense of the importance through history of this institution."

Could alumni help?

They might indeed, thought some of the Secretaries.

Lots of alumni have attics bulging with memorabilia of their college days, and Mr. Seamans thinks some of these would prove to be "absolutely priceless." Money, too, thinks Azel Mack, Secretary of the Class of 1915, who has been urging his classmates to consider a gift to M.I.T. earmarked for the Historical Collections.

Julius A. Stratton, '23, President Emeritus of the Institute, was pleased. He referred to his own "deep commitment and dedication to the project" as an essential element in the history of the Institute and, through it, of American higher education. The present arrangements represent a very limited, "hard-core" budget, and Mr. Seamans has had to "scrounge around a bit to keep things going." The history of M.I.T., thinks Dr. Stratton, is worthy of more than its present "shoestring" support. □

How to Choose — or Not Choose — Your Major Field

"Sometimes the things that you're best at aren't necessarily the things you should major in."

That's the conclusion of William W. Sawyer, '77, who was told as a high school senior that he was best suited to be an engineer. So he chose metallurgy for his M.I.T. major. But by this spring he was convinced he had made a mistake, and he was back at the "academic midway" to look into some other possibilities; he was drawn to urban studies and planning, he said, "because it's a lot more people-oriented."

The "academic midway"? Neither circus nor bourse, though it looks a little like the latter. Tables around the edges of the armory gymnasium, one table for each undergraduate course and academic activity; a chance, therefore, in the space of only an hour or two, for a student to talk with people from every department about what it's like to major in their fields.

Most freshmen come to M.I.T. with well formed ideas of what they want to study. And most of those proceed simply enough through the process of choosing a major and transferring from freshman to departmental advisers by the end of their first year

at the Institute.

While he was at the "midway," Farid Dowla, '77, decided to major in either physics or mathematics — and he determined to make his choice this spring, before his sophomore year. "That will give me a feeling of the department, and then I can decide if it's good or bad for sure," he said.

But for some, like Will Sawyer, the first year reveals that the Institute and its fields have unexpected dimensions. Others, like Catharine Chiles, '78, are simply not ready yet to make the big decision. She feels drawn toward a science, but after touring the midway this spring she decided to postpone her decision and enter the ranks of the "undesignated sophomores." But "don't ask me tomorrow," she said; "I may have changed my mind."

Robert L. Halfman, '44, Professor of Aeronautics and Astronautics who is Visiting Associate Dean for Student Affairs, thinks there are basically two reasons for students to enter their sophomore years at M.I.T. without yet having chosen major fields for study. Most are simply unsure of direction; "they are scared to open up and discover what department they like."

But there's another group of students who simply "want to keep all of their options open." They know what they're interested in, but they "don't want to get trapped. They're a self-sufficient bunch who want their way of remaining untied to any department."

All M.I.T. courses are required by the faculty to organize their curricula so that students who have fulfilled all first- and second-year requirements can chose their major fields as late as the end of the sophomore year and still complete bachelor's degrees in four years. About 20 per cent of each freshman class take advantage of this option, and as "undesignated sophomores" they are Dean Halfman's special responsibility. There are special advisers and counselling services and a particular effort to help students pick their major fields. That choice is required by the end of the sophomore year; "we just don't have the mechanism to take care of them after that," says Dean Halfman — a little regretfully.

The number of "undesignated sophomores" is decreasing, the result, thinks Dean Halfman, of a change in the times — from the free-and-easy days of the 1960s to a more competitive time today. "Before, everything was relaxed and long-ranged; today, everything is much more focused," he feels. □

Undergraduate Nuclear Engineering Approved

Beginning next fall, M.I.T. will be the 18th institution in the U.S. to offer an undergraduate curriculum in nuclear engineering. Award of the S.B. degree in that field was recommended by the faculty during the winter and approved by the Executive Committee of the Corporation this spring.

Nuclear engineering became a separate department at M.I.T. in 1958, and since then its graduate programs and research into energy systems and nuclear power reactors have won wide distinction. Now the Department will also offer a program of undergraduate studies.

Kent F. Hansen, Acting Head of the Department, advocates the undergraduate program because it will help respond to a growing and critical national need. He points to estimates that some 1,700 nuclear engineers with S.B. degrees will be needed this year, and that is four times the number enrolled in existing undergraduate programs. In its first year the M.I.T. program may enroll 20 or 30 sophomores, he thinks, and he hopes in five years that the Department's undergraduate enrollment may be as high as 100. If that goal is achieved, it will represent a 25 per cent addition to the nation's present undergraduate nuclear enrollment.

The undergraduate course at M.I.T. will prepare students for nuclear engineering jobs, and it will also "provide a base from which the student can extract more educational value from graduate-level studies," says Professor Hansen. Electives will give students "limited" opportunities to specialize in fission reactor engineering, applied radiation physics, and fusion reactor (applied plasma physics) engineering. □

Responding to the Survey

How can M.I.T. reach out to the 30,000 alumni identified by the 1974 alumni survey (*see March/April, pp. 74-79*) as having "interests and creative energies (which) might find greater resonance with M.I.T."?

That question, and other responses to the data and attitudes revealed in the survey, will be the focus of discussions at the 1975 Alumni Officers Conference in Cambridge on September 12 and 13. As many as 850 alumni and their guests are expected.

Among the speakers: Howard W. Johnson, Chairman of the Corporation; Constantine B. Simonides, '57, Vice President of M.I.T. who directed the survey team; James A. Champy, '63, Executive Vice President of the Alumni Association; and Howard L. Richardson, '31, who will become President of the Alumni Association on July 1. Formal sessions and discussion groups on Saturday morning will be followed by a presentation of M.I.T. research interests in the field of brain function and language formation on Saturday afternoon.

Alumni officers will be invited to receptions and dinner on Friday, September 12. □

Geometry in the Caves

We all have five fingers, two hands. It isn't surprising that ten is the most important number in mathematics, said Professor Emeritus Dirk J. Struik in the first of his seven lectures on the history of mathematics. What *is* surprising is the amount of abstract thinking done by "primitive" man 12,000 years ago, he said. "Don't underestimate the effort that went into cave drawings; they are a kind of geometry — three dimensions represented on a two-dimensional plane."

The oldest math of which we have records was written by scribes in Egypt and Babylonia about 3,000 B.C., lasting 4,000 years. It was the decimal system, without positions. Multiplication was done by duplication: $2 \times 7 + 4 \times 7 = 6 \times 7$, for example.

Each civilization had its own way of writing: hieroglyphics in Greece, numerals in Egypt, cuneiform in Babylonia. The Pythagorean Theorem was used as a computing device long before it was proved — "Do it this way because it works," they taught their children.

The age-old decimal position system, which began in China and spread to India and Europe, was interrupted only twice. First in Greece, there emerged an entirely new approach to mathematics — an abstract science that was part of the philosophy of life. Here began mathematics based on proofs, on a system of x's. But the "Greek Miracle" lasted only a few hundred years, during the time of Thales and Pythagoras in the 6th century B.C. It ended with the death of Archimedes. And the mathematics of the ancients returned.

A second interruption broke the spell of ancient algebraic mathematics during the time of the city states of the Italian Renaissance. Calculus came to full fruition, then analytical geometry, and probability. By the 17th century, there could be no turning from modern mathematics. □

Two New Companies For VI-A Program

The Charles S. Draper Laboratory, Inc., and M.I.T.'s Lincoln Laboratory have joined the Cooperative Program (Course VI-A) in the Department of Electrical Engineering and Computer Science, bringing to 15 the number of off-campus firms and laboratories offering opportunities in a practical learning environment to undergraduates.

It's a popular program, and a successful one, thinks John A. Tucker, Director of Course VI-A. Some 80 students in the Department applied for places in Course VI-A in 1975-76, but only about 50 could be ac-

cepted; those who succeeded in their applications will spend two or three semesters working at one off-campus location on increasingly sophisticated research or development assignments, eventually receiving S.B. and S.M. degrees simultaneously at the end of the fifth year of study.

The thirteen companies previously cooperating with M.I.T. in Course VI-A include AVCO-Everett Research Laboratory, Bell Telephone Laboratories, Comsat Laboratories, Digital Equipment Corp., Fairchild Camera and Instrument Corp., General Electric Co., General Radio Co., Hewlett-Packard Co., Honeywell, Inc., I.B.M. Corp., Naval Ordnance Laboratory, Naval Underwater Systems Center, Raytheon Co., R.C.A., and Texas Instruments, Inc. □

Lowering Bars from the U.S.S.R.

A Visiting Professorship at M.I.T. awaits Alexander Lerner, a U.S.S.R. specialist in computer engineering; but he cannot accept it because "Soviet authorities won't let me go there," he says in a taped message hidden in a recording of a Tchaikovsky symphony and thus delivered to M.I.T. by an American physicist late in 1974.

Professor Lerner is one of three Russian scientists who are the subjects of an *ad hoc* committee of M.I.T. faculty members seeking to help them leave positions of isolation in the Soviet Union. The others are Professor Mark Azbel, a physicist whose name is given to the Azbel-Kaner cyclotron resonance of which he is discoverer, and Professor Benjamin Levich, a Corresponding Member of the U.S.S.R. Academy of Sciences who is the author of a massive text on *Theoretical Physics*.

Eugene Stanley, Hermann von Helmholtz Associate Professor of Health Sciences and Technology in the Department of Physics, says there may be as many as 400 Soviet professionals who want to leave the U.S.S.R. So he and Ira A. Michaels, a post-doctoral fellow associated with the Harvard-M.I.T. Program in Health Sciences and Technology, have formed the M.I.T. Committee for Azbel, Lerner, and Levich with the goal of making it "unmistakably clear to the Soviet government that a significant number of scientists in the U.S. are committed to obtaining emigration rights" for their colleagues. Professor Lerner himself believes that if enough scientists throughout the world can be active enough in his behalf, the Soviet government would find his freedom necessary.

To support the cause, President Jerome B. Wiesner and Louis D. Smullin, S.M. '39, Jackson Professor of Electrical Engineering, have formally extended the Visiting Professorship invitation. □

Campaign Report: A "Very Positive" Response; Steering Committee Listed; Choosing Leaders

After a cross-country tour late in April to announce to leading alumni and friends M.I.T.'s $225 million Leadership Campaign (*see May, p. 73*), President Jerome B. Wiesner calls response to the heroic program "very positive."

Preparing for his last issue of the term, Michael D. McNamee, '76, Editor of *The Tech*, asked Dr. Wiesner how fast the Institute will be able to move toward its goals during the summer. That depends critically on two "very sensitive" factors, thinks President Wiesner:

— In the case of individual prospects, continued progress toward recovery by the stock market.

— In the case of corporate prospects, a positive national economic outlook — especially as it affects employment and earnings.

Among the alumni whom President Wiesner, Howard W. Johnson, Chairman of the Corporation, and Paul F. Hellmuth, '47, Co-Chairman (with Mr. Johnson) of the Campaign, visited were members of the Campaign Steering Committee:

— **Paul M. Cook,** '47, President of Raychem Corp., Menlo Park, Calif.

— **Marshall B. Dalton,** '15, Honorary Chairman of Arkwright-Boston Manufacturers Mutual Insurance Co. and Mutual Boiler and Machinery Insurance Co., Peterborough, N.H.

— **Luis A. Ferre,** '24, former Governor of Puerto Rico who is President of the M.I.T. Alumni Association.

— **Cecil H. Green,** '23, Director of Texas Instruments, Inc., Dallas, Tex.

— **Robert C. Gunness,** '34, retired Vice Chairman of the Board of Standard Oil Co. (Indiana), Chicago, Ill.

— **J. Kenneth Jamieson,** '31, Chairman of the Board and Chief Executive Officer of Exxon Corp., New York City.

— **Breene M. Kerr,** '51, Senior Partner, Resource Analysis and Management Group, Oklahoma City, Okla.

— **Paul V. Keyser,** '29, retired Executive Vice President and Director of Mobil Oil Corp., New York City

— **Ralph Landau,** Sc.D. '41, President of Halcon International, Inc., New York City.

— **Carl M. Mueller,** '41, Managing Partner, Loeb, Rhoades and Co., New York City.

— **Clint W. Murchison, Jr.,** '44, Partner in Murchison Brothers, Dallas, Tex.

— **William E. Murphy,** Director of Campbell Soup Co., Camden, N.J.

— **D. Reid Weedon, Jr.,** '41, Senior Vice President of Arthur D. Little, Inc., Cambridge, Mass.

— **Uncas A. Whitaker,** '23, Chairman of the Board of AMP, Inc., Harrisburg, Pa.

— **John J. Wilson,** '29, Secretary of the Corporation, M.I.T., Cambridge, Mass.

Leadership committees of alumni and friends are now being formed throughout the country to lead local efforts in behalf of the Leadership Campaign; several hundreds — even thousands — of alumni will soon be involved.

One day after their appearance at the Alumni Advisory Council on April 22, the officers of the M.I.T. Leadership Campaign officially announced the new $225 million program for the Institute at a New York press conference. The picture shows (left to right) Paul F. Hellmuth, '47, Co-Chairman; Howard W. Johnson, Chairman of the Corporation; Jerome B. Wiesner, President; and Paul E. Gray, '54, Chancellor, as they described the Institute's goals of providing "education, wisdom, and inspiration for a future that depends upon the development and wise use of new technology." (Photo: Wide World)

Honors to the M.I.T. Press

Recent honors for books published by the M.I.T. Press:

— A silver medal in the fourth Biennial International Art Book Contest of the Israel Museum, Jerusalem, to *Is Anyone Taking Any Notice?*, a collection of photographs by Donald McCullin.

— The Grand Prize of the Festival d'Arles, for the best photography book of the year, to *Travelog,* a book of personal photographs by Charles Harbutt.

— Selection for Fifty Books to travel under auspices of the American Institute of Graphic Arts: *Compendium for Literates – A System of Writing,* by Karl Gerstner.

— Selection for a traveling show sponsored by the Association of American University Presses: *Compendium for Literates* and *Taking Part* by Lawrence Halprin and James Burns.

— Certificates for typographic excellence from the Type Directors Club of New York to *Process of Choice* by the Group for Environmental Education; *Playgrounds for Free* by Paul Hogan; *Humanscale* by Neils Diffrient, Alvin Tilly, and Joan Bardogjy; and *Compendium for Literates.* □

Overheated Residents

Approximately half of the married students living in Westgate refused to pay an average of $8 a month more rent for their Westgate apartments effective March 1. A "rent strike," they said.

The $8 increase was needed to cover additional fuel costs, said H. Eugene Brammer, Director of Housing and Food Services. Foul ball! replied James M. Henle, President of the Westgate Community As-

How to Use Computers in Business? A Plan to Bring Diverging Experiences into Harmony

Do managers need computer-based decision aids?

If you ask that question you're marked as an old-line executive whose time is past. The questions to ask now are different: What kind of system, and how to use it?

Thinking that "explosive growth of the electronic computers used in information systems has been accompanied by increasingly complex choices for managers who have to decide which system is best for their needs," three members of the Sloan School of Management have formed a Center for Information Systems Research. Their goal:

"We want to be an impartial source of research-based information which will help managers understand the complex choices and risks associated with acquiring, implementing, and absorbing into their organizations computer-based decision support systems," says Norman L. Rasmussen, Senior Research Associate who is Acting Director of the Center.

For an example of the Center's work, consider the studies of Peter G. Keen, Assistant Professor of Organizational Psychology and Management: How do the psychological differences between managers and computer specialists affect the design of information systems? How should they?

The aim of C.I.S.R., says Michael S. Scott-Morton, Associate Professor of Management (he will be Director of C.I.S.R. when he returns from a sabbatical leave next fall), is to reach for just that "middle ground." To it, thinks Professor Keen, the Sloan School will bring "theory, a wider frame of reference, and — perhaps — some sort of ideal of how systems might be used."

He hopes executives will bring a sense of their experience and needs, forcing the Center "to be aware of just how managers have to operate," says Professor Keen. "We really need each other," he thinks. □

A new Center for Information Systems Research in the Sloan School of Management will seek a middle ground between academic theoretical experience and practical, management needs in computer-based decision aids. Richard J. Walters (center) of Martin Marietta Corp. presents a check for his company's participation in the new Center to its Director, Professor Michael S. Scott-Morton (right); at the left is Norman L. Rasmussen, Senior Research Associate in the Sloan School, who is Acting Director of while Professor Scott-Morton is on sabbatical leave this year.

sociation: a lot of fuel is wasted by a system which overheats the buildings (68° to 80° F.), and the tenants ought not to pay for what they don't want, don't need, and have to get rid of by opening the windows.

The impasse was short-lived. Paul E. Gray, '54, Chancellor, asked August L. Hesselschwerdt, '31, Professor of Mechanical Engineering, Emeritus, to coordinate correction of technical flaws (if any) which cause overheating. As it had agreed to do, the Housing Office reviewed cost data at the end of April. It found sufficient savings in consumption had been made to offset the increase in fuel price.

The Office withdrew the $8 increase, and Mr. Henle told *The Tech* he was "happy about the whole situation." □

A More Unified, Creative, Cost Effective Management Style

Most employees are willing to accept decisions regarding *what* work must be done, but they are more and more interested in having a voice as to *how* their own work is performed. Self-esteem and mutual support, feelings of participation and identity with group goals, are among the ingredients of a healthy work situation which lead to higher performance levels.

These are the views of Drs. Maureen and Adam Yagodka, who came to M.I.T. in February, 1974, as the Co-Directors of the Office of Personnel Development (see May, 1974, p. 82). Among their goals were the design of new programs for personnel and organization development, and to help work groups at M.I.T. improve the effectiveness of their organizations through consultation.

Ongoing M.I.T. personnel programs for orientation, tuition assistance, skills training, and administrative development are the responsibility of the Office. New to M.I.T. have been a series of workshops in "human processes" for both supervisors and non-supervisors, and several experiments in the development of a "participative group" management style.

"Participative group management?" Look at the Yagodkas' own office, which has been experimenting with this approach for at least a year. In a nutshell: all members of the Office of Personnel Development — there are 13 people in staff and nonstaff categories — take part in deciding long-range goals; they work together toward these goals and evaluate their success at reaching them.

Sense of shared responsibility, work load, specialized knowledge, and access to relevant information have become the important factors in decision-making; position and prerogatives in organization structure have become less important. The result is a more unified, creative, and cost effective office, say the Yagodkas.

The supervisory function becomes one of "facilitating." It emphasizes the development of an effective working group and includes being a resource of specialized knowledge and information. The Yagodkas agree that "facilitative" managers gain rather than lose influence in the organization. Involved employees feel less antagonism toward organizational goals. Flow of information and feelings are improved. When employees have an investment in group goals and a responsibility for the outcome, they are less likely to shrug off their frustrations and say, "It's not my problem" or "There's nothing I can do about it."

At first, in the Office of Personnel Development, a lot of time was spent in getting acquainted, developing skills, and learning group dynamics. The arts of constructive feedback and even good listening had to be developed. Later, two- to three-hour weekly meetings began to be oriented toward problem solving — finding ways to better distribute workloads and cutting down unnecessary work. Those with positions of higher authority found they had less work to do when the group discovered means to eliminate certain managerial tasks. Biweekly employees were able to take on new responsibilities, and staff members began to participate more actively in some necessary support activities.

Poor performance seldom becomes a problem when the guidelines for giving feedback are followed, said Priscilla Mead, a Personnel Development Officer. A problem should be pointed out and resolved as soon as it is discovered, instead of being ignored and then handled much later in a generalized or arbitrary way. In fact, the identification of problems and conflicts were said to be essential for creativity and personal growth.

Ms. Mead, who has worked at the Institute in various capacities for 32 years, says that the participative management style has not been a radical change in her work experience. But reflecting upon the values with which she grew up, she feels that tackling problems openly and supportively has been a transition.

As a result of the group support she received, she began to teach a course in technical typing when the need arose, something she had never before considered doing. She also thinks she has increased her effectiveness in volunteer activities outside M.I.T. Ellen Oglesby O'Hara, a nonstaff employee, finds her job experience enriched by participative management; she has worked with the Yagodkas in conducting

Sampling Life Aboard "Sea Venture"

A cold, raw wind blew across the Hudson River on Saturday, February 22 — not at all like the soft, warm breezes of the Caribbean which are M.S. *Sea Venture*'s stock in trade. But the schedule allowed a few hours in port, and Oivind Lorentzen, Jr., '43, President of Flagship Cruises, and his staff took the chance to entertain some 50 members of the M.I.T. Alumni Center of New York and their guests for buffet luncheon on board. In the picture are (left to right) Mr. Lorentzen; David A. Shepard, '26, of the Alumni Center; Ira Dyer, '49, Head of M.I.T.'s Department of Ocean Engineering; Torbjorn Hauge, Captain of the *Sea Venture*; Bruce G. Curry, '52, the Alumni Center's Chairman for the event; and Ronald E. Enstrom, '57, co-chairman. □

workshops for other groups at the Institute.

What about salaries, in a situation where responsibilities and tasks are so largely shared? Discussions of salaries, the Yagodkas feel, can be handled by the group. It is a problem made more difficult by various external constraints; but when the discussion is handled openly, constraints seem more acceptable. This spring's non-staff salary review, for example, turned out to be a group evaluation. After group discussion and feedback, each person being reviewed identified those members of the group who were sufficiently knowledgeable of their work performance to be able to evaluate it. The person being reviewed and all the others identified submitted percentage increase recommendations in view of the Institute-wide ground rules and limitations. The total input was then averaged and all seemed satisfied with the results.

Could a participative management system work if many of M.I.T.'s clerical and secretarial employees were unionized, as is now being proposed by A.W.A.R.E., the Association to Work for Reform in Employment (see *Technology Review,* March/April, p. 87)? Adam and Maureen Yagodka point out that where union contracts stipulate the kinds of work that can be performed, certain elements of participative management might be affected. With such a contract a staff member might be prevented from doing certain support activities and union members might be precluded from performing work defined for staff. On the other hand, they say, a number of U.S. companies that are unionized have adopted participative styles. In Europe, unionized workers have become increasingly involved with management in participative schemes.

Will other parts of the Institute experiment with more participative styles of management? Some are, and more may do so as the advantages and disadvantages are more clearly understood and predictable. One thing is clear, according to the Yagodkas; participative management cannot work unless a manager is committed to moving in that direction, and the work group engages in a time-consuming, but rewarding, initial process of developing needed skills and abilities. — *Susanne Fairclough*

"Food": Myth and Symbol

The Lobby of Building 7 was transformed into a fat fetishist's dream — or nightmare — late this spring with the opening of the mixed media show, "Food."

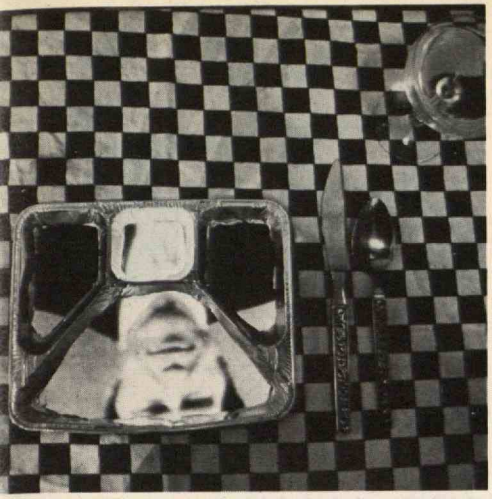
The exhibition, designed by Otto Piene, Director of the M.I.T. Center for Advanced Visual Studies, Suzanne R. Weinberg, M. Arch. '72, Lobby 7 Coordinator, and Ernest K. Pariser, Senior Research Scientist in the Department of Nutrition and Food Scientists, explored the popular, political, educational, and artistic aspects of food and nutrition. It was at once serious and whimsical, a forum for literally anyone with something relevant to display. Many students — moved at least in part by a deeply serious sense of the famines, shortages, and waste that beset the world — joined the professional artists. According to Ms. Weinberg, "For most of the students who contributed work to the exhibit, this was their first experience in producing and presenting their work for exhibition."

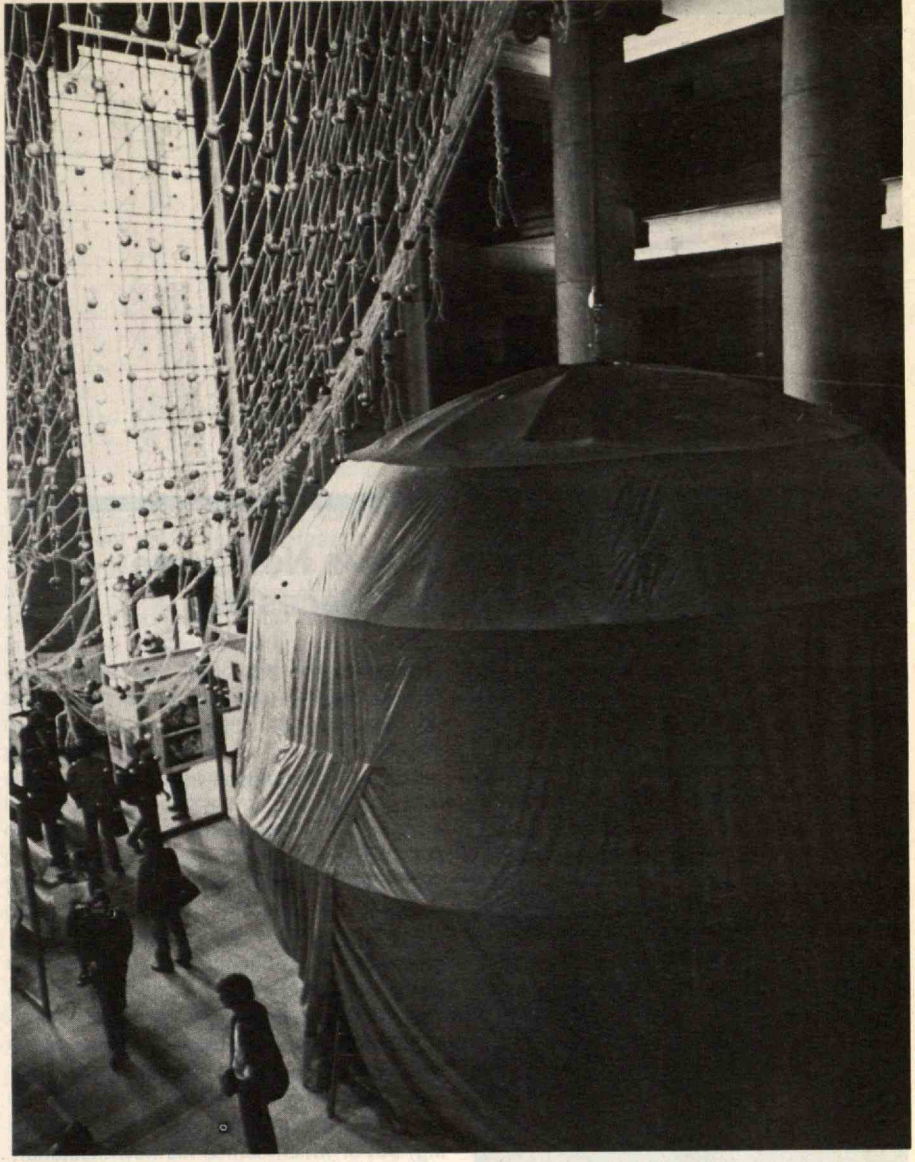
There was a 6-ft. sculpture of a tongue, a mechanical cow displaying production from crabgrass to milk, numerous graphics, photographs, and videotape displays. The centerpiece was a 27-ft. plastic apple housing a multimedia gallery of six concurrent slide shows, narrated by a tape of gurgling digestive noises. Hovering over it all was a giant fisherman's net strung with apples.

Little wonder that some would criticize the show for the waste it attempts to satirize. Soon after the show opened, complaints began to circulate, notably in letters to the student newspaper *The Tech,* that the show was offensive. Wrote one group of students, "Feed the Cambridge poor or help other world starving — don't throw mushrooms on the steps [one of the show's "happenings"] and let apples rot in the air . . ." Still others objected to the show's catholicity of taste, arguing that some of the exhibits affronted their aesthetic sensibilities. As a result, a move is underway to subject future exhibitions in Lobby 7 to review by an Undergraduate Association committee: "Why should the M.I.T. community be consistently subjected to this "art" as defined by a very small group of people?" one letter commented.

Ms. Weinberg, writing to *The Tech,* responded that because participation in the show was open and because Lobby 7 presented both a new and difficult space for many of the contributors, the exhibits indeed represented a wide range in quality. But "the work is meant to provide an educational experience and the process through which a student goes in producing such work is as valuable as the final product." She argues further that "money spent for this exhibit was spent for an educational effort, much like other educational projects in other parts of the Institute."

Despite the debate surrounding it, most of the M.I.T. community responded to "Food" with glee and enthusiasm throughout the show. Ritual dances performed by the M.I.T. Dance Workshop and two presentations by Kenyon Martin of the National Mime Theatre punctuated the show's run. Perhaps the highlight was Julia Child's visit at the exhibition's close. Serenaded by the M.I.T. singing group, "The Logarythms," Ms. Child entered into the spontaneous spirit of the affair, cracking jokes, mixing omelets, and dispelling at least one more myth in the multi-faceted subject of "Food." — *Deborah McGill*





"Food," a multimedia exhibition held in the Lobby of Building 7 in April, offered much to attract the eye and delight the wit. A 27-ft. plastic apple (above) housed a continuous presentation of six concurrent slide shows, replete with running commentary in the form of the gurgles and rumblings of digestion. The table setting (above left) held a surprise for the unwary observer. Titled "TV Dinner," it was precisely that. A number of events punctuated the show's run: members of the M.I.T. Dance Workshop performed food rituals (left and opposite left), Kenyon Martin of the National Mime Theatre presented two pantomimes, "Out to Lunch" and "The Artist" (this page, center), and Julia Child of the popular television series "The French Chef" (opposite page, top) closed the show with a demonstration of her culinary artistry. (Photos: Roger N. Goldstein '74)

People

George Bugliarello studied at M.I.T. for his doctorate in civil engineering and then focused his work on the contributions of engineering to biology and medicine. Now his concern for the human implications of technology can be expressed on a larger scale than ever before: Dr. Bugliarello was inaugurated this spring as President of the Polytechnic Institute of New York, the result of a merger of the Polytechnic Institute of Brooklyn and the New York University College of Engineering. He proposed in his inaugural address that the new institution now offered "a critical mass on which a comprehensive technical university responsive to the needs of New York can be built."

Size Is Not Curse But Necessity

Can we learn how it is that technology "takes hold and serves man — why it thrives under certain conditions and fails under others"?

The crucial question for modern society — and especially for the State of New York, thinks George Bugliarello, Sc.D. '59, who was inaugurated as the first President of the Polytechnic Institute of New York early this spring.

For it is by no means certain, thinks Dr. Bugliarello, that technology can come to terms with such modern problems as New York State's — energy shortages, transportation inadequacies, growing poverty, urban blight. But he proposes that the merger (of Polytechnic Institute of Brooklyn and the New York University College of Engineering) out of which comes his new institution "has created a critical mass on which a comprehensive technical university responsive to the needs of New York can be built." His goal as its President, he says, will be to build that institution and thus answer his basic question.

Overcoming our "Diffidence About Size"

William O. Baker, President of Bell Telephone Laboratories who spoke at an inaugural symposium, was optimistic. He argued that Dr. Bugliarello's prescription is just right, that institutions should be scaled to the size and complexity of the problems with which they are intended to deal.

In the case of science and technology, said Dr. Baker, new knowledge will contribute little unless there is "a large enough commitment of skills and materials" to assure that it becomes part of common knowledge upon which society can draw. A ten-to-one ratio may be about right: ten people concerned with transforming new knowledge into use for every person seeking basic new facts.

Indeed, Dr. Baker said, "if the nation is going to maintain its world and domestic stature, we must overcome (our) diffidence about size and abandon the dreamy idea that small, disjointed units can do the job.

"Knowledge simply will not be useful under those conditions." □

Equal Employment: Advocacy and Practice

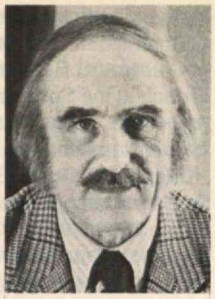
P. A. Wallace

Phyllis A. Wallace, an economist noted for research and teaching in the field of manpower and equal employment practices who has been Visiting Professor of Management in the Sloan School since 1973, has been named Professor of Management; she is the first woman to hold that rank on the School's faculty.

Dr. Wallace studied at New York University and Yale, and before coming to M.I.T. she had been Vice President for Research at the Metropolitan Applied Research Center in New York and Deputy Director of Research for the U.S. Equal Employment Opportunity Commission in Washington. Earlier Dr. Wallace held government positions in the field of international economic affairs, and she has taught at City College of New York and Atlanta University.

Professor Wallace is a member of the National Manpower Policy Task Force, the Committee on the Status of Women in the Profession of the American Economic Association, and the Board of the Manpower Demonstration Research Corp. Her publications are in the field of minority employment and equal employment opportunity. □

W. A. Rosenblith



A. H. Shapiro

New Distinctions for Rosenblith, Shapiro

Walter A. Rosenblith, Provost, and Ascher H. Shapiro, '38, Ford Professor of Engineering, have been honored by their faculty colleagues with appointments as Institute Professors. The designation is reserved for "scholars of special distinction" given upon recommendation of a faculty committee.

Professor Rosenblith's appointment recognizes his contributions to the study of sensory communication and brain function; in addition to his important administrative assignment as Provost, Dr. Rosenblith is Professor of Communications Biophysics in the Department of Electrical Engineering.

Professor Shapiro returned to teaching and research last year after nine years as Head of the Department of Mechanical Engineering; he has made notable contributions to the science and teaching of fluid mechanics, and he is how applying this and other engineering knowledge to the solution of medical problems and the understanding of human biology.

Professor Shapiro's earlier work was related to engineering problems of power production and propulsion engines; he is the inventor of a nuclear aircraft propulsion system and was Director of a study on the technology and economics of nuclear power for civilian use commissioned by the Atomic Energy Commission in 1953.

More recently he turned to fundamental research in fluid dynamics, an outgrowth of which was a series of innovative contributions to the teaching of fluid mechanics — notably a number of highly successful educational films.

Dr. Shapiro joined the M.I.T. faculty in 1943, three years before he completed his doctorate in the Department of Mechanical Engineering; he was named Professor of Mechanical Engineering in 1952 and Ford Professor of Engineering in 1962.

Professor Rosenblith's career in biophysics was profoundly influenced by his early associations with Professor Norbert Wiener, who was Professor of Mathematics when Dr. Rosenblith first came to the Institute in 1951. In announcing Dr. Rosenblith's appointment as Institute Professor, President Jerome B. Wiesner called attention to his "early use of computers in quantifying electrical responses to sensory stimuli and in detecting significant patterns in the electrical activity of the central nervous system." Ever since then Dr. Rosenblith has been a leading figure in the increasingly productive research in biophysics and communication sciences at M.I.T.; in the late 1950s he was a member of the steering committee of the Center for the Communication Sciences and in the early 1960s the first Chairman of the Committee on Engineering and Living Systems.

Dr. Rosenblith's career in the M.I.T. administration began in 1967 when he was elected Chairman of the Faculty; he was Associate Provost for two years and then succeeded President Wiesner as Provost in 1971. A native of Vienna, Dr. Rosenblith came to the U.S. after completing degrees in communications engineering at the University of Bordeaux (France) and the École Superieure d'Électricité in Paris. He came to the Institute from a research assignment at the Harvard University Psycho-Acoustic Laboratory; earlier he had been a member of the Physics Department at the South Dakota School of Mines and Technology. □

New Move for Machines to Learn, See, and Think

Patrick H. Winston, '65, Associate Professor of Computer Science and Engineering who has been Acting Director of the Artificial Intelligence Laboratory for more than a year, is now its Director.

He succeeds Marvin L. Minsky, Donner Professor of Science, and Seymour A. Papert, Cecil and Ida Green Professor of Education, who have been Co-Directors of the Laboratory since 1971. Both will continue on the Laboratory's Steering Committee while devoting full time to research in artificial intelligence and learning which has attracted worldwide attention in recent years.

P. H. Winston

Professor Winston contrasts artificial intelligence with other forms of thinking and wisdom: "Where traditional thinking resorts to such classifications of knowledge as 'intuitive versus formal' or 'tacit versus explicit', the artificial intelligence framework asks 'What is knowledge?' and 'How can it be represented?' "

He hopes the Laboratory will continue to focus on important areas of research into learning, machine vision, knowledge representation, and natural language comprehension, contributing to "the creation of intelligent automatic equipment that will increase productivity, improve education, and generally aid society."

Professor Winston's degrees are from M.I.T., and his doctoral thesis was on learning and machine vision. His work in these fields has continued, with the addition of interests in productivity technology, and he is now at work on a text on *The Psychology of Computer Intelligence*. □

A Statesman Explains His Faith in the Future

What were you doing most of last week? . . . Taken all together, would you say you are very happy, moderately happy, not happy at all? . . . If you are married for a second time, how did your first marriage end? True or false: I do not always tell the truth. My

mother was a good woman. My mind sometimes seems to work more slowly than usual. . .

The Census Bureau of the U.S. required American citizens to answer these questions and many more. The answers may have brought light to social planners, but Senator Sam Ervin thinks they bore no relation to the business of government.

Senator Ervin, appearing in Kresge Auditorium for the Lecture Series Committee in April, talked about privacy: Americans enlarged the concept that every man's home is his castle, he said. Laws were written to ensure the rights of the people. But now the government itself has become the chief challenger of the right to privacy. Government agencies are attempting in the name of security and lawfulness to open every aspect of individuals' lives to public scrutiny. The effort has its ludicrous moments: in 1968, 67 Colorado State University students engaged in a quiet protest against the war in Viet Nam were watched by 52 military intelligence agents whose attempts to tape record the demonstration were unsuccessful because of the noise from six army helicopters flying directly overhead. We may be a country calling itself "the land of the free," but if we want to have liberty, said Senator Ervin, we must keep an eternal vigil in the war against tyranny.

"Would you share your thoughts on the equal rights amendment?" asked a student. "I voted against it," said Senator Ervin, and the audience cooled. "I think it's totally unnecessary. Those who advocate it cite decisions of 1873, not recent decisions of the Supreme Court." Probed further, he responded that "the young lady asking the question has not seen women with children, married to sorry men, who must be protected. The Lord did make a difference between men and women — you can't pass an amendment that would make husbands the mothers of children."

On Ford's pardon of Nixon: "The pardoning power of the President is greater than the Almighty; the Almighty can pardon any sinners, but they must *first* confess . . ."

And a prophecy, before he left: "When you take charge, you'll do a better job than my generation." □

Five Visiting Teachers

Five distinguished visitors are completing assignments this month which brought them to the M.I.T. faculty for the spring term. They are:

— **James M. Douglas,** Visiting Professor of Chemical Engineering. A specialist in process dynamics, control, and optimization, Professor Douglas is a member of the University of Massachusetts faculty; his engineering degrees are from Johns Hopkins University and the University of Delaware, and he has previously taught at the Universities of Delaware and Rochester.

— **Karl G. Jugenfelt,** Visiting Professor of Economics. Professor Jugenfelt studied at the University of Uppsala, Sweden, and is now a member of the Stockholm School of Economics; his teaching and research at M.I.T. are in the field of productivity and technological change in industry.

— **Ian Lerche,** Visiting Associate Professor of Physics. A graduate of the University of Manchester (England), Professor Lerche holds a faculty appointment in the field of astronomy at the University of Chicago.

— **Mervyn S. Paterson,** Visiting Professor of Earth and Planetary Sciences. Studies of rock deformation at high pressures and temperatures have won Professor Paterson wide recognition among geologists and geophysicists; he is Reader in the Research School of Earth Sciences at the Australian National University, Canberra. Professor Paterson holds degrees from Adelaide University and Cambridge University, where he continued in post-graduate study as Angas Engineering Scholar and Overseas Fellow at Churchill College.

— **William W. Roberts, Jr.,** '64, Visiting Associate Professor of Mathematics. Professor Roberts has been a member of the University of Virginia faculty since completing his Ph.D. studies at M.I.T. in 1969; his current research interests are in fluid mechanics, star formation, and social problems of population growth and environmental protection. □

Administration Changes

Fourteen administrative posts were filled at M.I.T. during the late fall and winter:

— **Nelson Armstrong,** a member of the Office of Student Counseling at Dartmouth since his graduation there in 1971, is now Assistant Director of Financial Aid. An accomplished musician, he will especially be involved with counseling for students applying for financial aid.

— **Timothy B. Bird,** former Special Assistant in the Office of the Provost for University Planning and Administration, is back at M.I.T. (after a leave of absence to complete research for a University of Virginia doctorate dissertation) to work in the Office of Field Services in the Laboratory for Architecture and Planning; he will also be responsible for field-work components of the Law-Related Studies Program.

— **Barbara V. Buchan** is Assistant to the Director for Donor Relations in the Office of Resource Planning; her assignment includes donor and prospect cultivation. A graduate of Drew University, she came to M.I.T. in 1971.

— **Barbara A. Burke,** who has worked for the *Rochester Democrat and Chronicle,* United Press International, and the *Chelsea Record,* has joined the News Office as Assistant Director; she is reporting science and engineering developments at the Institute for *Tech Talk* and outside media. A graduate of Radcliffe, she has studied French at the Sorbonne and has contributed free-lance writing to the *Boston Sunday Globe Magazine.*

— **David W. Dove,** S.M. '71, and **Thomas R. Henneberry** have joined the staff of the M.I.T. Associates Program, where they will help develop and maintain relationships between the Institute and smaller technology-based companies in New England and throughout the U.S. Mr. Dove is a part-time faculty member in business administration at Boston University, where he received a Master's degree two years ago; Mr. Henneberry, who holds the M.B.A. from Northeastern, is attending New England Law School.

— **Bonny Kellermann,** '72, has returned to the Institute to be Assistant to the Dean for Student Affairs in the Freshman Advisory Council Office, succeeding Nancy Wheatley, who will continue to administer the Undergraduate Seminar Program. Ms. Kellermann will be counseling students and developing freshman orientation. As an undergraduate, Ms. Kellermann was deeply involved in the political activism of the 1969-71 period; now she's back after completing a master's degree in social work at the University of Chicago because "people listen and act on a student's ideas and problems" here, and she wants to see "that kind of flexibility and concern" continued at the Institute.

— **Eila Kokkinen,** a native of Finland who has been on the staff of the Museum of Modern Art in New York, has joined the M.I.T. Office of Exhibitions, where her first assignment was to organize a showing of abstract expressionist drawings in Hayden Gallery late in the winter. She came to the Institute because "outside, you hear that the arts are budding at M.I.T.," she told William T. Struble of the M.I.T. News Office,

B. Kellermann

E. Kokkinen

R. J. Radocchia

and now she is convinced that M.I.T. is playing "an important role" by complementing the richness in traditional art of Boston art galleries and museums.

— **Roberta F. J. Kurland,** who worked at M.I.T. even before her graduation from Boston University in 1970, is now Assistant Director of Financial Aid. Ms. Kurland has worked in the Educational Research Center, the Department of Architecture at M.I.T. and — for one year in 1972-73 — at the Primate Research Institute of Inuyama City, Japan.

— **Yvonne Littlewood,** formerly a secretary in the Graduate School office, has been named Administrative Assistant responsible for counseling graduate students concerning financial aid resources and applications and for liaison with the sponsors of graduate fellowships.

— **John L. Mack,** '73, whose degree is in the field of urban studies and planning, is Staff Recruiter in the Office of Personnel Relations; he is responsible for identifying qualified candidates for staff and faculty positions with special emphasis on members of minority groups.

— **Suanne Muehlner,** who studied library science at Simmons, has been named Assistant Director of the M.I.T. Libraries for Personnel Services; she has previously been Lindgren Librarian at the Institute and for one year worked at the Technical University of Berlin to help establish a new branch library in earth sciences there.

— **Margaret Otto** has been promoted from Assistant to Associate Director of the M.I.T. Libraries for Library Services; she thus becomes the deputy to Natalie Nicholson, Director of Libraries. A Simmons graduate in English and library science, she first came to the Institute in 1963.

— **Robert J. Radocchia,** known to countless members of the M.I.T. community and alumni as Manager of the Walker Memorial Dining Service, left that assignment on November 1 to devote more time to activities of the M.I.T. Quarter Century Club. That Club — to which all M.I.T. employees, including faculty, staff, and other personnel, of 25 years' or more service are automatically members — now has a roll of more than 850 and an active program of tours and social events. Mr. Radocchia will continue to manage the Walker Memorial building and to be responsible for on-campus vending services. □

Both Kinds of Men on Wall Street Are Wrong About Women; Alumnae Tell How to Break the Ice

Concerned that women are grossly underrepresented in the management of American industry — an industry therefore deprived of their skills — the Sloan School of Management wants more women in its classes and a better understanding of their problems and true potential throughout the business world. Hence the organization by Leslie Clift Hruby, S.M. '73, Assistant to the Dean, of the Sloan School's annual Women's Day — a seminar for women students currently at Sloan (42 out of a total of 200 in the Master's program), faculty, alumnae, and women who have been accepted into next year's classes.

Susan Trausch of the Boston Globe's *Financial News Staff sat in on the session in April, and here is some of what she heard and wrote:*

Prejudice follows a woman up the corporate ladder and she has to deal with it realistically.

That was the word from six women managers at M.I.T.'s Alfred P. Sloan School of Management.

"A client will look at me as if to say, 'Oh, isn't this cute, a woman consultant,' " said Margaret Herrick, consultant at Arthur D. Little Inc., Cambridge. She has a master's degree in mathematics from the University of Hartford.

"I don't get upset and yell and scream," she continued. "I just very coolly and calmly blitz them. I give them technical jargon until they are snowed and they figure maybe I know what I'm talking about. It works. I haven't yet been in a situation where I haven't been able to turn negative attitudes around. Once the ice is broken, I come back down and start talking English again and we get along fine."

Katherine J. Bishop, S.M. '71, Assistant to the President at Glass Container Corp., in Fullerton, Calif., said it takes a while for the ice to break.

"There had never been an assistant to the president before," Ms. Bishop said, "and so there were some problems. I was working as a manager with men in their 50s and 60s and was the age of most of their daughters. There was a certain amount of head-patting and 'Now, dear, let me tell you about business.' I handled it by working hard. I had to earn their respect as a fellow worker. The trust and rapport began to build and now I'm one of the gang."

Judith C. Lewent, '72, Assistant Treasurer-Strategic Planning at Bankers Trust Co., New York, said it is important to know when to fight and when to quit. Prior to working in the bank she was in the brokerage business on Wall Street and found she had to get out.

"There are two types of men on Wall Street," said Ms. Lewent, "the kind who will absolutely refuse to deal with a woman manager, and there is the kind who assume she is there to go to bed with the men.

"I had a choice of staying and sacrificing my life to a fight or getting on with my career. I decided I'd rather be working than wasting a lot of time and money on law suits."

Phyllis Fishman Lantos, S.M. '74, said an interviewer deliberately provoked her with a prejudiced attitude and then hired her when she lost her temper. She is a budget planner with the New York City Bureau of the Budget.

"He said he was testing me, and that anybody working with the New York City budget had to be a fighter. He hired me on the spot," Ms. Lantos said.

Emily C. Leonard, S.M. '69, said it was a plus being a woman in a budget job. She is a budget examiner with the Office of Management and Budget in Washington, D.C.

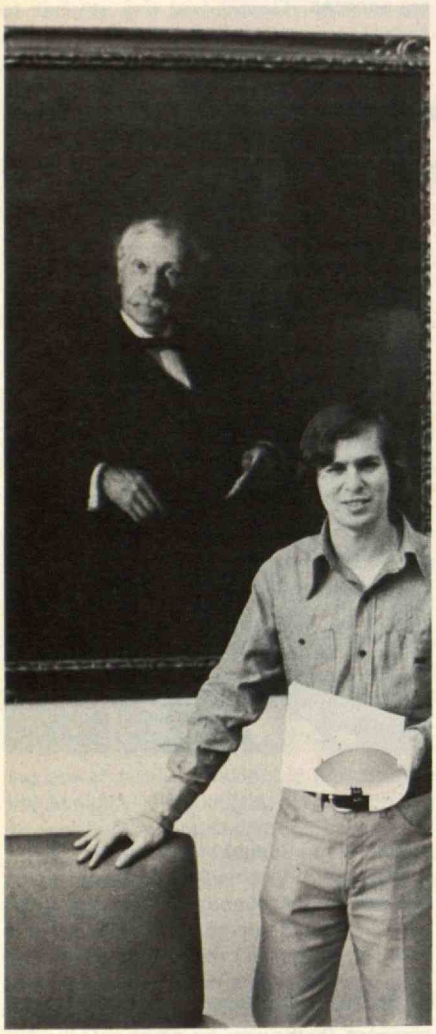
"You are at lunch with a man who wants $25 million," Ms. Leonard said. "You smile very nicely and say he can't have $25 million. He smiles and thinks you don't know what you're talking about. If you were a man there'd be a fight. But this way everything is pleasant. By the way, he never gets the $25 million."

Gudrun A. Zoeller, S.M. '73, talked about the problems of a woman being in charge of other women.

"At first I noticed secretaries would get projects done on time for the men managers while they let mine slide," said the Assistant Product Manager at Pfizer, Inc., New York.

"It was 'Yes, Mr. Smith,' and 'Hey, Gudrun.' I just sat down and talked over the problem with the secretaries. I explained my work and tried to include them in it. From then on things got better. I think it all boils down to treating people as people." □

An Extraordinary Compilation of Distinguished Men and Women: A Recent Graduate Finds the Author of "Dr. Doolittle" and Six Nobel Laureates Among "the Sons of M.I.T."



On the 100th anniversary of the founding of the M.I.T. Alumni Association, Fred Shapiro, '74, stands before the portrait of Robert H. Richards, '68, in the alumni hospitality center in the Rogers Building at M.I.T. It was Professor Richards who observed at the founding meeting of the Association that "no professor from the President down and no Institute officer from the members of the Corporation to the janitor can know as much of the operation and effects of . . . this school as the combination which is here present." He thus argued for an active role for alumni in the governance of M.I.T.

Alfred P. Sloan, Jr. . . . Daniel Chester French . . . Nathanael G. Herreshoff . . . Charles S. Minot . . . Godfrey L. Cabot . . . George Ellery Hale . . . Roger W. Babson . . . Hugh J. Lofting . . . Eric F. Hodgins . . . Joseph L. Levis . . . William O. Crosby . . . Charles T. Main. . . .

Industrialist . . . sculptor . . . naval architect . . . embryologist . . . philanthropist . . . astronomer . . . statistician . . . author . . . journalist . . . athlete . . . geologist . . . engineer . . .

Can there be a common thread in the lives of all these men?

There can indeed, writes Fred R. Shapiro, '74: All are graduates of M.I.T., and all appear in a remarkable roster of M.I.T.'s "most interesting" alumni which Mr. Shapiro assembled during four years of undergraduate study at the Institute. Now — in moments stolen from Mr. Shapiro's assignments as a first-year student at Harvard Law School — the list has been refined, Mr. Shapiro's brief biographical sketches have been polished, and the whole has been presented to the M.I.T. Historical Collections.

"Everyone Knew about John Kennedy"

Soon after Mr. Shapiro entered M.I.T. in 1970 he found himself curious about the Institute's alumni. "One of the ultimate tests of the education offered by a college is the achievements of its graduates," he later wrote. "How is it possible to call M.I.T. a great institution of learning unless we have evidence that the products of the learning process have made substantial contributions in later life? The education of leaders is not the only function of a university, but it is certainly a major one."

Mr. Shapiro found it strange that so few of his classmates — and even of the faculty — could name for him as many as ten truly distinguished M.I.T. alumni.

"Everyone knew that John Kennedy had attended Harvard and Scott Fitzgerald had gone to Princeton, but no one seemed to know who had studied at M.I.T."

Mr. Shapiro's curiosity was intensified when he learned from Professor E. Neal Hartley, Institute Archivist, that no comprehensive roster of outstanding alumni had ever been gathered. So began this extraordinary list of "prominent M.I.T. graduates."

Sampling a Few of Many

It was no easy task. Though innumerable biographical sources are available, Mr. Shapiro soon found that "engineers and businessmen, the two prime constituents of the alumni population, do not in the nature of things attain much publicity or fame, and are thus much harder to uncover than politicians, scientists or writers, who are easily accessible through lists of offices and awards." But working with "scattered and fragmentary sources" and with help from Professor Hartley, the Alumni Association, the News Office, Class Secretaries, and countless members of the faculty and staff, Mr. Shapiro came finally to a list of some 250 alumni "whom I considered sufficiently distinguished to merit inclusion."

No one will agree on criteria, and Mr. Shapiro — though he admits to using words such as "distinguished," "prominent," "noteworthy," and "interesting" — insists that his is not intended to be "*the* 250 *most* distinguished M.I.T. alumni." It is, he says, "only a sample of the many alumni who have attained extreme distinction."

The list is intentionally skewed to the older classes, because Mr. Shapiro fears that these are the men and women "more likely to be forgotten as time goes on." But he finds himself "amazed" by "how many members of the very small graduating classes of M.I.T.'s first few decades went on to achieve greatness of one kind or another. The remarkable per-capita production of leaders in technology, scholarship, and art by a 'Boston Tech' that was financially hard-pressed and too young to boast of a secure reputation in order to attract students has surely never been surpassed in the later history of M.I.T."

"Professions . . . Out of the Ordinary"

Everyone expects M.I.T. alumni to be outstanding in science and engineering. And so they are — the first name on Mr. Shapiro's list is that of Robert H. Richards, '68, a distinguished mining engineer who was also the founder of the M.I.T. Alumni Association. But the next two names on the list are William M. R. French, '68, and Edwin H. Blashfield, '69; Mr. French was the founder of the Art Institute of Chicago, and Mr. Shapiro calls Mr. Blashfield "the dean of

American mural painters." He painted the dome of the Library of Congress and murals for the World's Columbian Exposition in Chicago, among other artistic accomplishments.

In addition to 59 engineers and 46 scientists, there are on Mr. Shapiro's roster "35 businessmen, 29 government officials, 25 architects, 16 military men, 14 athletes, eight artists, eight social scientists, five astronauts, four educators, four writers, three physicians, two aviators, two lawyers, two philanthropists, two journalists, two composers, two chess players, a civil-rights leader, a city planner, a public health official, a photographer, a religious leader, a museum director, a philosopher, a labor leader, a literary scholar, a dancer, and a farmer."

Indeed, says Mr. Shapiro, he made a special effort "to include professions that, by M.I.T. standards at least, are out of the ordinary." So the list evolved into a roster not of the most distinguished but rather of the "most interesting" alumni.

But no one will ever agree on whose names should be included and whose rejected. To stimulate suggestions, Mr. Shapiro sent an early version of his list to M.I.T. department heads; one responded by challenging the presence of Joseph Levis, '26: "He was, to be sure, an Olympic fencer shortly after his graduation," wrote Mr. Shapiro's critic, "but I can't see this as a basis for including him in a list of distinguished M.I.T. graduates."

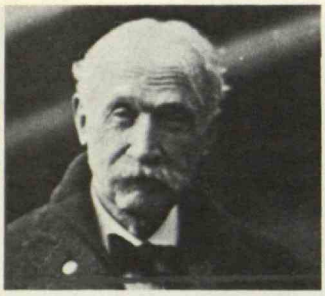
Mr. Shapiro disagrees. He proposes that "significant achievement in any field is worthy of recognition, and this attitude served as my only real criterion for selection." The result is what Mr. Shapiro finds "in many ways a fascinating chronicle."

There could be no better proof, he thinks, of the contributions of the Institute and its alumni — their "dominance" of many fields of science, engineering, and (especially) architecture. He hopes that, "at an institution which, by its nature always looks forward and rarely back, the historical awareness promoted by my work will prove a valuable catalyst for reflection on the character of the educational enterprise in which M.I.T. has been and continues to be engaged." □

Can you name these faces among M.I.T.'s distinguished alumni as selected by Fred Shapiro, '74? From above, clockwise: Gjon Mili, '27, photographer; Vannevar Bush, '16, the World War II strategist of science; James H. Doolittle, '24, pilot and aeronautical engineer; Arthur D. Little, '85, chemist and industrialist; and Paul W. Litchfield, '96, the builder of Goodyear Tire and Rubber Co. (Photos: M.I.T. Historical Collections)

Distinguished Alumni

M.I.T.'s alumni are distinguished as architects, engineers, scientists, and managers — and as statesmen, writers, artists, athletes, economists. . . . Here are some samples from a roster of names and brief biographies of more than 200 "distinguished M.I.T. alumni" assembled by Fred R. Shapiro, '74, during his undergraduate years at the Institute *(see left)*. For a copy of Mr. Shapiro's full list, write to the Editors at Room E19-430, M.I.T., Cambridge, Mass., 02139.



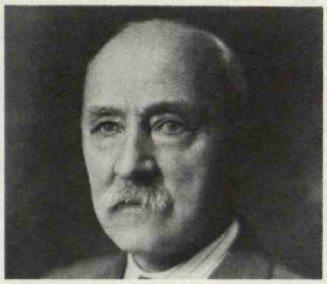
Robert H. Richards, '68
Mining engineer. Inventor of various metallurgical tools. Founder of M.I.T. Alumni Association. Author. Husband of Ellen Swallow Richards, '73.

Charles S. Minot, '72
Embryologist. Named in 1903 survey as foremost American anatomist. Inventor of biological instruments and author of valuable anatomical studies. President of American Association for the Advancement of Science. Conductor of prolonged studies of senility.

Louis H. Sullivan, '74
Architect. Founder of functional theory of architecture, modern steel-building and skyscraper architecture and building methods. Founder of Chicago School of Design. Mentor of Frank Lloyd Wright. Author. Designer of Chicago Auditorium, Chicago World's Fair Transportation Building, Chicago Stock Exchange, Schlesinger and Mayer and Gage Buildings (Chicago), Wainwright Building (St. Louis), and Guaranty Building (Buffalo).

John R. Freeman, '76
Civil and mechanical engineer. "Tamer of Yellow River" in China. Consultant on water power and supply (including Panama Canal). Government adviser on aeronautics and other areas.

Frank W. Rollins, '81
Republican Governor of New Hampshire. Originator of "Old Home Week." Lawyer. Banker. Author. Son of Senator Edward Rollins.



Godfrey Lowell Cabot, '81
World's leading manufacturer of carbon black. Named one of 50 wealthiest Americans in 1957 study. Philanthropist. Pioneer of military aviation and aeronautical inventor. Crusader against municipal corruption.

Fred S. Pearson, '83
Electrical Engineer. Designer of first large-scale electric railway ("epoch-making" step in development of dynamo), first underground trolley and power stations of unprecedented size. Businessman. Casualty of sinking of "Lusitania."

Abbott Lawrence Rotch, '83
Meteorologist. First to measure height and velocity of clouds and to use kites for meteorological data-gathering. Experimenter in wireless telegraphy.

Charles H. Woodbury, '86
Etcher and painter. Author. Portrayer of land and seascapes.

F. Gelett Burgess, '87
Humorist. Illustrator. Author of *The Purple Cow*. Coiner of the terms "bromide" and "blurb."

Harrison G. Dyar, '89
Entomologist. Authority on mosquitos and taxonomy.

William Z. Ripley, '90
Economist. Expert on railway and labor economics and economic organization of business and industry. President of American Economic Association.

Arthur Farwell, '93
Composer of works for orchestra and piano, song and pageant music. Widely influential student of American Indian, folk, and Oriental music. Organizer of choruses and public music programs. Founder of first publishers to introduce modern American composers to American audience and American Music Society. Professor. Author.

Francois E. Matthes, '95
Geologist, Topographer of most rugged regions of western U.S., including Bighorn Mountains, Glacier National Park, Grand Canyon, Yosemite Valley, and Mount Rainier. Unparalleled topographical artist. Geomorphologist. Glacialist. Author.

Alfred P. Sloan, Jr., '95
Chairman of General Motors and presiding genius through creative management of company's rise from financial crisis to international primacy. First to apply analytical methods to business policy. Named one of ten wealthiest Americans in 1957 study. Founder of Alfred P. Sloan Foundation (eighth largest in U.S.), Sloan-Kettering Institute for Cancer Research, and M.I.T. School of Management. Author of the best-selling *My Years with General Motors*.

Abram Garfield, '96
Cleveland architect and Vice-President of American Institute of Architects. Son of President Garfield.

Carleton Ellis, '00
Inventor. Research chemist. Author. Most prolific patentee in world.

Earle L. Ovington, '04
Aeronautical engineer. First U.S. Air Mail pilot. Airplane racer. Inventor. Manufacturer.

Hardy Cross, '08
Civil engineer. Originator of "Hardy Cross method" or "moment distribution method" of calculating moments in the members of a continuous framework as well as mathematical methods of pipe network analysis.

George C. Kenney, '11
Air Force general. First S.A.C. commander. Commander and "air brain" of Allied air forces in Pacific during World War II. World War I combat pilot. First to mount machine guns on airplane

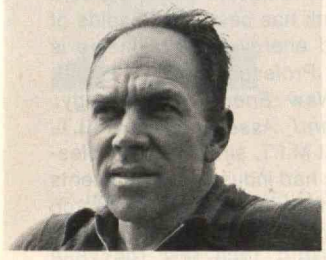
Earle L. Ovington '03, and friends, February, 1903. (Photo: M.I.T. Historical Collections)

wings and utilize parachute bombs.

David Dasso, '12
Peruvian Minister of Finance and Commerce. Promoter of Peruvian-American economic cooperation. Transportation executive and engineer.

Lewis W. Douglas, '17
Ambassador to Great Britain. Democratic Congressman from Arizona. Director of Budget during New Deal. Principal of McGill University. Vice President of American Cyanamid. Chairman of Mutual Life Insurance.

Irving W. Fineman, '17
Novelist. Screenwriter. Winner of Longmans Green Prize for first novel *This Pure Young Man*.



Walter C. Wood, '17
Founder of intercollegiate sailing.

Samuel V. Chamberlain, '18
Etcher, photographer, author, and epicure. Portrayer of New England and European landscapes and architecture.

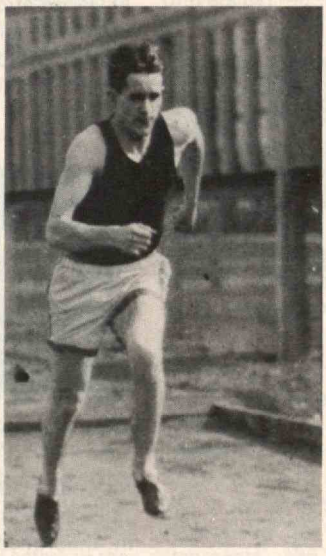
Wing L. Wei, '18
Captain of first Chinese Davis Cup team.

Crawford H. Greenwalt, '22
Chemical engineer. Chairman of Du Pont. Engineer of first commercial production of nylon. Researcher of explosives and pigments. Administrator in atomic bomb project. Author. Photographer. Son-in-law of Irenee du Pont.

John E. Burchard, '23
Architectural engineer and historian. Library and housing architect. President of American Academy of Arts and Sciences. M.I.T. Dean of Humanities and Social Sciences. Government adviser on structural defense. Author. Lecturer.

David Lasser, '24
Labor leader. President of Workers Alliance of America and American Security Union. Executive of International Electrical Workers. Industrial engineer. Government adviser. Author.

Martin J. Buerger, '25
Geologist. Internationally renowned authority on crystallography and mineralogy.



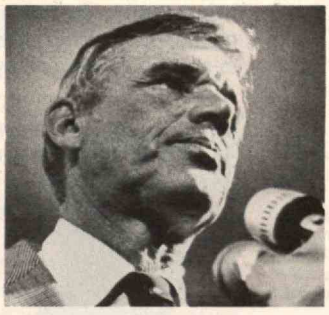
George J. Leness, '26
Track star. Chairman of Merrill, Lynch, Pierce, Fenner and Smith, nation's largest stock brokerage firm.

Chaim L. Pekeris, '29
Applied mathematician. Geophysicist. Student of seismology, underwater sound, atmospheric and electromagnetic waves, and hydrodynamics.

Manson Benedict, Ph.D. '35
Nuclear and chemical engineer. Designer of industrial plants for continuous processing of materials including first diffusion plants to separate U_{235} from natural uranium and other isotope separation processes. Pioneer in distillation processes.

Edwin R. Gilliland, Sc.D. '33
Chemical engineer. Authority on fractional distillation of petroleum, inventing process used today in all gasoline production. Expert on demineralizing salt water. Developer of processes enabling commercial production of synthetic rubber. Government adviser.

Harry M. Weese, '38
Chicago architect. Designer of U.S. Embassy in Ghana, Arena Stage Theater (Washington), Time-Life Building (Chicago), Auditorium Theater restoration (Chicago), Milwaukee Center for Performing Arts, and Washington subway.



Francis W. Sargent, '39
Liberal Republican Governor and Lieutenant Governor of Massachusetts. Supporter of "no-fault" auto insurance and antiwar activities. Conservationist.

Robert L. Sinsheimer, '41
Biologist. Collaborator in DNA synthesis and discoverer of single-stranded DNA. Student of bacterial viruses and ultraviolet radiation. Chairman of California Institute of Technology Biology Division.

Virgilio Barco-Vargas, '43
Economist. Colombian Minister of Finance, Minister of Agriculture and of Public Works. Mayor of Bogota. Executive Director of World Bank.

Keith B. McCutcheon, S.M. '44
Marine Corps general. Assistant Commandant of Marine Corps. Commander of all Marine forces in Vietnam. Director of Marine Corps aviation.

James B. Prigoff, '47
"Greatest squash tennis player of modern times." Seven-time national champion. Businessman.

Weston E. Vivian, S.M. '49
Electrical engineer. Democratic Congressman from Michigan.

Les Aspin, Ph.D. '65
Democratic Congressman from Wisconsin. Outspoken critic of defense, environmental, and energy policy. "Most newsworthy Representative." Economist. Rhodes Scholar.

Norman Weinstein, '71
One of ten leading chess players in the U.S. U.S. Open champion.

Highest Regular Faculty Rank to 23 Professors

Twenty-three associate professors in 12 departments and the Sloan School of Management have been promoted to the rank of full professor, effective July 1. They are:

— **David Adler,** Department of Electrical Engineering and Computer Science. Widely known for research in semiconductor materials and devices and in phase transitions in electronic materials, Professor Adler is a Fellow of the American Physical Society, a member of the Editorial Board of the *Journal of Nonmetals,* and a member of the Basic Research Committee of the National Research Council. During the past ten years he has taught six introductory electrical engineering subjects. His degrees are from Rensselaer Polytechnic Institute (B.S. 1956) and Harvard (A.M. 1958, Ph.D. 1964), and he has taught at M.I.T. since 1967.

D. Adler

— **Jonathan Allen,** Ph.D. '68, Department of Electrical Engineering and Computer Science. Professor Allen first came to M.I.T. for graduate work in 1958 after receiving undergraduate and M.S. degrees from Dartmouth. His student career at M.I.T. was interrupted by four years of work in the Human Factors Research Department at Bell Telephone Laboratories, and he finally joined the M.I.T. faculty in 1968. His principal research centers in the field of language processing, most recently on text-to-speech conversion by computer.

J. Allen

— **Suzanne Berger,** Department of Political Science. At. M.I.T. since 1968, Professor Berger has studied and written on modern European political history. Her degrees are from the University of Chicago (B.A. 1960) and Harvard (M.A. 1963, Ph.D. 1967), and she is a Trustee of the World Peace Foundation, a member of the Executive Committee of Harvard's Center for International Affairs (in which she taught from 1966 to 1968), and a member of the governing committee of the Center for West European Studies.

— **Aaron M. Bernstein,** Department of Physics. Professor Bernstein's work is in experimental high-energy physics, in association with the Laboratory for Nuclear Science; his degrees are from Union College (B.S. 1953) and the University of Pennsylvania (Ph.D. 1958). Dr. Bernstein joined the M.I.T. faculty in 1961 after four years as Research Associate in Physics at Princeton, and in 1966 he held a Guggenheim Fellowship at the Center for Nuclear Study in Saclay, France.

— **Jack B. Howard,** Department of Chemical Engineering. Professor Howard's recent professional work has been in the fields of combustion and energy conversion; he is co-author, with Professor Hoyt C. Hottel, S.M. '24, of *New Energy Technology: Some Facts and Assessments* (M.I.T. Press, 1971). At M.I.T. since 1965, Professor Howard has had industrial assignments at United Aircraft Corp. and Esso Research and Engineering; he studied at the University of Kentucky (B.S. 1960, M.S. 1961) and Pennsylvania State University (Ph.D. 1965).

K. H. Johnson

— **Keith H. Johnson,** Department of Materials Science and Engineering. A specialist in theoretical chemical and solid-state physics, Professor Johnson studied at Princeton (A.B.) and Temple Universities (Ph.D. 1965) and did postdoctoral research

at the University of Florida from 1965 to 1967, when he joined the M.I.T. faculty; he had previously (1964-1965) been Assistant Professor of Physics at Drexel Institute of Technology.

M. Lipsky

— **Michael Lipsky,** Department of Political Science. Professor Lipsky came to M.I.T. in 1971 from a staff position at the Institute for Research on Poverty at the University of Wisconsin, where he was Assistant Professor of Political Science from 1966 to 1969. His field of specialty is urban affairs, and he has been a member of the Executive Committee of the Joint Center for Urban Studies of Harvard and M.I.T. since joining the Institute faculty. His academic work was at Oberlin College (B.A. 1961), the Woodrow Wilson School of Public and International Affairs at Princeton (M.P.A. 1964), and the Department of Politics at Princeton (M.A. 1964, Ph.D. 1967).

J. D. Litster

— **James D. Litster,** Ph.D. '65, Department of Physics. Associated with the Center for Materials Science and Engineering, Professor Litster teaches courses in the theory of solids and is a consultant to the liquid crystal group at the I.B.M. Thomas J. Watson Research Center, where he worked before coming to the Institute in 1966. His undergraduate degree is from McMaster University (B.Eng., 1966), and he has recently been Visiting Professor at the University of Paris.

— **Robert D. Logcher,** '58, Department of Civil Engineering. Professor Logcher, a native of the Netherlands, has been at M.I.T. ever since entering as an undergraduate; his graduate degrees are in civil engineering (S.M. 1960, Sc.D. 1962). Professor Logcher's recent research and teaching have been in management information systems applied to construction, including decision methods; earlier he was active in the development of computer systems for engineering design.

A. R. Meyer

— **Albert R. Meyer,** Department of Electrical Engineering and Computer Science. Professor Meyer's research includes automata, computational complexity, functions, and logic; he is Visiting Scientist at the I.B.M. Research Laboratories in Yorktown Heights, N.Y. Professor Meyer joined the faculty in 1969 from a teaching post at Carnegie-Mellon University; his degrees are from Harvard (B.A. 1963, Ph.D. 1972).

D. Q. Mills

— **D. Quinn Mills,** Sloan School of Management. A specialist in labor relations, Professor Mills was Special Assistant to the Director of the Cost of Living Council and Chairman of the Construction Industry Stabilization Committee in the early years of the Nixon Administration; he has also been a consultant to the U.S. Department of Labor and a member of the Building Research Advisory Board of the National Academy of Sciences. Professor Mills taught at Harvard for a year after receiving his Ph.D. degree there (1968); his undergraduate degree is from Ohio Wesleyan University (1963).

M. J. Piore

— **Michael J. Piore,** Department of Economics. Noted for his research on labor, Professor Piore is a consultant on labor, manpower, and income maintenance for the Commonwealth of Puerto Rico, which he has in the past served as Research Coordinator; he has also held consulting assignments with the U.S. Department of Labor and the Boston Model Cities Administration, and he is now in Paris conducting research on labor markets in France. Professor Piore joined the M.I.T. faculty after finishing his degrees at Harvard (B.A. 1962, Ph.D. 1966).

— **Steven A. Orszag,** '62, Department of Mathematics. Professor Orszag teaches graduate-level courses in applied mathematics, and he is a chief collaborator in a series of texts in that field for graduate students; his research is on computational methods and the analysis of fluid dynamics. After completing his undergraduate degree

at M.I.T., Dr. Orszag was a Henry Fellow at Cambridge University; he then completed graduate studies at Princeton (Ph.D. 1966), spent a year at the Institute for Advanced Study, and joined the M.I.T. faculty in 1967.

— **Uttam Lal RajBhandary,** Department of Biology. Born in Nepal, Professor RajBhandary studied at the University of Putna (India) (B.Sc. 1952), the University of Calcutta (M.Sc. 1955), and the University of Durham (England) (Ph.D. 1962); he then came to the Institute for Enzyme Research at the University of Wisconsin. Professor RajBhandary came to M.I.T. from a faculty post at the University of Wisconsin in 1969.

J. M. Roesset

— **Jose M. Roesset,** Sc.D. '64, Department of Civil Engineering. A native of Spain, Professor Roesset is recognized for research in structural mechanics and earthquake engineering. He joined the M.I.T. faculty upon completing his doctorate, and in 1969 he held visiting professorships at the University of Chile and the Catholic University of Santiago, Chile.

F. C. Schweppe

— **Fred C. Schweppe,** Electrical Engineering and Computer Science. Professor Schweppe's first association with the Institute was as a member of Lincoln Laboratory from 1959 to 1968; he then joined the faculty and is now active in research on the analysis and planning of electric power systems. Professor Schweppe studied at the Universities of Arizona (B.S. 1955, M.S. 1957) and Wisconsin (Ph.D. 1959).

— **Michael S. Scott-Morton,** Sloan School of Management. A specialist in the new field of computer-based decision systems for managers, Professor Scott-Morton has been on leave this year to his native Scotland for work on two books on computer-based information systems. He studied at the Carnegie Institute of Technology (B.S. 1961) and Harvard Business School (D.B.A. 1967), and he has been associated with Rolls-Royce, Ltd., and Director of Data Processing for the City of Pittsburgh.

M. S. Scott-Morton *J. F. Shapiro*

— **Jeremy F. Shapiro,** Sloan School of Management. Professor Shapiro is Associate Director of the M.I.T. Operations Research Center and Senior Research Associate at the National Bureau of Economic Research; his special field is computer-based analyses of industrial and social systems. Professor Shapiro holds degrees in mechanical engineering (B.E. 1962) and industrial engineering (M.S. 1963) from Cornell and the Ph.D. (1967) from Stanford.

N. P. Suh

— **Nam P. Suh,** '59, Department of Mechanical Engineering. The author of an important new theory of the wear of materials, Professor Suh is widely known for contributions to materials engineering and manufacturing technology. After receiving his Ph.D. from Carnegie Institute of Technology in 1964, he taught for five years at the University of South Carolina before returning to join the M.I.T. faculty in 1970.

N. E. Todreas *D. R. Uhlmann*

C. I. Wunsch *R. K. Yamamoto*

— **Neil E. Todreas,** Sc.D. '66, Department of Nuclear Engineering. After a 12-year career in nuclear reactor engineering for the U.S. Navy and Atomic Energy Commission, Professor Todreas returned to M.I.T. as a member of the faculty in 1970. His undergraduate work was in the field of mechanical engineering at Cornell University (B.S., M.S. 1958).

— **Donald R. Uhlmann,** Department of Materials Science and Engineering. A specialist in ceramics, Professor Uhlman is the co-author of a forthcoming book on fundamentals of crystal growth. He has been at the Institute since 1965, having studied at Yale (B.S. 1959) and Harvard (Ph.D. 1963) and having held a postdoctoral fellowship at Harvard.

— **Carl I. Wunsch,** '62, Department of Earth and Planetary Sciences. Professor Wunsch brings a broad background to his current teaching and research in physical oceanography; his undergraduate degree is in mathematics, and his Ph.D. (1966 — also from M.I.T.) is in geophysics. He has been associated with the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge, and he has been a member of the M.I.T. faculty since 1967.

— **Richard K. Yamamoto,** '57, Department of Physics. Professor Yamamoto joined the research staff at M.I.T. in 1963 upon completing his doctorate here, and he became Assistant Professor of Physics in 1965. His teaching and research are in the field of high-energy accelerator design and use, and he has been a Guest Professor at the University of Nijmegen in the Netherlands. □

Warren K. Lewis, 1882-1975: Legendary Teacher, Father of Modern Chemical Engineering

Warren K. Lewis, '05, Professor of Chemical Engineering, Emeritus, who was founding Head of the Department of Chemical Engineering from 1920 to 1929, died on March 9 in Plymouth, Mass. He was 92.

Dr. Lewis was at once a great teacher and a great engineer, the one talent reinforcing the other in the classroom and in the field. President Jerome B. Wiesner said "he had a profound influence on all who knew him during his remarkable and extraordinarily long career at M.I.T.," and Howard W. Johnson, Chairman of the Corporation, described him as "one of the world's great chemical engineers, . . . literally a living legend to generations of M.I.T. students.

"He dominated a class and drove his students hard, but they loved him for it, and for his warm heart. And what is more," said Mr. Johnson, "they learned their chemical engineering and went on to make remarkable contributions to this field and to the industries in it."

The "Inventor" of Chemical Engineering

Dr. Lewis finished high school in Laurel, Del., in 1897 and in Newton, Mass., four years later. Chemical engineering was already a course — within the Department of Chemistry — when Warren Lewis chose to major in it, and he stayed on at M.I.T. after receiving his Bachelor's degree to work with Professor William H. Walker in the latter's new Research Laboratory of Applied Chemistry. Then came three years in Europe — for a doctorate in chemistry at the University of Breslau, Germany — and a year in the tanning industry before Dr. Lewis joined the M.I.T. faculty in 1910 to begin the remarkable contributions in association with Professors Walker and William H. McAdams, '17, to a score of chemical engineering processes and in the education of countless students.

In his autobiography, *Trolley to the Moon,* Eric F. Hodgins, '22 (he was a chemical engineering student, but legend has it that Professor Lewis recommended Mr. Hodgins for a degree on the condition that he never practice chemical engineering) writes that Professors Walker and Lewis, "aided by the distinguished chemist-alumnus Arthur Dehon Little, '85, invented chemical engineering and brought forth, out of such empirical and messy 19th-century arts as leather tanning, glue boiling, and papermaking, an engineering discipline susceptible to mathematical and other scientific manipulation." The work, wrote Mr. Hodgins (he fulfilled Professor Lewis' requirement by becoming an editor of *Technology Review* and later of *Fortune*) "brought order out of chaos to the chemical industry" and "made the engineering of chemistry a logical entity."

Perhaps Professor Lewis' most important technical achievement came shortly before World War II, when he and one of his students — the late Edwin R. Gilliland, Sc.D. '33, developed the "fluid bed" method for catalytic cracking of petroleum; there were also important contributions in the field of rubber chemistry and in the management of chemical and metallurgical research during World War II.

Awe and Affection

But M.I.T. students will remember Professor Lewis more as "the teacher of teachers" — Mr. Hodgins' description. He struck terror into undergraduates' hearts, but at the same time he compelled their respect, admiration, and even affection. The stories about his colorful classroom manner, his long index finger, his determination that students understand not only the content but the role of engineering in society, are legion. " 'Doc' Lewis" was a term of admiration, awe, and endearment throughout the Institute.

Professor Lewis was Chairman of the Committee on Educational Survey in the immediate post-war period, charged by the M.I.T. faculty with a long-range study of educational policies and curricula; the effects were "far-reaching," says President Wiesner, and the recommendations "guided the evolution of the Institute" for at least two decades.

Warren K. Lewis, '05, Professor of Chemical Engineering, Emeritus, who died on March 9, was a many-sided teacher. Former students remember his passionate demands – "For Christ's sake, young man, cerebrate!" – and also his friendship and concern – as here, with students in the School of Chemical Engineering Practice at The Bayway Refinery of Exxon. (Photo: Esso Standard Oil Co. from M.I.T. Historical Collections)

Most major awards in the fields of chemistry, chemical engineering, and engineering education came to Professor Lewis during his 38 years on the M.I.T. faculty; he retired in 1948. Among them are the John Fitz Medal and the Founders Award of the American Institute of Chemical Engineers, the Perkin Medal of the Society of Chemical Industry, the Lamme Medal of the American Society for Engineering Education, the Gold Medal of the American Institute of Chemists, the Gold Medal of the American Petroleum Institute, the Priestly Medal and the Industrial and Engineering Chemistry Award of the American Chemical Society, and the National Science Medal. There were honorary doctorates from Princeton, Harvard, Bowdoin, and the University of Delaware.

Contributions in Dr. Lewis' memory may be made to Project Hope, New York, N.Y., 10020. □

Ralph A. Sayers, 1906-1975

Ralph A. Sayers, who was Assistant Director of the Research Laboratory of Electronics when he retired in July, 1972, died suddenly on April 1 in Ormond Beach, Fla., where he made his home since retirement.

Mr. Sayers came to M.I.T. in 1943 to work in the Radiation Laboratory. He joined the administrative staff of the Research Laboratory of Electronics when it was organized out of the Radiation Laboratory at the end of World War II, and he was a key figure in its management for over 25 years; his brusque, casual manner masked a sensitive, effective administrator who endeared himself to faculty and students alike. □

Individuals Noteworthy

Kudos: Honors, Awards, Citations

Eight members of the M.I.T. faculty have been awarded Sloan Research Fellowships: **Tanya M. Atwater,** Assistant Professor of Earth and Planetary Science; **Robert W. Field,** Assistant Professor of Chemistry; **Sidney M. Hecht,** Assistant Professor of Chemistry; **Robert L. Jaffe,** Assistant Professor of Physics; **Loy D. Lytle,** Assistant Professor of Nutrition; **Peter Molnar,** Assistant Professor of Earth and Planetary Science; **David G. Schaeffer,** Associate Professor of Mathematics; **Christopher Walsh,** Assistant Professor of Chemistry. . . . Three other young M.I.T. faculty members received National Science Foundation awards: **Robert C. Armstrong,** DuPont Assistant Professor of Engineering; **Nils R. Sandell,** S.M. '71, Assistant Professor of Systems Science and Engineering; **Ronald W. Yeung,** Research Associate of Ocean Engineering.

To **John Moore,** Sc.D. '69, the Gas Turbine Power Award of The American Society of Mechanical Engineers . . . to **Kenneth Friedman,** '63, a $9,000 research award from the American Council of Learned Societies . . . to Major **William F. Anderson,** '61, the Meritorious Service Medal of the United States Air Force . . . to **Myron Kayton,** Ph.D. '60, the Gano Dunn Medal of Cooper Union's Alumni Association . . . to **Herbert R. Stewart,** '24, the Distinguished New England Engineer Award of the Engineering Societies of New England . . . to **Edward P. Kingsbury,** '53, and **Herbert Singer,** '55, N.A.S.A. Achievement Awards . . . to **C. Jack Corgan,** '69, the Young Architect of the Year award for 1974 of the American Institute of Architects . . . to Lt. Col. **Lynn L. LeBlanc,** S.M. '62, the Legion of Merit, one of the nation's highest decorations.

John F. Elliot, Sc.D. '49, Professor of Metallurgy at M.I.T., was named honorary member of the Society of Mining and Metallurgical Engineers of Venezuela . . . **Arden L. Bement, Jr.,** Professor of Nuclear Materials in the Department of Metallurgy and Materials Science at M.I.T., was named honorary member of the American Society for Testing and Materials Committee on Nuclear Applications and Measurement of Radiation Effects . . . to **Dean F. Peterson,** staff member of the satellite communications group at Lincoln Laboratory, the 1974 Microwave Application Award by the Microwave Theory and Techniques Group of the I.E.E.E. . . . to **Barry Vercoe,** Associate Professor of Music at M.I.T. and Director of the M.I.T. Studio for Experimental Music, an award from the Massachusetts Arts and Humanities Foundation . . . to **Daniel G. Quillen,** Professor of Mathematics at M.I.T., the Cole Prize of the American Mathematical Society for his work in algebraic K-theory . . . to **Bernard J. Frieden,** M.I.T. Professor of City Planning and Director of the Harvard-M.I.T. Joint Center for Urban Studies, and to **Isadore M. Singer,** Norbert Wiener Professor of Mathematics, 1975 Guggenheim Fellowship awards . . . **Susan E. Schur,** '60, Vice President of the M.I.T. Alumni Association, was chosen one of the ten outstanding young leaders of 1975 by the Boston Junior Chamber of Commerce. . . . to **Jadish Bhagwati,** Ph.D. '67, Professor of Economics at M.I.T., and **Sukhamoy Chakravarty,** former Assistant Professor of Economics at M.I.T., the Mahalonobis Memorial medals of the Indian Econometric Society.

The *Review* extends its apologies to **José M. Roesset,** Sc.D. '64, for omitting his name as one of the recipients of the 1974 Moisseiff Award of the American Society of Civil Engineers. Professor Roesset was the lead author of the paper, "Some Structural Problems: Standard Oil of Indiana Building," for which the award was given.

Counselors: Officers, Directors, and Advisors

Paul W. MacAvoy, Henry R. Luce Professor of Environment and Public Policy at M.I.T.'s Sloan School of Management, has been named to the National Petroleum Council . . . **Janet Guernsey,** Ph.D. '55, President of the American Association of Physics Teachers . . . **Edward A. Flinn III,** '53, Director of Lunar Programs in the Office of Space Science at N.A.S.A. headquarters, Washington, D.C. . . . **Arthur W. Busch,** S.M. '52, Vice President of Environmental Affairs of Southwest Research Institute . . . **Amos E. Joel, Jr.,** S.M. '40, re-elected President of the Institute of Electrical and Electronics Engineers . . . **Howard W. Johnson,** President of the M.I.T. Corporation, and **Paul A. Samuelson,** Institute Professor of Economics at M.I.T., Program Advisory Committee of The Bicentennial Forums sponsored by New England Mutual Life Insurance Co. . . . **Richard White,** '72, Administrative Assistant in Massachusetts Governor Michael Dukakis' press office . . . **Frederick P. Salvucci,** '61, Secretary of Transportation and Construction for Massachusetts . . . **Judith T. Kildow,** Assistant Professor of Ocean Policy in the M.I.T. Department of Ocean Engineering, to the advisory board of the College of Marine Studies at the University of Delaware . . . **David R. Clare,** '45, Vice Chairman of the Executive Committee of the Board of Directors of Johnson and Johnson . . . **W. H. Krome George,** '40, Chief Executive Officer of the Aluminum Company of America . . . **William G. Kay, Jr.,** S.M. '63, President of Standard Brands Foods . . . **Ben C. Ball, Jr.,** '48, Vice President and Officer of Gulf Oil Corp. . . . **William E. Dirkes,** S.M. '61, Director of the Physical Sciences Group at Systems Research Laboratories, Inc. . . . **Goff Smith,** S.M. '53, Director of the Ceco Corp. . . . **Mildred S. Dresselhaus,** Abby Rockefeller Mauze Professor of Electrical Engineering at M.I.T., Chairman of the nominating committee of the American Physical Society . . . Professor Dresselhaus and **Vera Kistiakowsky,** Professor of Physics at M.I.T., have been named members of the new committee on the Education and Employment of Women in Science and Engineering within the Commission on Human Resources of the National Research Council . . . **Bernard Frieden,** M.I.T. Professor of Urban Planning and Director of the M.I.T.-Harvard Joint Center for Urban Studies, member of committee to advise Harvard President, Derek Bok, on the environmental impact study for the John F. Kennedy Library . . . **Robert C. Seamans, Jr.,** Sc.D. '51, has resigned as President of the National Academy of Engineering to become the first administrator of the Energy Research and Development Administration . . . **James R. Killian,** '26, Honorary Chairman of the M.I.T. Corporation and former M.I.T. President, resigned as Chairman of the Corporation for Public Broadcasting.

Items of Interest

Judith Wechsler, Associate Professor of Art History, edited the book, *Cezanne in Perspective* . . . **Robert A. Alberty,** Dean of the School of Science, is a co-author of a revised edition of the standard college text, *Physical Chemistry* . . . **Lawrence R. Rabiner,** '64, co-authored *Theory and Application of Digital Signal Processing.*

The well-known photograph by **Harold E. Edgerton,** Sc.D. '31, Institute Professor Emeritus of Electrical Engineering at M.I.T., which shows a bullet emerging from an apple through which it has been fired is one of 400 prints in the exhibition, Photography U.S.A., which will be circulated in Eastern European countries by the U.S. Information Agency . . . **Bernard Kupferschmid,** S.M. '56, exhibited his work, "Photographs of North America, Europe and Latin America" at the Newton Free Library in Newton, Mass.

Appointments: Rising in the World of Business

Elliot Newman, S.M. '65, Vice President and Director of the Office of Eastern Operations, Environmental Research and Technology Co. . . . **Ben C. Van Assche,** M.S. '74, Assistant to the President, International Division, of Travenol Laboratories, principal operating subsidiary of Baxter Laboratories . . . **James M. Baldwin,** M.Arch. '74, Housing Research Specialist in the Architectural Programming Group of Samborn, Steketee, Otis and Evans, Inc., Toledo, specializing in the design and evaluation of large, low-cost urban dwelling environments . . . **Alan T. Hundert,** S.M. '62, Organization Development Manager in the Manpower Development Division, Corning Glass Works . . . **Thomas C. Duke, Jr.,** '49, Manager of Management Information Systems at Adam Opel AG, General Motor's German manufacturing subsidiary . . . **John H. Davis,** S.M. '63, Department Head in the Toll Crossbar Switching Laboratory, Columbus, Ohio . . . **Gordon B. Pye,** '55, Senior Economist and Vice President of the Economic Research and Planning Division, Irving Trust Co., New York City . . . **Sven A. Vaule, Jr.,** '56, Executive Vice President of Jones and Vining, Inc., manufacturers of lasts and unit soles for the domestic shoe industry . . . **William M. Hannan,** '52, Assistant Vice President of the American Bureau of Shipping.

Harold W. Miller, '57, Vice President and Director–Operations for the Defense Communications Division of International Telephone and Telegraph Corp. . . . **Whitney Newton II,** '42, Vice President–Research for Holly Sugar Corp. . . . **Stephen Williams,** '65, Assistant Vice President in the Finance and Planning Division of the American Stock Exchange . . . **Harold E. Stahl,** S.M. '61, Production Manager at Fisher Body, Coldwater Plant . . . **George H. Reichenbacher,** S.M. '67, Engineering Manager of the Modular Instruments Department of Analogy Devices, Inc. . . . **Joseph J. Paterno,** S.M. '65, Assistant Director–Organic Products Research and Development for Norton Company's Grinding Wheel Division . . . **Alan S. Cleland,** S.M. '66, Vice President–Finance of the Lehigh Portland Cement Co. . . . **Irwin I. Boris,** S.M. '66, Assistant Vice President, Marketing Planning and Forecasting of the Fingerhut Corp. . . . **Oliver R. Smoot,** '62, Vice President of the Computer and Business Equipment Manufacturers Association . . . **Gary E. Frashier,** S.M. '70, Vice President and General Manager of Latin America, Loctite Corp. . . . **John Kasarda,** '68, Vice President of Engineering Computer Systems, Inc., Lexington; and Manager of the firm's newly opened New York City office . . . **Richard Conway,** S.M. '57, Development Associate in the Research and Development Department of Union Carbide, South Charleston, W. Va. . . . **Chester W. Diercks, Jr.,** S.M. '62, Executive Vice President of Allis-Chalmers Corp., responsible for the Electrical Products, Power Transmission, and Power Generation Groups . . . **Stephen T. McFadden,** S.M. '65, Treasurer of Exxon's Operations in Colombia, South America . . . **Claude W. Brenner,** '47, Vice President and General Manager of Laser Graphic Systems Corp., Sudbury, Mass. . . . **Albert M. Bottoms,** S.M. '62, Head of the Warfare Analysis Department of the Naval Underwater Systems Center, named Naval Science Advisor to the Commander, 7th Fleet.

Deceased

Edward B. Belcher, '01; March 9, 1975; 100 Bonnybrier Rd., Portland, Maine

Louis H. Asbury, '04; March 19, 1975; 3700 Shamrock Dr., Charlotte, N.C.

Samuel Seaver, '05; January 8, 1974; Box 91, Markham, Ontario, Canada

Richard D. Gatewood, '06; February 28, 1975; Apt. 2B, 434 East 58th St., New York, N.Y.

Emory Leon Chaffee, '07; March, 1975; 130 Goden St., Belmont, Mass.

Hugh B. Conover, '07; November 18, 1973; 525 Granada Ave., Box 383, Venice, Fla.

E. Sykes Goodwin, '07; November 24, 1972; 77 Hamilton Blvd., Buffalo, N.Y.

William G. Perry, '07; April 4, 1975; 67 Central St., Andover, Mass.

Paul Remick, '09; March 17, 1972; R.F.D. 2, Wells, Maine*

Channing Turner, '09; March 24, 1975; Old Stables, Bidborough, Tunbridge, Wells, England*

Murray H. Mellish, '10; February 1, 1975; c/o M. Vaile, 1423 San Lorenzo Rd., Palm Springs, Calif.

Charles A. Robb, '10; April, 1973; 1855 Beattie Ave., Ottawa, Canada

Otis S. Smith, '10; November 27, 1972; 249 Gilford Ave., Laconia, N.H.

Talbot Flanders, '16; May 31, 1973; R.F.D. 3, Plymouth, Mass.

Spencer D. Hopkins, '16; October 20, 1974; 1355 Orchard Ridge Rd., Bloomfield Hills, Mich.*

Benjamin M. Bond, '17; June 7, 1974; 16219 Lamplighter #1029, Southfield, Mich.*

Foster C. Harlow, '17; July 16, 1972; 64 Park St., Milton, Mass.*

Carl E. Adams, '18; November 18, 1974; 48 Inman St., Hopedale, Mass.*

Lloyd B. Van DaLinda, '18; January 3, 1975; Residence Bellevue, Lausanne Ouchy, Switzerland*

Charles L. Phillips, '21; January, 1970; Rancho Del Sacorro, P.O. Box 7727, Tucson, Ariz.*

James Duane, '22; March 13, 1975; 2 Dellwood Cir., Bronxville, N.Y.*

Harold L. English, '22; December 9, 1974; 73 Garfield Rd., Melrose, Mass.*

José C. Espinosa, '22; December 25, 1974; 1 Guevarra Ave., San Juan Rizal, Philippines*

Frank A. Fletcher, '22; August 25, 1973; 533 Strathmore Rd., Havertown, Penn.*

Kenneth B. Lacy, '22; January 21, 1975; Box 216, Highland Park, Ill.*

Elizabeth C. Nickerson, '23; March 26, 1975; Wellesley Manor Nursing Home, Wellesley, Mass.

Everett W. Vilett, '22; March 11, 1975; 70 Stewart Rd., Short Hills, N.J.

Cornelius Sippel, Jr., '23; December 7, 1974; 2316 Orrington Ave., Evanston, Ill.

Harold A. Bauld, '25; January 25, 1974; 12 Pleasant St., Fayville, Mass.

Bernard K. Freudenthal, '25; March 19, 1975; 7121 Park Heights Ave., Baltimore, Md.

Philip J. Lamoureux, '25; May 30, 1970; 239 N. Pine Creek Rd., Fairfield, Conn.

Nelson C. Mallery, '25; March 9, 1973; 4715 55th St., San Diego, Calif.

Donald C. Grinnell, '26; January 12, 1974; 40 Oakland Ave., Arlington, Mass.

George V. Steele, '26; February 24, 1975; 53 School St., Dedham, Mass.

Edward E. Talbot, '26; June 30, 1974; 442 Grove St., Westfield, N.J.

John O. Collins, '27; March, 1975; 805 Shadowlawn Dr., Westfield, N.J.*

Bernard Y. McCarty, '27; November 11, 1974; 423 N. Old Ranch Rd., Arcadia, Calif.*

James B. Snediker, '27; February, 1975; 7161 Northledge Dr., Lockport, N.Y.*

Charles E. Lyons, '28; March 13, 1975; 476 12th Ave., Naples, Fla.*

Sister Laurentine Marie, '29; February, 1974; Covent of Notre Dame, Worcester, Mass.

Levon Seron, '29; March 15, 1975; 510 Jersey St., Joliet, Ill.

Raymond H. Shriver, '29; June, 1972; P.O. Box 33, Bellwood, Penn.

Ina M. Granara, '30; February 18, 1975; 101 Monmouth St., Apt. 408, Brookline, Mass.

Hermon H. Scott, '30; April 13, 1975; Grasshopper Ln., Lincoln, Mass.*

Chester W. Turner, '30; March 22, 1975; 6 Pilgrim Rd., Reading, Mass.

Peter L. Loewe, '31; December 29, 1974; 1745 Northland Ave., Highland Park, Ill.

Charles H. Marvin, '32; January 14, 1975; 24 Torsey St., Stratford, Conn.*

Robert C. Scott, '32; February, 1975; 340 Common St., Belmont, Mass.

Donald R. Waugh, '32; March 13, 1974; Lake Hills Village, Apt. #4, Bldg. #1, Wolcott, Conn.

L. Hart Cirker, '33; January 14, 1974; 400 E. 15th Ave., Apt. 3B, Columbus, Ohio*

Robert K. Kepner, '34; January 10, 1975; 50 W. Shore Rd., Danville, N.J.*

Maynard A. Sayles, '34; February 25, 1975; 419 Hillvale Turn East, Knoxville, Tenn.*

Joseph Castronovo, '36; June 11, 1973; 41 Clarke Rd., Barrington, R.I.

Jackson H. Cook, '36; September 26, 1974; P.O. Box 685, Patten Ln., Chatham, Mass.*

William W. Garth, Jr., '36; April 11, 1975; 256 Simon Willard Rd., Concord, Mass.*

Frederick W. Locke, Jr., '36; February 15, 1973; 4824 29th St. N., Arlington, Va.*

Millard M. Brenner, '39; January 6, 1975; 6032 Sheaff Ln., Ft. Washington, Penn.

Charles R. Houssiere, Jr., '39; October 26, 1974; P.O. Box 1089, Jennings, La.

Howard P. McJunkin, '43; March 8, 1975; 920 Newton Rd., Charleston, W. Va.

Charles F. Street, '45; March 20, 1975; 125 Governors Dr., Warwick, R.I.*

David J. Tobin, '46; May 8, 1974; 15 E. 7th St., Hinsdale, Ill.*

Willard F. Gray, '47; July 7, 1973; 21 Windoor Dr., Tuscaloosa, Ala.

Daniel J. Crowley, Jr., '49; February 2, 1973; 64 Edgewater Dr., Needham, Mass.

Samuel R. Heller, '50; January 21, 1975; 7002 Vagabond Rd., Falls Church, Va.

Charles J. Henry, '51; September 30, 1974; St. Augustine Seminary, Bay St. Louis, Miss.

Warren W. Heimbach, '58; February 17, 1975; 3266 Robinson Bay Rd., Deephaven, Minn.

Melvin N. Oliven, '64; March, 1975; 441 Lexington Ave., Iowa City, Iowa*

* Further information in *Class Review*

Class Review

96

The generosity of the late **Myron Fuller** made possible the establishment of the Brockton Art Center. This unique institution has been highly praised by art critics in Brockton and Boston and also by many of the children from surrounding towns. In the past year both the number of young people enrolled in classes and the number of Brockton school children visiting the Art Center has doubled. One scholarship student is quoted as saying that the only good thing in his life is the workshop at the Fuller Memorial Art Center! — **Clare Driscoll,** Acting Secretary, St. Joseph H.S., Box 517 Frederiksted, St. Croix, U.S.V.I. 00840

01

Edward B. Belcher, 96, died on March 9, 1975 in South Portland, Maine. Mr. Belcher designed some of the first automobiles made in New England. A charter member of the National Association of Watch and Clock Collectors, he was well known as a specialist in grandfather clocks. He is survived by his wife, Elizabeth Philpot Belcher, two daughters, a son, a step-daughter, four grandchildren, two great-grandchildren and several nieces and nephews. — M.L.

03

Well our rugged classmates still hold on, with **Clarence M. Joyce,** V, (born on April 1, 1881) at the Cresent, in Montclaire, N.J., looking for a tennis partner.

Again, your active Class Secretary **John J. A. Nolan** with surprising ability to board planes for Louisville, Ky., enjoyed Easter and his 94th birthday at son John's estate, amidst the tall trees and spacious grass land.

Our ever cheerful **"Stan" Foster,** X, 254 Foster St., Lowell, still awaits atomic energy for overcoming his grass cutting and would enjoy a word from our happy group. — **John J. A. Nolan,** Secretary, Treasurer, 13 Linden Ave., Somerville, Mass. 02143

04

Louis H. Asbury, 97, died on March 19, 1975. He was a retired architect and owner of Louis H. Asbury and Son. Mr. Asbury opened his architect's office in Charlotte, N.C., in 1908 and was the first member in North Carolina of the American Institute of Architects. He served on the City Council on the Perimeter Board of Adjustments. Surviving are one daughter, Miss Malvine Asbury of Charlotte; one son, Louis H. Asbury, Jr. of Charlotte, four grandchildren and four great-grandchildren. — M.L.

05

We now number 17 classmates in this 70th year after graduation! Fred had been a faithful Secretary all these years keeping our class together with news of each other. My thanks to Marjorie Lyon of the editorial staff at *Technology Review* who has offered her assistance which, with my wife Peggy's help, will hopefully enable us to carry on "Goldie's" tradition. Your notes and letters will be most essential, so keep them coming.

Responses to the Memorial Fund for Fred have been good. A report will be made later.

Some letters dealing with health, hobbies, family, etc. were received by Fred and Ruth and the following excerpts are from these letters: **Herman Eisele** says, "I have been indisposed with a stomach problem including a spell in the hospital. Now I think that I am surviving." . . . **Charles Mayer** writes that he has seven great-grandchildren, six boys and one girl whose name is Ruth. He says, "Guess old age is creeping up on me because, for the first time in my life, I've been a patient in the hospital. Now I know physically and financially what that is like! I've recovered, still drive and play contract bridge with the Seniors." . . . **Herb Bailey** comments on the lack of rain this year in southern California and says "our mountains, only 8 or 10 miles from my home, seem well covered with snow. My stamp collection is my enjoyable hobby and has been profitable. Perhaps my best deal is the three Graf Zepplins that I bought some 30 years ago for $32 but couldn't duplicate today for less than $600."

Roy Allen and **Bill Spaulding** have been in close touch with the Goldthwaits during Fred's illness and after his death.

It is sad to have to report that we have lost three classmates. **Arthur J. Manson** died in Houston, Texas, on November 17, 1974; and **George W. Whiting** on January 16, 1975 in Baltimore, Md. I have no further details. **Warren K. Lewis** died in Duxbury, Mass., on March 9. We all remember "Doc" and all that he did for our class. Prof. Lewis was the first head of Chemical Engineering at M.I.T. and was regarded as the "father" of modern chemical engineering. After graduating from M.I.T., "Doc" studied at the University of Breslau in Germany and received his Ph.D. in chemistry there. He returned to M.I.T. as an Assistant Professor in Chemical Engineering and after a year or two was made a full professor. His career included being consultant to the Goodyear Tire and Rubber Co. During World War I Prof. Lewis was advisor to the Army's Chemical Warfare Service.

Over the years "Doc" has received numerous awards for distinguished accomplishments, among them the Perkin Medal presented in 1936 by the American Chemical Society and in 1947 the Priestly Medal, the Society's highest honor. In 1948 Prof. Lewis was the recipient of the Medal for Merit. This was presented by President Truman and is the nation's highest award to civilians for outstanding service. In 1957 he was awarded the Petroleum Institute's Gold Medal.

Just before World War II Prof. Lewis and Prof. Edwin R. Gilliland, also of M.I.T., developed the "fluid-bed" method of catalytic cracking of petroleum which made possible expanded production of aviation gasoline, and which is now used to produce most of the gasoline in this country. He worked on various problems for the U.S. Office of Scientific Research and Development and served on the committee that made the crucial decision of priorities for the four processes for the separation of uranium-235 for the atomic bomb.

There is little chance that I will be able to attend Alumni Day this June but I hope **Henry Buff** will continue his almost unbroken attendance. I will appreciate a report. — **William G. Ball,** Secretary, 6311 Fordham Place, Bradenton, Fla. 33507

07

Milton E. MacGregor writes that he started to weave when he was 85. "I joined the Weavers Guild of Boston and did the necessary things to qualify for a rating of 'Journeyman.' When 90, I wove material for dresses for both my wife and daughter which are to be modeled by them in the May meeting of the Guild. My teacher was Mrs. Margaret Holmes and my daughter made the dresses."

Emory Leon Chaffee, 89 died in March, 1975. Dr. Chaffee was a pioneer radio and electronics engineer who had been a

member of the Harvard University faculty for 42 years. His career began at Harvard in 1911. In World War II, he directed a Harvard program training men in the armed forces in various aspects of electronics and also directed research that brought about improvements in radar and other electronic equipment.

In 1944, Harvard awarded Dr. Chaffee an honorary doctorate in engineering (he earned A.M. and PhD. degrees in physics at Harvard in 1908). The Case Institute of Technology gave him a similar honorary doctorate in 1955. After Dr. Chaffee's retirement from Harvard, he taught at Northeastern University. — M.L.

08

Spring does not always come on March 22. Before the year that I was President of the Canton Historical Society, on April 19 we always had what we called the "Fast Day" walk over ancient roads to find old cellar holes where members would read historical papers about the people who once lived there. There were generally 30 or 40 persons to go on these walks and the local baker with his covered wagon usually provided the midday lunch: hot coffee, New England baked beans, brown bread, doughnuts and apple pie.

This walk was generally blessed with good spring weather, but I recall there were two years when it snowed on April 19 and that was the last of the historical walks.

So March 22 is not always the first day of spring.

The Alumni Fund received many gifts from the class, and one graduate, **J. Worth Maxwell,** of El Paso, Texas wrote on the back of his envelope, "My main activity is sitting before the heater rubbing 'pain killer' on my knees and studying how to treat arthritis." If successful he should let us all in on the secret. — **J. W. Wattles III,** Secretary, 26 Bullard Rd., Weston, Mass. 02193

09

Once again it is time to call attention to Alumni Day and the opportunity for us to get together. There will be tables for lunch with class designations where we will be able to meet. It is hoped that quite a few of us will be able to attend.

In March a selected number of class secretaries received a personal letter from Howard W. Johnson, Chairman of the M.I.T. Corporation, inviting us to a luncheon sponsored by the special Committee for Historical Collections. The committee has an extensive program of restoring portraits, collecting and cataloging photographs and material associated with the history of M.I.T. A temporary storage area is the second floor of the Epsco Building, 264 Massachusetts Ave. (opposite the NECCO Building), not far from the campus. An illuminated glass case about six feet long was devoted to **Florence Luscomb.** It contained about 20 photographs of her from her coed days to the present time, together with mementoes of her many activities. During Alumni Day there will be notices of the exhibition with directions to its location.

We regret to report the following obituaries: **Paul Remick,** died March 17, 1972 in Welles, Maine. Our records show that until 1953 he lived on Beacon St., Boston. . . . **Clarence W. Osborne** died May 30, 1973 in Portland, Ore. Our records show that he lived all his life there.

Brother Daniel died in Glen Ellyn, Ill., April 23, 1974. Until 1914 he was with the Guantanamo Sugar Co., Cuba. He returned to Dorchester, Mass., in 1914 and later entered Maryknoll Preparatory College in Pennsylvania. He became a Maryknoll Father in San Juan Banlista, Calif.; Maryknoll, N.Y.; and Glen Ellyn, Ill.

Lockwood Towne, 87 years, died in Brockfield, Conn., March 17, 1974. He prepared at De Pauw Academy and De Pauw University. He taught at the Universities of Nebraska and Illinois and later joined the Consulting Engineering firm of Stone and Webster in Boston and New York. He was a former consultant to the Connecticut Highway Department and was a member of the Hoover Commission. He retired from Stone and Webster as vice president in 1950. He was a former member of the Riverside Church in New Yale and St. Paul Episcopal Church in Brookfield, Conn. He leaves his wife, the former Helen M. Jones, a daughter, Mrs. Merrill T. Hunt, a son, Dr. Lockwood Towne of Westport, five grandchildren, and seven great-grandchildren.

Charles Freed died February 11, 1975 in Chestnut Hill, Brookline, Mass. He prepared at Cambridge English High School. He lived most of his life in Brookline, Mass., and Dorchester, Mass., and was employed at an electrical company.

Channing Turner died March 24, 1975 in Turnbridge, England. He prepared for the Institute at Broune and Nichols School, Cambridge, Mass. While at the Institute he was very active, with involvements such as the Mechanical Engineering Society, Technology Club, Golf Team Captain, Technique, and Editor-in-Chief of *The Tech.* He was with the Radiation Laboratory and other labs at M.I.T. until 1946 when he joined the First National Bank and Trust Co., New Canaan, Conn. In 1949 he moved to Turnbridge, Wells, England, where he remained until his death. — **Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

11

Paul A. Cushman writes: "I am working seven days a week, three to four hours daily on out-of-doors work."

Joseph Nathaniel French died on February 28, 1975. Mr. French moved to Detroit in 1913 to work as architect on Henry Ford's home, Fair Lane, in Dearborn. During World War II, he designed buildings and sites around the world for the U.S. Armed Services. He retired in 1967 after 52 years with Albert Kahn Associates, an architectural firm that he joined in 1914. Surviving are his wife, Yolanda C., five daughters, a son, 22 grandchildren and eight great-grandchildren. — M.L.

12

Larry Cummings and Julie sent me a nice, long letter telling in detail of their month in Florida on Long Boat Key, West Coast. There are many new condominiums and the community is built up greatly. They tried some excellent restaurants and visited several friends, most of whom live in these new apartments. Larry also tried several golf courses, but his game "is not improving." They planned to attend the wedding of a granddaughter in the East in May and I hope to see them at that time. . . . From Julie I received more details of **Jim Cook**'s accident last November (reported in the April issue), when he broke his left leg. He was being cared for by his daughter, Mary, but she broke her leg skiing, so he went to stay with another daughter, Sue, in New Hampshire. But he strained his back severely lifting a suit case and had to go back to the hospital. Sincerest sympathy and hope to hear he has improved greatly. . . . **Harold Brackett** wrote from Florida in April that he and his niece, Eleanor Forbes, were also spending ten days at Long Boat Key. He tried surf fishing which he greatly enjoys, but got few bites this year, which is unusual. Harold also reports the big increase in building in the vicinity, both condominiums and hotels, which have changed its appearance greatly. As usual they planned to leave for the summer home in Limerick, Maine, the first week in April.

A brief note from **George Robinson,** who spent many years with the Navy Dept. in Washington, says, "General health, poor. Can get around, am last of family." . . . **Clarence Woodward** of Melrose, Mass., writes: "I am in fair health and get around O.K., also continue to drive, mostly locally. Both Ida and I have considerable arthritis. I still play duplicate bridge and am usually successful, but have discontinued golf. My daughter and family still live in Charlestown, W. Va., where her husband is manager of a Union Carbide plant. They plan to visit us soon. My car was stolen from the garage a few weeks ago and when recovered, had been seriously wrecked. Kids were responsible but they are seldom punished." . . . **Jonathan Noyes** sent me a covered bridge placemat saying: "You see we really do appreciate covered bridges." He says he is on the go most of the time and the doctors tell him he is in fine shape. He plans to go to Maine this summer as usual, and attended the Mexican Reunion last March. . . . **Carl Rowley** reports that he and Betty are well. They plan to drive down to the Cape Cod cottage this summer as usual but Carl has recently given it to his son, Charles. The Rowleys recently celebrated their 61st anniversary and both birthdays now follow. "How steep the stairs are."

Jesse Hakes writes, "Mary is slowly recovering from her accident and I am about the same but have given up any outside work as my recent operations are not doing so well. Hope the doctor does not want to operate again. Just heard from Dorothy Cremer who accompanied us on our last cruise. She is planning to attend the Mexican M.I.T. Festival." . . . **Fred Busby** writes, recalling that he and I were the only two last year at the 1912 class luncheon table. Hope we may do better this year. He expected to take a trip to Tallahassee this spring to visit his daughter and some of her ten children and his nine great-grandchildren. . . . **Wallace Murray** writes that like several of our classmates, he has had prostate trouble and after several months is slowly recovering. This naturally has prevented him from making plans for his customary annual trip to the "far away places."

Phil Dalrymple writes that United En-

gineers and Constructors with whom he has continued to work for years are making changes which may eliminate the work he used to do for them. He has been home for nearly six months but they have given him a new office so the future is uncertain. Phil says they now have four great-grandsons, including twins. He and his wife are planning a trip to Houston and Atlanta to visit some of the rest of his large family. In the meantime, he is using the time at home for maintenance work around the house. . . . **Ralph Hyde** surprised and pleased me with a note saying that both he and Ruth are in reasonably good health. He still lives on his large Mapleledge Farm which he bought some 30 years ago, raising poultry and milk. It is now partly tenanted but he maintains it himself. He also grows a sizeable vegetable garden. Ruth has continued with her activities as a children's photographer and keeps very busy. They plan a trip to Tennessee to visit family and see a great-grandchild. . . . **Bernard Stevens,** a special student in Course II., writes from Chatham, Mass., that he is in excellent health except for his eyes, which are bad, preventing his driving. He enjoys lawn bowling. He has three grandchildren, now grown, who live on the Cape. One is an artist, one a secretary (married) and the third a medical student at Boston University.

Harold Manning, of Woodbury, Conn., says briefly that his health is fairly good but he does not drive nor play golf. Since his wife's death last year, he has been living in a rest home. . . . **Jerry Hunsaker** advises that with the exception of a stiff hip joint, he has recovered satisfactorily from his accident and is able to walk reasonably well. This is welcome news, Jerry. . . . **John Hall** writes that his wife, Gladys, died in January at their home in Allenhurst, N.J. He decided that it would be best to move to Illinois near his daughter, Virginia, and family of four grandchildren, so he has taken an apartment across the street. His new address is 5142 Elmwood Place, Downer's Grove, Ill. 60515. . . . **Mac MacCormack** has also a change of address: 1905 Maplewood Av., Abington, Penn. 19001. Mac lived with a son in Maryland but he was transferred to Jackson, Tenn., and Mac is now living with his daughter in Pennsylvania. . . . **Julius Rosenburg** writes that all's well with him and his wife. They have bought a new home in Lakeland, Fla., and the address is 615 Lurter Rd., Lakeland, Fla. 33801.

I regret to report the deaths of three classmates. **Philip Jones** passed away suddenly with a stroke on April 5 at the Naples, Fla., Community Hospital. Phil had spent most of his time since retirement in Naples and loved the community, in which he was most active. He was largely responsible for the new Naples Library. He was a philosopher and published several articles in magazines. Phil spent most of his career with the Goodyear Tire and Rubber Co. and became their chief electrical engineer. Phil was an ardent bridge player and for exercise walked every morning along the sandy beach. Five years after his wife's death in 1965 he re-married a "Boston girl named Sue" who was equally interested in his activities. He is survived by her and one son and family.

Belatedly I report the death of **Arthur Bennis** in September, 1973, in the East Orange, N.J., Veterans Hospital where he had been a patient since 1970, and an invalid for many years before. His sad story appeared in the December, 1971 issue of the *Review* from data supplied by his wife, Lucy, and this notice is from his daughter, Mrs. Jane Billings. We all regret this sad ending and the class extends our deep sympathy.

We also report the death of **Early Kilman** of Onanaco, Va., which occurred on December 12, 1972 and who was also an invalid. His story also appeared in the December, 1971 issue of the *Review.* I received this notice from his wife, Sally, in reply to my inquiry for news. He is survived by his widow, five grandchildren and two great-grandchildren. The class belatedly sends its deep sympathy. — **Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Penn. 19081

13

Another milestone of our class will be celebrated in June — 62 years. We hope to be able to attend the Alumni Days and greet some of our classmates. We have received a number of letters from officers of the Alumni Association regarding some important future meetings: a special meeting of the Alumni Advisory Council; a luncheon meeting sponsored by the Committee for Historical Collections, and, of course, Alumni Day.

We are pleased that **Henry Glidden** was able to attend the "Historical Collections" meeting. Here is his report on this: "The day of M.I.T. activities was the wettest I have ever experienced! Although a bit late arriving at the meeting of Class Secretaries, I did get some notes. The big discussion was on funding a budget for care of "Historical Collections." The goal amount was set at $73,000.00. A letter from Howard Johnson in regard to this is coming out. It was suggested that the Class Secretaries approach the wealthier men in their classes for donations, but as the goals will be really high, it was decided that prospective donors should be approached by the most likely person to succeed, such as some top M.I.T. man. Any letters the M.I.T. office is to send out would be sent to Class Secretaries for approval. Historical Collections has much information regarding class activities including M.I.T.-related photos and movies, but wants more. We were told that a meeting of Class Secretaries regarding historical material is to be called. I saw some of the architectural historical collection — there were works by people I had not been in touch with since graduation. Even saw my own thesis drawings!"

We received an interesting note from **George W. Bakeman** enclosing an outline of his career after graduation. Some excerpts: "Born: Newton Upper Falls, Mass., May 17, 1889; married: Mollie Davidson, in San Francisco, May 27, 1919; American Red Cross Typhus Mission to Serbia, April, 1915. Worked with prisoners of war on eradication of typhus fever and on rural sanitation, transportation and feeding of war refugees in Serbia, Montenegro, Albania, Greece, Italy, and France. Work completed in April, 1916. Dept. of State, Wash., D.C., appointed in July, 1916, as Special Assistant to the American Ambassador to Russia for investigation and report on Russian treatment of some 2 million war prisoners in Russia and Serbia. Medical College of Virginia, February, 1941 to July, 1959, Appointed as Administrative Assistant to the President; also served as Secretary of the Board of Visitors; later as Associate Dean of Medicine. (Leave of absence from M.C.V. to direct the American Relief for France, May 1945 to August 1946.) Retirement, July, 1959." George advises the summary was requested by his children and grandchildren — he has a much more complete one.

We are indebted to **Ken Blake** for an article published in *Sports Illustrated* about our classmate, **Marion Rice Hart.** Marion certainly keeps active and we congratulate her for both her flying accomplishments and her writing. . . . Roz and I are extremely happy to see spring finally arrive in Maine. Although it was a relatively mild winter with little snow, it ended up with a "bang." At the height of the last rain and wind storm, we heard a crash and the sound of breaking glass. One of our windows on the ocean side had completely blown in. Other than needing a new window, there was no damage, so we were lucky. So long for now. — **George Philip Capen,** Secretary; **Rosalind R. Capen,** Assistant Secretary, Granite Point Road, Biddeford, Maine 04005

14

If you haven't yet made a gift to the 1975 Alumni Fund, there should still be time when you read this to get one in before the fund year ends on June 30. The April progress report credited us with the highest ratio (55 per cent) of contributors to active members of any class except one, much senior to us, which apparently has only three active members, of whom two gave. In total amounts given, however, we were nowhere near the top; in fact, our total was 24 per cent less than at the same time last year, even after deducting from last year's total a large sum from a trust set up by a deceased classmate.

Lacking news from anybody else, I'll mention that early in April, I was one of a number of secretaries of older classes invited to a luncheon at the M.I.T. Historical Collections. We saw many pictures of the people and buildings of the Institute of our day, including a splendid painting of Dean Burton. Some of you may well have pictures which Warren A. Seamans, the director, would be glad to know about. The address is 265 Massachusetts Ave., Cambridge 02139. He was interested in some snapshots I took at the M.I.T. summer surveying camp near East Machias, Maine, where the late **George Perley** and I were tentmates in 1913; and in a photograph of some of the naval officers, including **Ray MacCart** and me, who were in a graduate aeronautical engineering course at the Institute in the first term of 1918-1919. — **Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

You've all had the notice of our 60th Reunion. I do hope you will return the "yes" card at once, so we can all get together for a happy time. It will be Friday afternoon, June 6, at the M.I.T. Faculty Club, 50 Memorial Drive, Cambridge. Plenty of free parking is in the rear of the building. It will be *FREE* to

all classmates and their families — a cocktail party at 4 o'clock followed by dinner at the Club at 6:30 — no walking necessary. This is Alumni Day at M.I.T. and we suggest that you attend the events *on your own* — your Committee cannot be responsible for any Alumni Day lunch, hotel or transportation reservations. . . . In the March issue of *American Society of Civil Engineering*, **Phil Alger** had a long article on "The Human Element of Engineering" — a fascinating and inspirational story for any young engineer. . . . **Bill Brackett** had one of those dreaded household accidents, where in a fall he got a bad head and hand cut. Hurry up and get well, Bill.

Ellis Ellicott: "We are just back from Yucatan. It's a miracle how those Mayans built those wonderful stone pyramids without metal tools, or the wheel — beasts of burden!" . . . **Orton Camp:** "We have been in Florida for a couple of weeks. We had perfect weather, lots of sunshine and warm water. It was very nice. Actually, however, where I live in southern Connecticut, it has not been a bad winter at all. It has been very good. We have missed the storms and hurricanes which have been all too frequent in the West and Southwest, and sometimes rather bad up in Massachusetts and northern New England. . . . **Alton Cook** — "The Woof": "Just before I took off for California to visit my daughter and her family here in Yorba Linda, I had a nice letter from Joyce. In it she reminded me of our 60th class reunion in June and I am planning on making it." Replacing good old Ben Neal, Joyce has been doing a splendid job as Class Agent.

The sympathy of our Class goes out to **Otto Hilbert,** whose wife, Helen, died recently. She and Otto had traveled a great deal. She was very active in many activities in Corning, N.Y. Otto is continuing his preparation of the history of the Corning Glass Co.

John Staub: "The Houston Museum of Fine Arts is going to publish a book of houses I have designed. Numerous color plates will be used and the hope is for a so-called certified book catalogue. Since no records were kept, I am now busy trying to get copies of the plans from the owners and with a professional photographer getting pictures of about 40 houses in Texas, Tennessee, and Louisiana. It will take about a year before the book appears. It is a most unexpected honor." Congratulations, John. . . . In March good "old" **Bob Welles** wrote from Altadena, Calif.: "My daughter and I plan a trip to Organ Pipe National Monument, a federal park on the border of Arizona and old Mexico. It is as far south as you can get in this part of the U.S.A. and is a strictly dry desert region, given over to desert growth found in few other places. We have been there before and love it. We travel with a house-trailer and one-ton truck and have the comforts of home. Here it's the time of year when citrus fruits are ripening, and if you weren't so far away I would enjoy dropping in on you with a basket of navel oranges, tangerines, lemons and limes. Extra good crops of all of them this year. At 84 years of age my traveling days might soon be over; so my daughter and I plan a trip to Europe this summer. I was brought up over there and I long to see a bit of France again, my home for my first 24 years or so. Our timetable will have to fit my daughter's schedule, but I have hopes it won't interfere with my attending our 60th at M.I.T." I do hope Bob makes it with us, for we were all so glad to see him at our 50th. Later he wrote: "You mustn't think of yourself as too old to do interesting things. I'm 84 and no longer as spry as I could wish, with a bad back and a bad hip, and I don't walk any great distances if I can avoid it, but I still drive a car and enjoy life. Here I get around in my orchard with the help of a little Sears Roebuck tractor my daughter refers to as my 'Cadillac.' I equipped it with a little platform that I can load down with baskets or boxes of fruit. Saves walking and carrying heavy loads. We leave here for a month in Europe June 12, sailing from New York on the Queen Elizabeth II. Haven't crossed the Atlantic by boat in about 20 years and we are looking forward to it."

Joyce Brado is doing a splendid job for us as Class Agent. She acknowledges every contribution with a newsy, personal letter and has, thereby, acquired a lot of "fans" for herself. Nice going, Joyce, keep up your good work for 1915. . . . **Henry Leeb** wrote from Gladstone, N.J., to Joyce: "Trina and I are well, after her recovery from a heart attack a couple of years ago, and after a second operation on my spine which was rather uncomfortable. We live a rather bucolic but nevertheless quite active life here on our dairy farm in the Peapack Valley of north central New Jersey and spend summers at our place at Mere Point, Maine, with trips abroad every few years. We would welcome any classmates who might be in this vicinity. Very busy running the place here and with local politics where I have been on the Chester Township Council, Chairman of the Finance Committee and member of the Planning Board for many years until recently, as well as Chairman of Red Cross and involved in other interesting local activities. When you live in the country you really become part of it and local interests and activities assume a very important role in life. I am glad I have plenty to keep me busy from morning to night and enough to worry about to keep me on my toes. I might add that for about 20 years I have taken up cabinetmaking. I have a well-equipped shop and it keeps me out of mischief during the winter months and has provided a considerable number of rather presentable mahogany reproductions of all kinds for us and for our daughter's family. I am hoping to get to Boston for our 60th in June."

Bob Mitchell wrote from Clearwater to Joyce: "My gardening operations are a source of much pleasure and good health but are not good for letter writing; at this stage, arthritis in my right thumb takes over and I have to quit. Same thing in driving a car — no more long tours in my own car. Up north and at Cape Cod my grandchildren are always happy to take us around. If you can come this way we will put you up over night. This happens often with us and we enjoy it. We have a lovely country home and like to have our friends enjoy it. I can hardly wait to see you all at our 60th. — **Azel Mack,** Secretary, 100 Memorial Drive, Cambridge, Mass. 02142

16

The early returns for our 59th Reunion were very encouraging. We will have a good turnout again. Even more encouraging, however, are the many indications from classmates to attend our 60th.

Rudi Gruber writes that he will be in Germany at the time of our 59th. . . . We're sorry to hear that **George Crowell**'s wife was hospitalized in April and we sincerely hope that she is now well. . . . **Roger Lord** had just come out of the hospital in April and didn't feel that he would be able to attend the 59th. . . . We must have had responses from at least 75 of our classmates within two weeks of our mailing, and it is nice to see this continued interest.

Hearty congratulations to **Maury Holland,** who celebrated his 84th birthday on April 4. . . . **Tred Hine** wrote in early spring: "Everything fine. Winter in Florida and summers at our cottage on Lake Huron in Canada." . . . Gypsy and **Cy Guething** wrote on Easter Sunday: "Ideal weather in Florida this last winter, but miss all that nice snow up yonder. Hope you all keep breathing." . . . Had a pleasant phone call from **Dina Coleman** in early April to let us know that he will be coming to our 59th Reunion. . . . Also have had telephone conversations with **Joe Barker** and **Francis Stern** and am happy to report that Joe and Mary and Francis and Gladys are all well and active. . . . Nice letter from **Theron Curtis:** "You are a good sport to plan another outing (59th) for our class. It is hard to plan anything in these times but we will try to be with you for a short visit. We have not opened our summer house at Falmouth as yet and probably will not do so before June 10 this year. This makes it a long trip from Barrington to Chatham and return. We are lucky to keep fairly well so we will look forward to seeing you." . . . And this welcome letter from **Vert Young:** "The disability of **Harold Dodge** and the sad loss of Peb Stone has really thrown the burden of the class on your shoulders. I guess we can expect losses from among our ranks with increasing frequency as we must all be over 80 years of age — I'll be 82 in July. Heart still ticking, albeit a bit feebly! This year I'm planning to take Sylvia back to Hartford for the 60th Reunion of the Class of 1915 at Trinity. Are there any plans for a gathering at Chatham Bars Inn this spring, of our glorious class? We might be able to make both. Sylvia has only about 5 per cent vision and a failing memory which gets us into some funny conflicts on engagements, but we both still enjoy life — and she is mighty courageous. The enclosed may startle you — never thought I'd make the Cover Page of the *Times Picagrame Magazine*! Don't try to quote all this in the '16 Class notes!" We won't quote it all but here is a small part of it: "What started out in 1959 as a dream-of-a-life-time big game hunt in Africa wound up as a global rock hunt. Retired Bogalusa industrialist Vertrees Young, who has since traveled the four corners of the earth in search of geological specimens, has assembled a diverse collection of more than 4,000 types of minerals. One day, Young expects to give the best of his collection to Tulane University.

"Meanwhile, at the age of 81, he continues to build and catalog the monumental collection begun only 15 years ago when he retired from active management of Bogalusa's largest industry, the Gaylord Container Corporation. Vertrees Young has been a busy man all his life and his accomplishments have won much acclaim. One of the builders of the Gaylord organization, he still found time to play a key role in the formation of Louisiana's Public Affairs Re-

search Council, the Council for a Better Louisiana, and the Gulf South Research Institute. He has headed all three of the latter organizations as well as the Louisiana Forestry Commission and numerous industrial groups. He has been listed in *Who's Who in America*. When retirement came, it meant for him not a time for idleness but rather a time to pursue other long-postponed interests. Among these was the hunting of big game. So in 1959 Young and his wife, Sylvia, set sail for East and South Africa in pursuit of hunting trophies and visits with relatives and friends. Enroute aboard a freighter, Young found time to begin reading about geology and mineralogy, another postponed interest. Once in Africa, he quickly developed acquaintanceships with mine geologists, and his interest in rocks began to grow. On a second trip in 1964, he literally 'fell' into the hobby which has since become his consuming interest. While game hunting in Southwest Africa, he took a spill in high grass and injured his right eye on a granite boulder. Ex-game hunter Young chuckles as he remembers. 'While my eye was saved, this was conclusive proof to me that, at 70 years, I was too old for big game hunting, but not for rock hunting!'

"Many groups visit his 'rock house' yearly and are fascinated by Young's lecture on rocks and minerals. As they walk around the room looking at hundreds of specimens labeled with exotic names such as 'tourmaline needles' and 'beryl crystals' from such far-off places as Rhodesia and Tahiti, Young captivates them with his vast knowledge of geological history concerning the specimens and entertaining anecdotes of how particular samples were obtained. Vertrees commented on the rewards of his hobby: 'Aside from providing an endless fascination because of their natural beauty and extraordinary variety, these rocks and minerals have given me a keener appreciation of our world and what it took to make it habitable' observed the dedicated collector. Taking a long, long draw on his ever-present pipe, he added: 'Many of these rocks and minerals are not visible on the surface. Maybe it's like everything else in life — a little digging for something makes you appreciate it more.' "

We'll close with this letter from **Ed Parsons:** "You probably have heard of **John Ingle**'s death but I am enclosing these clippings sent to me by a mutual friend in San Diego. They do not do justice to his unusual business career. As I remember it he stood number one in Course II in our class and was a member of the honorary society. When he was with Goodyear he was in charge of their crude rubber operations in the East having spent many years living in Batavia and later Singapore. During the war he served on the committees for crude and synthetic rubber in Washington. After retirement he suffered a bad heart attack digging post holes to enclose his avocado ranch in Escondido. We enjoyed many happy times with John and his lovely wife, Ke, who is a Hawaiian descended from one of the original missionary families. **Arvin Page** and I had a room right side of John and **Paul Austin** on Newberry Street.

As a sad note, we report the deaths of classmates, **Walter Junkins,** February 7, 1975; **Arthur Neave,** April 5, 1975; and **Spencer Hopkins,** October 20, 1974.

Keep those letters coming and we hope we will see many of you at our 59th at Chatham Bars Inn, on June 3 to 5. — **Ralph A. Fletcher,** Acting Secretary, West Chelmsford, Mass. 01863

17

After 29 years as a director our young and vigorous-looking **Walter Beadle** has resigned from the board of the DuPont Co. Walt joined DuPont in 1928 as a technical investigator in the Development Dept. and became Assistant Treasurer in 1942. He was elected Treasurer, a Vice President, and a member of the Board of Directors in 1946. He retired as a Vice President and member of the Executive Committee in 1958.

Nelson Chase's 4 ft. by 4 ft. painting hanging in the Town Clerk's office in Belmont, Mass., attracts much attention. It is a bird's-eye view of Belmont Center as of about 1905 showing the grade crossing with a B and M railroad train, gates, rearing horse with buggy and so forth. Many groups of children come to study the scene and the guest book bears prominent names. . . . Arthur Fiedler, wearing his 1917 red jacket, had the almost impossible task of conducting about 2000 musicians assembled in the Boston City Hall Plaza, to play for a bicentennial event. . . . **Dutch Neumann** says that he is going to attend our 58th Reunion next October (probably at Northfield). He reports: "still have some spring in my step and, I hope, have all my marbles."

Ray Brooks reports the death of **George Dana Spear** at Sun City, Calif., on February 3. Ray refers to a notice in the "Daedalus Flyer" which drove this secretary to his dictionary. Naturally both Ray and George qualified as artful craftsmen (flyers).

Merrill Lee writing from Richmond, Va., refers to the one who "sent me to M.I.T." — his mother, who is in her 105th year. It is good to have **George Henderson** and **Elmer Joslin** also use the back of the alumni fund envelope for messages.

The deaths of **Benjamin M. Bond** on June 7, 1974, in Southfield, Mich., and **Foster C. Harlow** on July 16, 1972, in Milton, Mass., are recorded with regret. — **Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

Maybe we have had the best of both worlds. The problems facing us as we left M.I.T. over 50 years ago were comparatively simple and generally could be solved in a reasonable time and fashion. As a consequence, we have enjoyed the fruits of these conquests in a rising standard of living. Today all situations are complex and sophisticated — with no easy or quick solutions. Recently M.I.T. agreed to teach nuclear science to a number of qualified Iranian students — selected and paid for by that government. A protest movement supported by some students and faculty is vigorously developing because Iran is a nation governed by one man — be he benevolent or despot — and that government is the antithesis of our American society. The answer is not black or white — but in the gray area. What do you do if you are the M.I.T. administration?

Class of '18 October '74 mini-reunion

I am very happy to enclose parts of a letter from **Joe Kelley.** What he did not report was that both of us went to Cleveland in 1918 to work on a pilot plant for manufacturing mustard gas. Within 60 days a factory was in operation in Edgewood Arsenal near Baltimore, supplying two tons of mustard gas a day. We all received burns during this development — and Joe in particular was in the hospital for a number of months — all of which should entitle him to a Croix de Guerre. "You certainly have been persistent over the past many years in endeavoring to get information in class notes. I haven't responded before because I certainly have had no world-shaking data to give you. But I yield to your persistance. In March, 1918, quite a few of us '18 students went into chemical warfare service at Doc Lewis' suggestion. After the war I spent another year at Tech in Business Administration, then went to Texas to get into the production end of the oil business. From there I went into the refining end of the business in a little refinery in Oklahoma, then back into the marketing end of the oil business with Cities Service Oil Co. I stayed with Cities Service for the rest of my business career — nearly 40 years — and eventually became Marketing Vice President.

"After retiring to a nice little home in Peterborough, N. H., Mrs. Kelly and I spent winters in Florida and summers in New Hampshire. A couple of years ago we decided to buy this little house we're living in now in North Carolina, about half-way between New Hampshire and Florida and a good place for all year round living. So there's my simple, easy-to-read story."

I am very happy to include an interesting letter from **George Brewer**: "I was pleased to get your card at the holiday season. The place is the Pacific Ocean. My wife, Pat, and I are on a cruise from Los Angeles to Curacao in the Caribbean. We passed Acapulco, Mexico, yesterday. The weather is hot, the sea calm. This is a beautiful ship — a 20,000-ton cargo-passenger ship. It is essentially a freighter but carries about 100 passengers. We don't have as much entertainment on this trip as is true on some of the larger cruise ships but that suits us fine. Some short trips are available and we plan to take one at Panama. February 12: We are now in the Panama Canal. During a taxi tour of the city we saw many very elaborate and fancy headdresses and costumes. An interesting custom here is that at 6:00 the next morning after carnival, they bury 'the sardine,' go to the seashore and have a ceremony of some sort, and the celebration is ended."

Sam Chamberlain's passing has been reported. **John Abrams**' letter is so nostalgic and heartwarming that I print long ex-

cerpts: "It's been a month since Sam Chamberlain died. I'm sure gentle Sam would have liked your remembering me, his far-away boyhood friend, by sending the sad tidings after his funeral. He needs no eulogy from a schoolmate now. What I can do best is to tell of the post-bellum period before he found his niche in the hall of fame. Then came that treasure trove of beaux-arts and mastery of disciplines and their creations of art forms and matchless prose, which, in their profusion, made him great.

"Each of us came to Tech from another college in 1915-1916, to leave midyear of 1917, and return from overseas to Boston in April, 1919. Strangely enough, both had left the hog wallow embarkation camp of the Port of Brest at about the same time. I steamed into Boston Harbor on April 30, 1919, landed and checked in at Camp Devens. Then lost, two years out of academe, I sought counsel with Dean Talbot on what next: drop out or try to make it in Dr. Walker's new graduate industrial training school, X-A? He said, 'Stay.' That I did when I returned in the Fall to later find a place in the Post War Class of 1918.

"I bumped into Sam the day before the Institute opened in October, 1919, at one of his eateries, the Minerva. He readily disclosed that he had problems of wanderlust, self-appraisal and decision-making. These beset him during the time I lived in the environs of our old hangout, at Mass. Ave. and Huntington. I was near enough to his modest studio to see him often. I recall now that he was a contriver, an innovator, right off. A Francophile already, he was inspired to make water-color sketches of Filene's pretty girls from 'La Vie Parisienne,' matt them up and peddle them to Filene's at $25.00, as window displays, by the dozen.

"I want to share with you some fond recollections taken from cryptic entries in my musty daily journals. They point up the paradoxes of his life style before his peregrinations took him up the ladder to the heady realms of glory. My old roommate Brick Dunham — as you will remember — often joined us in town when I had my two-room pad 'with a nice parlor' at 11 Irvington St.

"Those years are very important. On Feburary 10, 1920, Sam hosted a cozy luncheon at his Chinese joint, the Santung. His guest was his hometown, childhood playmate, Bess Finch, of Aberdeen, Wash. A 'fine girl, talented, and dressed like a Polish cathedral' she was later to become my wife in Old South Church the next year. We had 'good times' with Sam and Brick and other cronies during that stormy courtship where, for a short time, rivalry had a part.

"Our voluble Sam always had le mot juste, sometimes poised, in table talk. It blossomed in tearooms and other genteel Back Bay salons of culture and, predictably, melded as lively wordplay with the illustrations of his greatest book, to me, *Etchings in Sunlight.*

". . . Now, in a surge of nostalgia, at age 81, I happily recall how we friends, with Bess, Brick and others, enjoyed most of all the honest meals at Durgin and Parks, the egalitarian camaraderie with fishmongers and apronned meat-cutters at red-checkered tablecloths and the trade-mark, hot Indian pudding with whipped cream. Shall I ruminate further on our pastimes or vigorous walks in the forsythias of the Fens, or in the Blue Hills or across the Charles or the innocent joys of movies at the Fenway, music at the Pops? Or shall I tell of canoeing the headwaters of the Penobscot or excursions down the Cape, fishing through the ice? No, long ere this I should have closed. But that's the way the ball rolls, Mr. Secretary — and I think Good Old Sam would like it."

Sometimes life has some pleasant interludes. Such was the case today, April 19, 1975, when I listened to fellow alumnus (class of 1926) and good friend Bob Dawes. As a direct descendant of William Dawes, who rode from Roxbury Crossing to Lexington on April 19, 1775, to warn the citizens that the British were coming, he participated in the ceremony in Brookline (and other places). He told in a most interesting way many anecdotes of his famous predecessor.

We note with sorrow the deaths of the following classmates: **Carl E. Adams** on November 18, 1974, and **Lloyd B. Van Da Linda** on January 3, 1975. — **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 509 Washington St., Brookline, Mass. 02146.

19

Aubrey P. Ames writes, "Have been rather inactive in all matters in recent years. After sailing for over 40 years I dropped it in 1949. Was at one time Commodore of Manila Yacht Club (Philippines)." Aubrey was with Standard-Vacuum Oil Company in the Far East.

Chuck Drew called from Miami area in March, where he spent a little time away from the cold wintry Minneapolis, Minn. All his reports were for the good and we are hoping to get together next year.

The Alumni Register reports the death of **Harold C. Moberg** on February 5, 1975 at 12 Idlewood Dr., South Yarmouth, Mass. 02664.

Your secretary has enjoyed excellent weather here in Florida this year with plenty of golf and ocean swimming; heard talks in March by James B. Lampert and Ross Jim Smith on future plans for athletics at M.I.T.; have seen **Nelson Bond;** and will miss **Don Way** who didn't make it south this year. Expect to spend July and August at 43 Vincent Ave., Chautauqua, N.Y., this summer and into the New England states in September. — **E. R. Smoley,** Secretary, 50 East Rd., Delray Beach, Fla. 33444

20

Worthy representatives of the class spirit were Eleanor and **Bob Tirrell** who accompanied the 25th Century Club tour to Rio earlier this year. Observing that nothing was scheduled for that particular date, Bob and his wife decided to sponsor a cocktail party for the entire group of thirty-five. It was a huge success according to all reports.

Ted Bossert writes, "Imagine one, who spent his entire business career in metallurgical research and development work with Alcoa, devoting, since retirement in 1962, half of his time collecting portraits of botanists from all over the world and from all time (as a volunteer worker for the Ghent Institute for Botanical Documentation at Carnegie Mellon University), and still enjoying it." More power to you, Ted! . . . **Fred Earle,** Captain U.S.N. reports that he finds retirement living at Carl Vinson Hall very satisfactory. The residence, at McLean, Va., is maintained for retired navy, marine, and coast guard officers by a private, non-profit foundation.

The eagle-eyed **Karl Bean** sent me a clipping picturing the noble brow of Prexy **Norrie Abbott** with the news that our distinguished classmate is now an Emeritus Member of the Supreme Council Thirty-third Degree, Ancient Accepted Scottish Rite of Freemasonry. During his 23 years of service as an active member, he served as Scottish Rite Deputy for Rhode Island, Grand Keeper of the Archives, and a member of various committees. . . . **Fraser Moffat** of 18 Lake Ave., Montrose, Penn., advises that he has sold his co-op apartment in N.Y.C. so that the above will henceforth be his "legal domicile." Fraser and Lydia spent the five months of winter in Vero Beach, Fla.

Through the kindness of "Doc" Smith, '23, I have received the sad news of the death of **Chuck Reed** of 17852 Lake Ave., Lakewood, Ohio. Chuck was a faithful attendant at many of our class reunions and was deservedly popular at these events for his three-dimension color slides of class activities and of his worldwide travels. He was a loyal and valued member of the class and will be deeply missed by us all. Chuck was past President of Forbes Varnish Co., now a division of Pittsburgh Plate Glass Co. He retired in 1963 as Divisional Director. He was also a Director of S. C. Wagenman Paint Stores Co. and Great Lakes Diesel Co. At one time he was President of Mercury Clutch Corp. of Massillon, Ohio. He was a member of the Union Club and was past President of the Cleveland M.I.T. Club. In his note, "Doc" Smith comments, "he was always a leader in the M.I.T. Club of Cleveland and one of Tech's very loyal supporters." He is survived by his wife, Else, and two sons, and four grandchildren. We shall miss him very much. — **Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

A year from now, our class will have its 55th Reunion and another five years will have gone by. "Time marches on!"

Joseph Wenick of Caldwell, N.J., one of the mainstays of the M.I.T. Club of Northern New Jersey, had another bout with surgery this winter and was hospitalized for seven weeks. His plans for spending a month in Florida had to be cancelled, but Joe came from the hospital in the middle of February and now tells me he is regaining weight and strength. We hope to have a luncheon date soon with Joe and Dorothy.

Two letters from our California correspondent **Grant Miner** came in response to a letter I sent him, saying **Jim Parsons** wanted to be remembered to him. Quoting Grant: "We had a gang, a fraternity loosely organized, which met in those undergraduate days at 50 Mass. Ave. for tea, toast, marmalade, cheese, salami — whatever the larder provided. The gang included John Burr Starkweather, '22, the deceased **Herbert De Staebler, Sammy Moreton, James Stewart Parsons,** and several others. The sessions were lively and I look

back on them with a great deal of pleasure. I'd like to do it all over again. The punning went on and on; we were all hard-worked and it was a good time to let off steam. When J.S.P. went home to Gloversville, N.Y., he sent me a beautiful pair of pigskin gloves that I wore for years and years. John Starkweather was a 1921 man until he had a motorcycle accident and had to drop out a year. We write to him and his wife, Ellen, and see them when they come out to California to visit their son Dave. The last time we saw Herb De Staebler was here at our home when he visited a son who was then a student at Stanford. We've been in touch with Sammy Moreton all these years and were guests at his home in Brookhaven, Miss., a few years ago." Thanks, Grant, for two interesting letters of reminiscence.

Clipping bureaus are fortunately functioning well these days. Two clippings from the March issue of *Gulf Shore Life,* Naples, Fla., show **Philip T. Coffin** riding a large tricycle with a big bag of groceries in the basket behind; and hosting a gay dinner party at the Moorings Country Club. Phil and Edna both seemed to be in fine shape when we saw them at lunch during our Florida stay in February. . . . Two more clippings, these from the *Coast Star,* tell of the Borough of Brielle, N.J., being honored as one of the first municipalities in Monmouth County to be recognized officially by the federal government as a bicentennial community. A photograph shows **Carole A. Clarke,** Co-Chairman of the Brielle Bicentennial Committee, and Brielle mayor Garet Pilling reading the recognition award scroll, with the Borough's bicentennial flag in the background. Congratulations, Cac, for your success in getting national recognition for Brielle.

A good letter from **Wallace Adams** of Middletown, Ohio, tells of a two-week trip he and Anne took to Florida and back in late February-early March. He overlapped our stay in Sarasota by a few days, visiting old friends. His company, Armco Steel, has a reunion in Bradenton, Fla., every February and Wally attended that. He reports "good health if one admits his age. I play golf regularly and walk the 18 holes. Anne is at the Art Center three days a week working in oils and enamel on copper. We are scheduled to take a combination rail-bus trip in late May from Chicago to Salt Lake City and then visit numerous western parks."

A postcard from Helen and **Bob Miller** dated March 5, 1975 from Mexico City told of visiting their daughter there and then taking a six-day circuitous trip to Vera Cruz and back. They attended the Fiesta luncheon at the University Club and visited with Helga and **Jim Parsons.** While in Mexico City, Bob phoned and talked to **Viviano Valdes.** Their entire trip lasted four weeks and Bob reported it "a great success." In mid-April they were heading for Cape Cod to open their summer cottage at West Chatham and erect a new flagpole to replace the one that blew down in a bad storm last winter.

Last month I reported the marriage of the "blue-eyed, golden-haired" granddaughter of **Donald Carter** of Glastonbury, Conn. Subsequent to this I wrote Don and told him my wife had found his name as one of her dance partners on an old Dorm Dance program in her scrapbook. This was more than 50 years ago and my recollection of acquaintance with Don was a blank. A letter in response indicates his memory matches mine. Don reports he married Emelyn Bidwell, Mt. Holyoke, '21, and they now have two sons and a daughter, eight grandchildren and two great-grandchildren. For eight years after graduation, Don worked in the industrial field in automobile manufacture, textiles, and refrigeration equipment. In 1929 he joined Travelers Insurance Co. in the General Accounting Dept., and eventually was made assistant chief accountant. He also worked for Travelers in other departments — methods and planning, budget and expense control, financial results — until retirement in 1963. His activities since retirement include playing cello for ten years in the Manchester Civic Orchestra, chamber music, wood-working, photography and travel. Thanks for your letter, Don.

A card from **Ralph Shaw, Jr.** tells of a trip to the Florida east coast and a call on **Herbert Nock** in Pompano Beach. Herb retired in 1958 and owns a condominium at 710 N. Ocean Blvd. . . . A brief note from **Bill Knoepke** reports that he and Marge celebrated their 50th wedding anniversary on March 20. Congratulations! . . . **Laurence O. Buckner** wrote on an Alumni Fund envelope, "Everything O.K. Never thought I'd be alive, much less working, when I entered Tech 58 years ago. Best wishes." . . . **Walter E. Church** of Arch Cape, Oregon, reports, "My wife and I spend much time right here, enjoying our grand coast, doing a lot of traveling, visiting family and friends, doing painting and photography. My wife is a hand bookbinder." . . . **Eugene S. Clark** of San Diego, Calif., writes to urge that at Commencement greater emphasis be placed upon making the United Nations more effective. . . . **Angelo O. Festorazzi** of Mobile, Ala., retired in 1961 from the Airtemp Division of Chrysler Corp. Following this he served with the U.S. Army Corps of Engineers, Mobile district for 13 years, retiring Dec. 31, 1974.

We extend the sympathy of the class to the families of four classmates whose deaths have been reported recently: **Charles L. Phillips,** Tucson, Ariz., in January, 1970; **Paul L. Hanson,** Largo, Fla., on January 6, 1975; **Frederick E. Haeberle,** Coronado, Calif., on February 24, 1975; and **Fred M. Rowell,** Osterville, Mass., on April 18, 1975. Phillips was the owner of Rancho del Socorro in Tucson, Ariz. Hanson was the President of Northwest Kold-Draft Co. for many years in Minneapolis, Minn., and in later years worked for Electronics Industries in California. . . . Rear Admiral Haeberle was head of the design and construction branches of the Bureau of Ships during World War II, Commandant of the New York Naval Shipyard from 1945 to 1949, and later deputy chief of the Bureau of Ships. He served on the battleship *Wyoming* as an ensign in World War I. . . . Fred Rowell was past President of Plymouth Five Cent Savings Bank and retired from the New Bedford Gas and Electric Co. where he was Manager and Vice President. He was also Vice President of the Cape Cod Hospital, a director of the Cape Cod Chamber of Commerce, and past President of the Cape Cod Boy Scout Council which awarded him the Silver Beaver Award.

I am indebted to **Phil Payson** for reporting the death of Paul Hanson and to **George Chutter** for the information regarding Fred Rowell. — **Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary, 3310 Sheffield Circle, Sarasota, Fla., 33580; **Samuel E. Lunden,** Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

This month the highly cherished laurel goes to **William B. Elmer** of Andover for good news and an extra dividend. Remember the Class gave Cathleen and Bill the punch bowl at the 1962 Reunion for being parents with the youngest child. Ned graduated from Dexter in Brookline with many school prizes and continued on the honor roll at Andover, now finishing his third year. Cathleen is a regular book reviewer for the *New York Times* while taking exceptionally good care of Bill, Ned and others. Bill Elmer is now collecting old, old clocks and will accept any, even those that won't run. His book, *The Optical Design of Reflectors* has been reviewed by the Engineering Societies Library and is on the way to becoming a classic. Bill has copyrighted an album of classic concert piano music (18 pieces) with favorable response from a famous New York critic and he continues to work industriously every day with hopes of slowing down the rate at which "our country is going down the drain." His latest April writing "Reflections of an Old American" exposes many of our problems in a way that perhaps something will be done about it. Perhaps through the appearance of a new leader "with the courage, strength and morality to halt the spreading disintegration and to turn our country back toward its rightful direction."

We were sorry to hear of the death of **James Duane** of Plymouth, Mass., while he was visiting in Bronxville. He was an enthusiastic supporter of our first five year reunion in Falmouth and many later celebrations. Jimmie was a member of the National Lancers and was active in scouting. He has worked with the First National Stores and was Sales Manager of Marton L. Hall Co. of Boston. Our sympathy goes to his wife, Alice, and his two sons and daughters. . . . We also send sympathy to the families of **Jose C. Espinosa,** San Juan, Rizal; **Frank A. Fletcher,** Havertown, Penn.; **Harold L. English,** Melrose, Mass.; **Kenneth Lacy,** Highland Park, Ill.

Louise and **Don Carpenter** represented the class at the 27th M.I.T. Fiesta in Mexico during March. . . . **Paul S. O'Brien** is busy as ever at Baton Rouge, La. He is President of Alcohol Affairs, Inc., publishing a periodical on their subject, circulation 6,000. . . . **Samuel Zack,** Harrisburg, Penn., is retiring as Vice Chairman and Senior Vice President of the consulting engineering firm of Gannett, Fleming, Corddry and Carpenter. Sam and Dottie are now full-time residents of Hollywood, Fla. . . . **Dwight F. Johns** of Piedmont, Calif., hopes to be with us at our Reunion in '77. . . . **Winthrop F. Potter** of Lexington prefers holding our reunion before Alumni Day so that he can attend the Pops and M.I.T. celebration. Win will bring Tony (Mrs. P). . . . **Elmer E. Sanborn** of Atlanta invites us to call as we pass through the area. Elmer and Betty will be with us in '77. . . . **Edmund D. Ayres** of Burlingame, Calif., is located only a few minutes from the San Francisco International Airport. Mona

joins him in wishing us well at the 55th. . . . **Arthur F. Rogers** sends best regards from Hollywood-by-the-Sea, Fla.

The **Dale Spoors** of Richmond are again hoping to visit classmates during this coming summer. . . . **Charles Brokaw** sends an enthusiastic "yes" for a 55th before Alumni Day. . . . Chuck and Lorna have three new families of their children near them — all busy and healthy. . . . **Francis M. Kurtz** of Delray Beach, Fla.. and Carlys are still welcoming classmates in the sunny south as they continue playing tennis and bridge. Our apologies to them for not being able to stop in February. . . . **C. Harold Whittum** and Margaret of Rockhall, Md., will be with us although they are thoroughly enjoying their "spot on the water" and have much to keep them busy. . . . Your Secretary and Dorothy will spend May in Paris, Luzerne, Berlin, and London hoping to return in time for Alumni Day. . . . We have been told that the trouble with Reunions is that you go there thinking you have made good — and meet a lot of people who have made better. With the various organizations sweeping the country, it should be cleaner than it is. — **Whitworth Ferguson,** Secretary, 333 Ellicott St, Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

Our worthy Assistant Secretary of the Great Class of 1923, **James A. (Pete) Pennypacker,** recently was asked by Corporation Chairman Howard Johnson to attend a meeting of the Committee for Historical Collections of M.I.T. Pete attended the luncheon meeting held at 265 Massachusetts Ave. While the warehouse in which the exhibits are housed is somewhat forbidding, the displays are excellent: portraits of famous people associated with the Institute, the development of the telephone industry, old prints and pictures of great historical value, and records (including activities and achievements) of every student who attended M.I.T. is most worthy of a visit by all who happen to be in the vicinity. The exhibit is open during business hours on weekdays. Warren Seamans is in charge and he and his staff will be glad to see you.

Alan R. Allen writes that he is now planning to attend the 100th Reunion of the Great Class of 1923 in the year 2023. He is apparently in great health now that he has learned how to conquer arthritis (see this column in the December 1974 issue of the *Review*). Al also claims to have found ways to control his malignant cancer and is "still up to his old tricks" of walking up the 29 flights in the hotel building where he lives. We congratulate you, Al, and we hereby invite anyone who wishes to hear more to get in touch with you at 525 Lexington Ave., New York, N.Y., 10017. . . . **Pete Pennypacker** has just written a song for the Bicentennial Commission of the town of Deep River, Conn. It is entitled "The Good Old U.S.A." If it is anything like your previous good musical compositions we again salute you. Also it is good to learn that someone has something nice to write about our country both patriotically and musically. We also hear that it plays and sings so well that other nearby towns in Connecticut will use it for their Bicentennial celebrations. Since this is the beginning of our countrywide Bicentennial celebration and because, Pete, the poetry reads so well I am going to repeat one of the stanzas here though you instructed me not to do this:

"From thirteen struggling colonies two hundred years ago / To fifty strong united states we've seen our nation grow. We share the joy of freedom, together we will stay — One nation indivisible — the good old U.S.A."

The whole song is available from Pete.

So long until the next month's issue — we are happy to report no need for necrology in this June, 1975 publication. — **Thomas E. Rounds,** Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488

24

It is 6:00 a.m. Sunday, April 12, as your Secretary begins scribbling, unable to fight off the magnificient sunrise flowing over the Boston skyline and Fenway Park. The city has become "high rise" within fifteen years and the comfortable look of Commonwealth Ave., Back Bay and downtown as we knew it has long gone, along with the Atlantic Ave. "El." Shortly, the "El" from North Station to Sullivan Square will be replaced by subway, eventually to Medford and beyond.

Now nostalgically reminiscing, I am reminded that **Herb Stewart** and I were guests of Dr. Howard W. Johnson at a luncheon for nearby area Class Secretaries on April 10 at the M.I.T. Historical Collections building. The Committee on Historical Collections reports to him as Chairman of the Corporation. He has found that the Institute had not consolidated historical information, which should be expected of an old efficient organization. To immediately correct this situation, he wished to acquaint us with this currently productive project and gain counsel on means of expanding and supporting the collection; cataloguing and storing photographs, architectural theses, models and written articles of the past.

Those among us who have had occasion to go back years in search of titles, stock purchase data or obituary information, well know that reliable sources save time, energy and money.

The Class softies, who have spent some time in Florida, are winging their ways back north, according to the mail. Eleanor and **Bill MacCallum** have been in Ft. Lauderdale for two months and drove to Tampa to attend the '24 Florida Fiesta, which was tagged as a fine affair. On March 1 they were to head for their home in Cotuit, Mass., on Cape Cod. . . . **Phil Blanchard** was enthusiastic about the Fiesta and Allora and **Clint Conway** as hosts. He was particularly happy about his opportunity to become very friendly with Dr. and Mrs. Howard Johnson and Dr. and Mrs. Killian during their stay at the Mt. Lakes Club in Florida previous to attending the Fiesta. . . . Luisa and **Nish Cornish** and **Al Roig** enlivened that affair, at which Al conned the group into holding the Fourth Florida Fiesta in Puerto Rico during 1976.

We have a note from the Secretary of the M.I.T. Club of Mexico, indicating that four of our members appeared at the 27th M.I.T. Fiesta in Mexico: Allora and **Clint Conway** from Clearwater, Fla.; Helen and **Paul Miller** from Ft. Lauderdale, Fla.; Luisa and **Nish Cornish** from Mexico City, Mex.; and Eva and **Jack Walthall** from Sheffield, Ala. Twenty-seven were present, along with Dr. and Mrs. Howard Johnson and Mrs. Pearson (Mrs. Conchita Lobdell).

Dick Shea kindly sent us a clipping from the I.E.E.E. Power Engineering Society Newsletter concerning the Harbishaw Award to **Herb Stewart** on January 28, 1975. For those who missed the May *Review* issue, Herb's honors were more fully reported. Dick is leaving Venice, Fla., and heading for South Yarmouth on Cape Cod to arrive April 7. With the cold, snow and rain we have been having, he probably wishes that he had waited another month.

We regret the printing errors and deviations in the class notes of the March/April issue and apologize to **Dippy Davol** for his moniker change. Reading a little further, it intimates that **Sox Kinsey** might have missed the Reunion. We happily report that he, with a red jacket and Catherine with her multi-colored print dress certainly were at Plymouth. Proceeding to the next paragraph, **Ted Taylor** was, "Looking forward to joining the group on our 55th," and I am sure that his locus was the Pocono Lake Preserve.

P.S. — Just hours before the deadline for these words, **Luis Ferré, Frank Shaw, Ray Lehrer, Herb Stewart** and your scribe, at the Faculty Club, discussed possible Class participation in supporting the Historical Collections project. Ninety minutes afterward, **Luis Ferré** as President of the Alumni Association, led a special meeting of the Alumni Advisory Council in a preview of the M.I.T. Leadership Campaign to raise $225 million in the next five years. Your officers decided to table the Historical Collections operating fund effort — **Russell W. Ambach,** Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart,** Co-Secretary, 8 Pilgrim Rd., Waban, Mass.

25

I looked back into my archives and discovered that a document was issued by M.I.T. on July 16, 1925 conferring on one **Ernest Willard Gardiner** the degree of B.S. in General Engineering. I therefore assume that this is the date that commemorates our departure from the Institute. I am glad that it is written in English. If I had gone to Harvard I am sure that it would have been in Latin and today I would have no idea what it all meant. I am writing these notes in late April but I can make a prediction that the June issue of *Scientific American* which has a column called "Fifty Years Ago" will make no mention of the fact that the M.I.T. Class of 1925 was let loose upon a world unprepared for the magnitude of that event. Now on the more serious side think of the developments in technology that have taken place in the last 50 years. I imagine that most of us have had our ups and downs but on the whole these have been pretty satisfactory years and at least we have survived.

A few letters that I have received indicate that the following plan to be with us for the Reunion: **James Evans, Wilder Perkins** and **Milt Salzman.** Milt also states that he is getting exercise shoveling snow. He is also "needling" classmates for contributions for the Alumni Fund. **Joseph Hobbs** writes that he is still in practice. I note that **Edward**

Harris attended the M.I.T. Fiesta in Mexico in mid-March.

I am sorry to have to report the passing of **Philip J. Lamoureux** of Fairfield, Conn., on May 30, 1970; **Nelson C. Mallery** of San Diego, Calif., on March 9, 1973; **Harold A. Bauld** of Fayville, Md., on Jan. 25, 1974; **Douglas E. Steinman** of Beaumont, Texas, on July 10, 1974; and **Bernard R. Freudenthal** of Baltimore, Md., on March 19, 1975. Bernard received both his B.S. and M.S. degrees in Chemical Engineering at M.I.T. He developed a process to make water potable and oversaw the production of food and water used in lifeboats aboard merchant and transport ships. His chemical engineering firm supplied more than 1000 Liberty ships with sanitation chemicals. He also worked with hospital staffs to control the spread of hospital infections. He was a Director of the Internal Sanitary Supply Association which awarded him a lifetime membership on his retirement. He aided our class in the solicitation of Class Gifts. His wife, the former Elsa Lipton, a sister, two nephews, and a niece survive him. — **E. Williard Gardiner,** Secretary, 53 Foster St., Cambridge, Mass. 02138

26

On a recent weekend trip for sailing to Key Largo, Fla., we had picked up a car at the Miami airport and headed south on Route 1. Before leaving the airport we decided to give **Tony Gabrenas** a ring to see where he lives in relation to our route. As luck would have it he is just a few blocks off Route 1 in south Miami so we swung by and paid a short visit. Tony has a real nice Florida-type home and swimming pool, all on two acres of land. Tony has never missed a reunion and plans to be on hand for our 50th. He is in a little different age bracket than the rest of us and will be 80 for our reunion. All these years I have thought Tony was Greek but he tells me he came from Lithuania and plans to visit the old homestead prior to reunion. We spent an interesting hour reliving his travels building bridges, which in retirement took him to South America. The visit was all too short. En route home a short visit with classmate **Bill Vaughan** at Seminole, Fla., (south of Clearwater) resulted in a phone call to **Pete Doelger** in Palm Beach because Bill had just read in the morning paper that a master swindler had been renting a luxury home at 4 El Bravo Way. We were relieved to learn from Pete that he had sold his house to a reliable third party who was the one stuck for the back rent. While in the area we also paid a quickie visit to retired M.I.T. dean Tom Pitre and his wife Hester at Mease Manor in Dunedin and found them both busy and fine. We arrived home just in time to attend a meeting at the Historical Collections at M.I.T., this being a relatively new effort you may like to know something about. From a start in 1971 with an ultra-modest budget, Warren Seamans, the director, has put together a real impressive collection in what would be considered stark quarters if they were not used so imaginatively. An area on the second floor of the EPSCO building on Mass. Ave. (opposite NECCO) serves as headquarters, and already 44 portraits, including an unusual find of William Barton Rogers by Lazarus, are skillfully displayed. The largest single component in the Historical Collections are the photographs, which are being organized, catalogued, cross-indexed and stored for preservation. Since M.I.T. had the first school of architecture in the country, there is a vast collection of drawings rendered as theses. Having been stored for years rolled up in a dusty warehouse, they could scarcely be touched without crumbling. Using a special chemical process, moisture was gradually reabsorbed into the paper fibers and over a period of months they have been flattened and cleaned. Storage and exhibition space is a major remaining problem. Many instruments, models and devices of historical importance have also been gathered into the collection; memorabilia such as the desks of William B. Rogers, Richard C. Machaurin and Norbert Wiener have been found. Selecting was done to avoid the sentimental in favor of the historical. The director is sincerely interested in photographs and other artifacts that would enrich the collection. When you are at the Institute you certainly would find a visit to the Historical Collections an enriching experience. The centrex direct telephone number of Warren Seamans, Director, is 617-253-4444. He is always happy to arrange a visit and can tell you how to find the place.

We have asked the Class Notes Editor for an extra day on the deadline in order to report to you first-hand the final Alumni Council meeting of the year and the most inspiring I have attended in 30 years as a member. When I tell you that this meeting was the kick-off for the largest capital fund drive the Institute has ever launched you may question my term "inspiring." However, if I can impart just a tiny bit of the motivation behind the drive you may get an insight into why it was truly inspiring. I won't attempt to condense any of the talks because this information will be available elsewhere, but I will tell you that the meeting was chaired by Alumni Associate President Louis Ferré, ex-Governor of Puerto Rico, and the objectives were detailed by Chairman Howard Johnson (who also heads the drive), President Jerry Wiesner, Chancellor Paul Gray, Provost Walter Rosenblith, Co-chairman (with Howard Johnson) Alumnus Paul Hellmuth, '47, President Emeritus "Jay" Stratton and finally the dean of all of them, our own **Jim Killian.** The talks were not long but all were to the point, the main point being that M.I.T. has retained its position as number one in the field of science and technology by a wide margin for more than 100 years. The objective is to retain and enhance this position. The opportunities for solving the problems of today in energy, health, nutrition, transportation, and low-income housing lie not with the politician but with the scientist. M.I.T. is a problem-solving institution that has the capacity for solving them. Constructive and intelligent use of science has never faced a greater challenge. When we went to M.I.T., it was a great institution, and the facility that was awaiting our arrival was there because people like Coleman duPont had given the Cambridge land and George Eastman had backed the building project. I don't think they expected us to thank them for what they did, but to use it to solve the problems of our day. Certainly we can bask in the reflected glory of our many, many classmates who have done just that. I believe as a class we have been foremost among those who care about perpetuating this great institution and now we will have an opportunity to do our part to perpetuate the great traditions. Fortunately our Class Gift effort, the Sailing Pavilion Project on which I am working, will pour into the overall capital drive which will continue beyond these projects for a total of five years. Principal objectives are increased faculty endowment, increased student support (tuition will be $3700 next fall!) and capital improvements. This to keep M.I.T. in its number one position for solving the critical problems ahead and continuing to attract the cream of students to prepare for the great task. The challenges and opportunities were never greater for any institution and to feel that we can help face them provides that inspiration I have been talking about. Cherrio until next month. — **George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

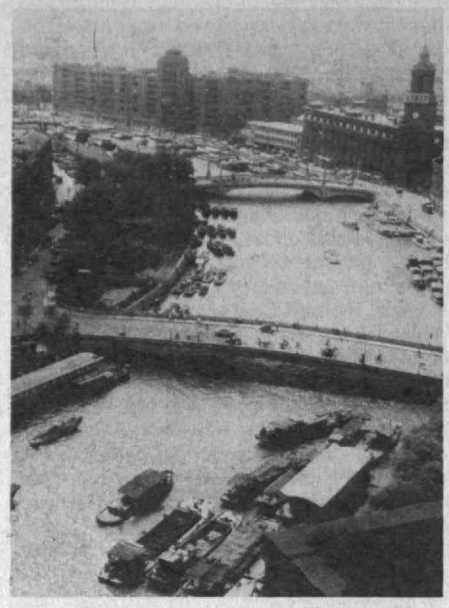
27

Joe Harris sends me a clipping from the *New London* newspaper describing the whaling museum which **Carl Wies** has founded in New London. Some of you may remember that in the February, 1973, notes I reported on the fire that had destroyed the old house on Whale Oil Row which Carl owned, and on his plans for rebuilding it to duplicate the original historical structure. The rebuilding has now been completed, and the second floor has become a museum with an authentic whaling boat and the 1200-pound jawbone of a finback whale at its center, and a display of harpoons, scrimshaw, and other whaling mementoes. Carl attended Yale Medical School after graduation from M.I.T. and has been practicing in New London ever since. . . . **Joe Harris** is still working with S.C.O.R.E. and has been on the radio a couple of times recently plugging the S.C.O.R.E. program. He and Ann hope to take a trip to the Mediterranean this summer. . . . **Hank Kurt** invites all yachtsmen in our class coming to Bucks Harbor, Maine, this summer to look him up at Harbor Island or the Yacht Club. Hank — who was the first M.I.T. graduate to receive an S.B. in aeronautical engineering — has recently written a book (*Water Flying,* N.Y., Macmillan, 1974) of reminiscences and practical guidelines on water flying.

Gordon Calderwood keeps busy with volunteer activities. He and his wife were planning a trip to Spain in late May. . . . **George Cunningham** should be driving cross-county from California to Miami, or perhaps on his way up the East Coast, just about the time these notes appear. He plans to spend a few days at the Institute with his wife, and is looking forward to joining us for the 50th Reunion — only two years off now. . . . **John Kelley,** who became President of Kelley Mortgage Co. in Newport Beach ten years ago, after retiring from the Los Angeles Department of Water and Power, writes that he is now working as a real estate broker. He is living in Santa Barbara. . . . **Tom Scott** retired a year ago from the U.S. Tariff Commission after 37 years, interrupted only by three years in the Army (1942-44).

I noted in the March/April *Review* that **Charlie Pope** was wondering if he could get his red 50th Reunion jacket in advance, so he could wear it at his Stanford '76 reunion. I have now learned that the jackets will become available to us in the winter of 1977.

continued on page 96



"The Wisdom of the Masses"

Recording his impressions of the People's Republic of China, an engineering educator finds himself skeptical of Chinese doctrine but convinced of the results

Hunter Rouse, '29

On August 19, 1974, ten American engineers with primary interest in water resources began a month's tour of the People's Republic of China — to the best of my knowledge, the first group of American engineers to visit that country since its founding a quarter of a century ago. Our itinerary had been arranged by the Chinese Society of Hydraulic Engineering, and we had the moral support of the U.S. State Department and National Academies of Sciences and of Engineering and the financial support of the Ford and National Science Foundations.

Entering from Hong Kong, we were met at Canton by five representatives of the Chinese Society: three engineers (two of whom were members of its Board of Directors) and two administrative secretaries, who remained with us throughout the tour. All knew some English, two of them — an engineer and a secretary — enough to serve effectively as interpreters. We visited seven major cities (Canton, Hangchow, Shanghai, Nanking, Chengchow, Peking, and Tientsin), and we made bus trips to five additional towns and many hydraulic installations and other works.

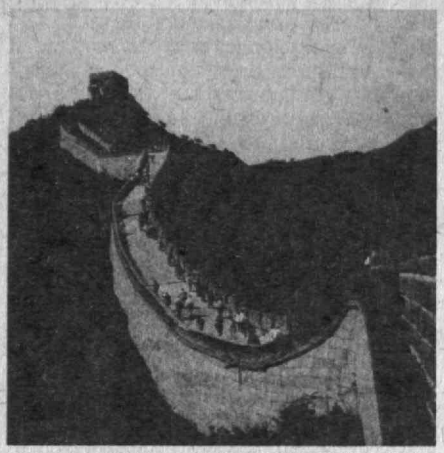
The delegation included, in addition to the writer, Professor M. L. Albertson of Colorado State University, who organized the tour; George Bugliarello, Sc.D.'59, President of the New York Polytechnic Institute; Ven Te Chow, Professor of Hydraulic Engineering at the University of Illinois; James W. Daily, Professor of Engineering Mechanics at the University of Michigan; Charles Greer, Instructor in Geography at the University of Texas; James E. Nickum, Lecturer in Economics at the Long Beach Campus of California State University; Dean F. Peterson, Vice President for Research at Utah State University; William W. Sayre, Professor of Hydraulic Engineering at the University of Iowa; Richard T. Shen, Professor of Housing at the University of Malaysia and formerly a member of the hydraulics staff at Fort Collins; and Dr. Chong Hung Zee of the Grumman Aerospace Corp. Various aspects of hydrology, biomechanics, hydraulic machinery, systems analysis, and water-resource engineering were thus represented, with a strong minor in engineering education. In addition, the two younger members had just completed doctoral dissertations on the regulation of the Yellow River and on the economics of small Chinese watersheds, and both had good facility with the language; three of the delegation had spoken Chinese since childhood, and this was to prove of great importance to our mutual understanding.

"Everyone Seemed to Have Something to Do"

Various superficial details were at once striking. Never have I drunk so much hot tea. Mugs of it were served — and constantly refilled — at every visit. There are literally millions of bicycles on the streets but no private cars whatever. Sedans made in Shanghai abound as taxis, and there are small and large Shanghai buses and countless homemade conveyances; the din of horns was terrific. The Chinese International Travel Service was always friendly and accommodating, and we had no feeling of relief when we finally returned to Hong Kong. Few of the Chinese people seemed ever to have seen — much less communicated with — an American. We were stared at in surprise wherever we went and crowds rapidly surrounded us. The slightest show of friendliness on our part drew smiles and even applause.

Probably the strongest impression that we received wherever we went was that of tremendous activity; everyone seemed to have something to do, and there was no visible evidence of either hunger or discontent. Mao stated his goal succinctly nearly 20 years ago: "The aim of this [people's democratic] dictatorship is to protect all our people so that they can devote themselves to peaceful labor and build China into a socialistic country with a modern industry, agriculture, science and culture." Instead of holding that its goal is the conversion of the world, the effort of the P.R.C. is directed toward the creation of a classless and self-reliant Chinese society, and everything is judged according to its contribution to this end. There is no evidence of an intellectual or political aristocracy. Salaries among those technically employed seem to have at most a two-fold range, and intellectualism is scorned in favor of what will best "serve the people."

We still think of China as having a runaway population problem; actually her rate of growth is now nearly comparable to ours (and, for that matter, to Russia's). In addition to using standard birth-control methods, the Chinese are effectively encouraged not to marry till their middle or late 20's and then to have only two children. We in America pride ourselves on our standard of living, freedom to travel, and the right to select one's own livelihood. The Chinese living standard is admittedly lower, but it is much more uniform and slowly rising as it continues to even out. It must also be granted that the Chinese travel only when and where they are sent and do professionally only what they are directed to do by the government. However, the government takes care of all its citizens medically and in their old age and has also freed them from starvation, exploitation, venereal and other diseases, beggars and thieves, rape, and (almost) flies and spitting on the floor! How much would Americans give to be equally free from crime, unemployment, strikes, and inflation?



Left to right: peasants weeding rice field in Malu Commune near Shanghai; Shanghai River traffic; street scene in Tsunhua Commune near Peking; Shanghai industrial exhibition; Hall of Prayer, Temple of Heaven, Peking; guardian beast in Peking's Palace Museum; repaved stretch of Great Wall at Pataling near Peking.

The Primacy of Food — and Therefore of Water

The western provinces of China are mountainous sources of China's two great rivers, the Yangtze and the Yellow. The eastern provinces are the agricultural ones, and those between supply (among other things) the silt that causes much of the country's river problems. Though there is on average plenty of rainfall, it occurs mainly in certain regions and seasons, so that there is an alternating battle with flood and drought. With 80 per cent of the people on the land (despite the crowding of the country's larger cities), the government's wise policy of improving the food situation before all else has involved provision of an adequate but not overabundant supply of water as needed: during the spring and summer in the north and throughout the year in the south. This in turn has required control of sediment erosion in the midwest and flooding in the east; the impounding of water for the dry season; its balanced distribution throughout the fertile zone; and the reclamation of land not yet arable. All of this program has been pursued with a vengeance, and largely by hand labor. Motion-picture records of hundreds of thousands of people building dams, aqueducts, and canals are as impressive as the countless finished works that we inspected.

How these feats are accomplished — not to mention comparable ones in shipbuilding, machine-tool manufacture, watch-making, and literally all industry from the cottage to the factory variety — is difficult for a westerner to comprehend. True, the Soviets provided an initial impetus; true, too, that many Chinese engineers still alive were educated abroad and that western literature abounds in their technical libraries. However, individual expertise is no longer held in esteem but is at least ostensibly belittled in comparison with the "wisdom of the masses" — i.e., the belief that a better decision can be reached by pooling the knowledge of many rather than by relying upon an elite few. Who makes the ultimate decision depends upon the magnitude of the question — whether of communal, county, provincial, or central governmental consequence — and it is often difficult to distinguish in this respect between the Government and the Party. As one descends through the provincial and county governments to those of the communes, one encounters a succession of Revolutionary Committees, often with party members as their heads. Indeed, every enterprise down to factory, farm, and other production brigades has its own Revolutionary Committee, the chairman of which usually outranks even the technical leader. We were invariably received by such chairmen, and it must be granted that they were thoroughly versed in the work of their organization, yet completely lacking in arrogance.

Specialization and Nonelitism in Education

The current Chinese policy on engineering education is original to say the least. As early as 1957 Chairman Mao had declared that "our educational policy must enable everyone who receives an education to develop morally, intellectually, and physically and become a worker with both socialist consciousness and culture." In the late 1960s, as part of the Cultural Revolution, all colleges and universities were closed for several years, to the end of discontinuing past practice on the one hand and of substituting something better on the other. Anything theoretical was thus cast aside, and in its place the Chinese devised a system as practical as possible. Even the various professorial ranks were abolished in favor of the general title "teacher."

Instead of the previous four or five years of study, a three-year curriculum is now prescribed, and it is not too easy to distinguish between the training of technicians and engineers. Prospective students can apply for admission only after the equivalent of tenth-grade education and two years of practical experience. Upon recommendation by their fellow workers, approval by the local government, and the successful outcome of a thoroughgoing review, those who are accepted (perhaps 10 per cent of the applicants) enroll in institutions giving special training in the field of their past experience.

The three years of training, including no little dialectics, are about evenly divided between classroom and factory or field, and the students actually participate in the design of necessary structures or machines. Neither grades nor examinations are given, the better students being responsible for the progress of the poorer ones. After completion of the course — no one fails — they return in large part to the jobs that they originally had and continue to learn as they produce.

Compared with American practice, which is moving in the direction of generalization, the Chinese student is purely a specialist. The ultimate success of the system, which will surely bear watching, cannot yet be properly assessed, for the first three-year class has just been "graduated."

I questioned our hosts about the physical health of Chairman Mao and his deputy Chou En-lai and what might happen upon the demise of either or both of these aging leaders; without exception, my respondents were firm in their conviction that the purposeful dissemination of Mao's thoughts and writings over the past 25 years has so imbued the people with his spirit that any change will be impossible. This is surely to be hoped, for thanks to its present policy the country is not only advancing rapidly under its own power but gives every sign of assuming a responsible international role.

The author is Carver Professor of Engineering, Emeritus, at the University of Iowa; he was for many years Director of its distinguished Institute of Hydraulic Research and more recently was Dean of the College of Engineering.

. . . Your Secretary has just been going through an interesting experience. As the senior member of the Board of Directors of the Westchester Symphony Orchestra, I have been faced every few years with the need to hire a new music director, and we have just been through a series of analyzing resumes and interviewing applicants. Orchestra conductors are *sui generis,* and it's quite a different experience from hiring a secretary, or a technical director, or a plant manager. The Orchestra has just completed its 50th year, but it still takes a lot more than momentum to keep it going and reasonably close to solvency.

We have lost three more members of the class. **John Oliver Collins** died in March in Summit, N.J. John was born in Lawrence, Mass., and took his bachelor's degree with our class and a master's degree in 1929. He retired nine years ago after 37 years as a research engineer with Exxon at Bayway. He leaves his wife, who was Elizabeth Hart, his son, John O., Jr., of Larkspur, Colo., and two granddaughters. . . . **Jim Snediker,** who reitred in 1968 after many years with the long lines division of A. T. and T., died in February, in Lockport, N.Y. . . . and I have belatedly learned of the death last November of **Bernard Y. McCarty** in Arcadia, Calif. At last reports, he had retired from Texaco; I had not heard from him lately. — **Joseph H. Melhado,** Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

28

Tom Larson writes that he and Lillian stay six months or more each year in the lovely city of Lake Worth, Palm Beach County, Fla. It is an ideal spot for golf and other outdoor activities. In May they will drive to Cape Cod, Mass., via Ann Arbor, Mich., to visit daughter Linda and her family, then stop in Morris Plains, N.J., to visit our son Bob. In October they will follow the same route in reverse back to Florida. Tom retired from American Hoechst Corp. in January, 1972. He had a call from **Maury Beren** early in the year and has had contact with other classmates through Alumni Fund acknowledgements.

A letter from Helen and **Roland Earle** tells us that they did a lot of traveling last summer. They have sold their large house in Hollywood, Fla., and have built a smaller home on Key Largo. Also they have a smaller boat now suitable for fishing in the Keys water. In late April they were planning a cruise to Cozumel and the Yucatan Peninsula and looking forward to visiting the Mayan ruins. . . . Marie and **George Chatfield** wrote to report that their radio stations, WFGL (AM) and WFMP (FM) in Fitchburg, Mass., won two awards this year for excellence and for editorial excellence from United Press International. The award for editorial excellence has been won by them three times in the last four years. In addition to business both Marie and George are much occupied with church activities.

A most welcome collection of envelope news panels from the Alumni Fund office provides the following notes: **James J. Nargis** is still active in the practice of architecture in Fresno, Cal., where he is a member of the Mayor's Civic Center Advisory Committee. He is also a board member of the Fresno County Historical Society, consultant to the State of California relative to historical buildings in the path of proposed freeways and in charge of restoring the Meux Residence for the bicentennial. . . . **John Houpis** sends greetings from sunny Greece and says: "Still going strong — no aches or pains yet. I'll be 77 next August and should be around for our 50th." . . . From **Des Shipley:** "As your travel advisor and considering the economy abroad, I believe our best vacations can be had north of the border. The Maritime Provinces, especially Prince Edward Island is, for those who are camper equipped, beautiful any time of the year. Banff, Lake Louise and Jasper (don't sell Jasper short) are traditional travel meccas. Food is excellent and gas is available anywhere." . . . Good old **Gus Solomons** reports: "My second son, Noel, is now a full fledged medical doctor on the staff of the Chicago Medical School and is at present in Guatemala City, Guatemala setting up a clinic in malnutrition. Son Gus (M.I.T. '61) is in New York and has his own dance company and opened his own studio of dance. He is well known as an expert choreographer. My wife Olivia, has just retired as a remedial reading teacher in the Boston school system. As for me, I am in my second career as an electrical engineer with the Metropolitan District Commission and will soon retire from this second career." . . . **Roberta L. Halligan** writes: "Although I accepted my pension in 1971, I am keeping active in public health as Secretary-Treasurer of Essex County Health Officers Assoc., Treasurer of New Jersey Public Health Assoc., was re-elected to the Executive Board of the N.J. Health Officers Assoc. and I am Health Officer of Essex Fells, N.J." . . . **Tom Wood,** completing his first five years of retirement, says: "It is by far the best job I have ever had. I've been too busy to do half the things I had always planned to do."

We deeply regret to report that **Charles E. Lyons** (Course V1-A) died March 13, 1975 in Naples, Fla. The information was received from his son Richard, '55. — **Walter J. Smith,** Secretary, 37 Dix Street, Winchester, Mass. 01890

29

Michael Comperchio has retired as of June, 1974, after 33 years of service as chief of Production Engineering Branch, Department of Defense, Boston, Mass. . . . **John F. Joyce** writes: "Since 1947, I have been engaged in the purchase and sale of industrial electrical equipment, such as motors, transformers and controls, both new and reconditioned. Our son, John, Jr., has been working with me for the past five years, which has been quite a help, permitting Mary and I to get away for frequent pleasure trips. Our youngest daughter is living in Cohasset with her husband and two children. The other children live near Philadelphia. For activities, I sing in our parish choir, play bridge (rather badly), and presently, I am taking oil painting lessons at our local junior high school. I have no definite plans for retirement. Best regards to all."

J. Gordon Carr has sent a note reading: "I am about to retire or be retired by the economy, since I am an architect and the building industry is the hardest hit in this current recession. My painting still keeps me busy, and gives me great pleasure, and helps me to reduce pressure and tension that life usually produces daily. I just had a large one-man exhibition of my watercolors at Grand Central Art Galleries in New York, and another one (three-man show) at Greenwich (Conn.) library, put on by the Silvermine Guild of Artists. You might be interested to know that the 1975 Connecticut Mutual Life Insurance calendar shows one of my paintings for the month of April. Thanks for remembering my birthday, which I like to forget, but guys like you keep reminding me of it. But I really do appreciate it."

Theodore S. Alexieff has taken an early retirement in 1972. For the past six years prior to that date, he was in charge of the engineering department of Factory Mutual International based in London, England. "Having either worked or traveled in most of the U.S.A.," he continues, "we chose California (near San Francisco) for a retirement home. We still have the travel bug so we went back to London and the continent for a visit to see what we had missed before. We also have visited Hawaii and various parts of the U.S. to see old friends and relatives. While not traveling, which is most of the time, I find it very enjoyable doing gardening, be it vegetables, fruit, flowers or even lawn (no, we do not have a ranch, just a modest house lot). All and all there is always enough to do to keep us contented and happy. Your birthday card idea is very good. Best regards to all."

Ted Malmstrom's wife Florence has sent the following note: "Greetings from Hawaii! Ted thanks you for the birthday card which he received here, while visiting our oldest daughter, Jackie, and her husband and our three grandchildren (note the 'our grandchildren,' not their children!). We were glad to leave Needham with its freezing weather and 12 inches of snow, and arrived here to enjoy this marvelous weather. We have had several beautiful days at the beach watching the surfers at Makaka, which was fantastic. We will be here until March 18." The Malmstroms plan to spend a couple of days on Kauai and two more days on Maui. Then they will fly to Portland, Ore., and spend a week there; and on to San Francisco by Amtrak for a week and returning home by April 1. Last Christmas, Ted and Florence visited their younger daughter Polly, and her husband and two grandchildren in St. Louis.

Jackson H. Emery has sent me a sad note stating that Franie (his wife) had passed away on March 11, 1975, at his daughter's home in Pennsylvania after a long illness. Jackson had previously informed your secretary of his wife's hopeless condition and sufferings, saying that "we are living from day to day." In his note he states, "We had spent a good Christmas and our joint birthdays at our daughters. I expect to remain in Wolfeboro and play host to my two daughters and their families this summer. I shall also probably work with the Wolfeboro Railroad Club on their projects." Jackson was the director of the local railroad museum for many years prior to his retirement.

Charles B. Bacon is still active in his business of plumbing, heating, and air-conditioning, plus a hardware and appliance store. Since he has two sons and a son-in-law in the business, he has plenty of leisure time for golf and other activities associated with retirement. . . . **T. Bailey Curran** has now been retired for two years and he likes

it immensely. He has five grandchildren all under four years of age who keep him and his wife active, young, and happy. Last summer they took a trip to Yugoslavia and Greece; and they are planning an auto trip to Richland, Wash., where he lived during 1944 while he was working on the Manhattan Project. Recently he was appointed a Fellow of the Bridgeport (England) Institute.

A newspaper clipping sent by the widow of **Harold Tallman,** gives the news of his death on Feb. 27, 1975. The note reads, "Harold died suddenly of cerebro-vascular embolus after suffering from rheumatic heart disease for several years. He was a great man with tremendous compassion for people and a vehement love of life, leaving an impact on a host of close friends and young people. He served in World War II in the U.S. Navy." Since 1952, he has been living in Whitinsville, Mass., working for Whitin Machine Works until 1966, when he became associated with the Worcester Redevelopment Authority as a business relocation specialist. He retired in 1974.

Heinn F. Tomfohrde, Jr.'s wife, Harriot, has sent the following note, "As Mr. Tomfohrde is away, I shall answer your request. He has recently retired from Getty Oil Co., where he was group Vice President in charge of manufacturing, marketing, transportation, and finance. He was also Director of Getty Oil Co. and Mitsubishi Seiku (Tokyo, Japan). He is a Chemical Engineer, B.S. '27, Tufts University and S.M., '29, M.I.T., specializing in fuel and gas engineering. We have one son, a chemical engineer, Cornell, '56, who is Vice President of Union Carbide Corp., in charge of chemicals and plastics."

Elizabeth M. Stefani writes: "No news is supposed to be good news, but in my case it means that I am not making any progress in doing the things that I want to do. My try to become an architect in 1929 was not the best of choices I could have made, so I went to Paris looking for prosperity. I tried painting for a while but I found out soon that bringing up and educating four boys was a greater task than I had imagined. Presently, I live in Provincetown, Mass., doing a little of this and a little of painting. It is nice to have one's birthday remembered which I appreciate. I am glad to say that I don't need a wheelchair yet to attend my Smith College 50th reunion in May." — **Karnig S. Dinjian,** Secretary, 6 Plaice Cove, Hampton, N.H. 03842

30

One consequence of the increasing number of retirements among our classmates is a corresponding increase in the amount of news available for the Class Notes. It appears that our retirees have more time to communicate or more urge to communicate or perhaps both. In any event, we have brief items this month from four members of the class from whom I have not previously heard. . . . **John Steele** retired from the Army in 1962 with the rank of Brigadier General. Thereafter he worked as Business Manager, Dickinson School of Law in Carlisle, Penn. He retired from the Law School in October, 1973. . . . **Bill Driscoll** retired from the Joseph T. Ryerson Co. in 1963. Subsequently he went to work for the Dept. of Public Works in the town of Framingham, from which job he will be retiring in August, 1975. . . . **Dave Stanley** has retired as a freelance writer on air transport economics. The Stanleys live in Evanston, Ill., and have two married daughters and ten grandchildren. Dave reports having recently seen **Morris Shaffer** who, as previously reported, is Dean of the N.J. State Medical School. . . . **Rudolph Israel** works for the California State Highway Dept. He was recently honored by the Engineering Council of Sacramento Valley for "outstanding service to the engineering profession" extending over more than 40 years.

Franklin Temple reports that he has retired but does not say when or from what. My records indicate that he worked for Foote Mineral Co. in Exton, Penn. He and his wife live in Devon, Penn. . . . After 27 years on the faculty at the University of California, Berkeley, **Walter Soroka** has become Professor Emeritus. During his years at Berkeley he pursued four successful careers. He originally joined the mechanical engineering faculty as a vibration specialist, became very active in the field of differential and analog computers, gave this up to begin a third career in acoustics, and three years ago became Chairman of Continuing Education in Engineering while continuing to teach acoustics half-time. Among the buildings that bear the mark of his expert acoustical design are Zellerbach Hall on the Berkeley campus, the Golden Gateway Redevelopment Project and the Bank of America building in San Francisco, the music complex at University of California in Davis, and the San Francisco B.A.R.T. stations. His pioneering work in jet aircraft noise abatement includes developing organ-type sound attenuators for the first 707 planes. He has served as a consultant on noise to the California State legislature and its advisory committees and is a Fellow of both the American Society of Mechanical Engineering and the Acoustical Society of America. According to the article from which the foregoing items were taken, his immediate plans include getting back to nature and particularly encouraging the California Golden Poppy to grow around his home.

As previously reported, **Reg Tarr** retired in 1971 from the Mystic Valley Gas Co. He has since kept busy as a member of the Wenham Housing Authority and also as assessor of the town. He lists sailing as his hobby and has a boat which he keeps at Eastern Point Yacht Club in Gloucester, Mass. . . . **Allan Stone** was a semi-retired consultant for many years and became fully retired about three years ago. He and his wife live in Elkhart Lake, Wisc., where his hobbies, in addition to the more conventional activities, include restoring antique cars. . . . **Jay (Cappy) Ricks** is owner of the Ricks Realty Co. in Thomasville, N.C. He has recently been traveling and doing some work in the Middle East. Since October, 1974 he has made three trips, the most recent of which was to Jeddah, Saudi Arabia, where he is "involved in hotels-motels and industrial plants." . . . **Joe Kania** is still taking annual trips with the Vancouver Board of Trade Mission. His most recent trip included Finland, Sweden, Norway and Denmark. He says that he now has about 26,000 color slides that he has taken on his various foreign trips over the past 21 years. . . . **Howard Robinson** has retired from the faculty of Adelphi College in Garden City, N.Y. In the winter he lives in Massachusetts and in the summer in Mt. Holly, Vt.

We have at hand a notice that **Herman Scott** died on April 13 after a long illness. As most of you know, Scotty was one of our most distinguished classmates whose manifold business and civic activities have been frequently reported in the notes. He was granted more than 100 patents and is perhaps best known as the founder and guiding genius for many years of H. H. Scott, Inc., a manufacturer of exceptionally fine high-fidelity sound equipment. Scotty's talents showed up while he was still at M.I.T. where he invented a sweep circuit that has been characterized as "one of the inventions that made TV possible." His company, which he founded in 1947, is credited with numerous important innovations including a broadcast-model dynamic noise suppressor for radio stations, the first successful commercial wide-band FM tuner in 1954, the first commercial stereo tuner in 1961 and the development of field effect transistor circuitry for both FM and AM tuner front ends to eliminate cross-modulation and drift.

In addition to making important technological contributions, Scotty sponsored a program for training mental patients and the physically handicapped in the assembly of electronic equipment. His company employed many of the trainees and in 1961 was the recipient of the nation's first Distinguished Service award from President Kennedy's Committee on Employment of the Physically Handicapped.

Scotty was a trustee of the Union Savings Bank of Boston, the Boston Ballet, the Deaconess Hospital and the Diabetes Foundation; a former Governor and President of the Audio Engineering Society; Fellow of the I.E.E.E., the Acoustical Society of America, and the Audio Engineering Society; and recipient of the Potts Medal of the A.E.S. He is survived by his wife Eleanor, two daughters, Priscilla who lives in New York and Jane who lives in Harvard, Mass., and two grandchildren. — **Gordon K. Lister,** Secretary, 530 Fifth Avenue, New York, N.Y. 10036

31

The only sad part of being Class Secretary is reporting the deaths of our fellow classmates. During the past month, a very thoughtful letter from Sumner Hayward, 1921 Class Secretary, told of **Arthur Partington**'s death on March 18. Sumner reports that Art had been in and out of the hospital for the past few years and that he last saw Art early in December. Art was Chairman of the Board of the Passaic Rubber Co. of Wayne, New Jersey. Word from the Alumni Records also reported the deaths of **John M. Gaines** in October, 1974; and **Harry C. Jepson** on October 8, 1970. Our deepest sympathy to their families.

This year, Sally and I attended the Mexican Fiesta and enjoyed every minute of it. One evening, **Alvino Manzanilla-Arce** invited the class of 1931 members present to dinner at his wonderful home. Those present included Alvino and his lovely wife, Irma; **Howard Richardson** and Evelyn; Alvino's brother, **Lorenzo Manzanilla-Arce,** his wife Emillia; **Antonio de la Torre** and Carmen, as well as yours truly and Sally. Needless to say, a grand time was had by all — and until that evening none of

us realized what a big game hunter Alvino is. Saturday evening, Luisa and "Nish" Cornish, '24, entertained all of us at their home for the famous "Noche Mexicana." Wonderful Mexican food, dancing girls and all sorts of entertainment . . . a most fitting ending for the Mexican Fiesta except for those who took the post-Fiesta tour of Guanajunto-Queret and San Miguel.

Ed Worden, who wrote the preceding notes, is off to Australia, Japan and Manila in April. Says he's been cutting down on these trips but I'm not sure. Your assembler of these notes in his absence, **John Swanton,** and wife Louise; after various trips since retirement in '73 (last year was Greece and Egypt), aren't going anywhere this year. We hope to see many of you at Alumni Day.

Retirements continue to be the order of the day. **C. J. Hamlin** reports that he has retired from North American Aviation. He has entered the real estate business, associated with Wm. Wilson and Co. in the Commercial Division, in California. . . . A similar note from **Tom Pureka** tells us he retired (in 1973) and is doing part-time real estate business with T-P Realty, Cotuit, Mass. . . . **Al Sims,** retired as of November 1, 1974, says he will probably sell his home here in Massachusetts this year and establish permanent residence in Florida. He writes, "My wife, Lillian, and I are in the meantime enjoying life and doing some traveling."

Congratulations and best wishes to our own Class President, **Howie Richardson,** as the new President of the Alumni Association. — **Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880; **Ben W. Steverman,** Assistant Secretary, 260 Morrison Dr., Pittsburg, Penn. 15216; **John R. Swanton,** Assistant Secretary, 27 George St., Newton, Mass. 02158

Top to bottom: Antonio de la Torre, '31, and Carmen in front of a Mexican pyramid; Evelyn and Howard Richardson, '31, at the Mexican Fiesta; Ed Worden, '31, and Sally during lunch in Cuernavaca, Mexico.

32

Donald K. Morgan reports in with the news that he retired on December 30, 1974, and like so many of us is doing design and consulting work to keep busy and out of trouble. . . . **Maurice D. Triouleyre** retired January 1 from management engineering work at the Wesson Memorial Hospital, Springfield, Mass., and planned to take a three months driving tour around the U.S.A. . . . **Frederick B. Hoyle** is planning to retire from the Federal Civil Service in June '75. After that, considerable time will be required to complete a summer vacation home in the mountains on the Mogollan Rim of Arizona (otherwise known as the Tonto Rim à la Zane Grey, according to Fred).

Word has been received from the Alumni Records Office of the passing of **Charles H. Marvin** on January 14, 1975 and **J. Cecil Rowe** on February 2, 1975. Our sincere and deepest sympathy is extended to their respective families. — **John W. Flatley,** Secretary, 6652 32nd Street N.W., Washington, D.C. 20015

33

What is so rare as a day in?? June, of course, and it sure is. We lead off today, (April 12) with a formal announcement: the 1933 non-official reunion at the 1976 Mexico City M.I.T. Fiesta. I am making this announcement on behalf of **William E. Baur,** the Chairman of such activities. This party is with the Mexico City Club, as their guests, and we have no intention of interfering with the plans of this great group of loyal alumni. We are merely adding our little bit mostly for our own pleasure. Bill Baur says we ought to have close to 50 of the faithful, plus wives et al. Our interim letter, in early September, will have the complete story, with instructions. We already have one firm commitment from **Maurice L. Brashears,** plus, of course, **Bill Baur,** probably Ye Scribe, and **Prentiss Lobdell,** the only '33er to attend this year. So, fellas and gals, start making your plans, and, as you do so, please write **William E. Baur,** 1100 Curlew Road, Dunedin, Fla., 33528, and tell him that you will make it. We need early entrants so that we can start the snowballing early, and make more than 50. And, remember, one slightly earlier class had something close to 30 classmates, just a year or so ago. You may write me, too, but Baur is the top man and he will keep me informed.

From **Jack Frost Andrews** we have a three-page typed letter, reporting on many items. Jack was Chairman of the Northern New Jersey Club, M.I.T. Seminar, "The Management of Technical Innovation," held Jan. 22, 1975, at the Sarnoff Research Center, R.C.A. Corp., Princeton, N.J. Jack suggests that there is a very definite lack of M.I.T. Club work in the Trenton, Brunswick, Princeton area, as they have no Club. Jack avers that the Northern New Jersey Club serves its area admirably, and the Delaware Valley Club takes care of the southern area, Philadelphia-Wilmington. Jack has long been active in the Princeton Christian Science Church, and has just completed a three-year term as Reader, which involves conducting two services every Sunday, plus a Wednesday evening meeting, and preparation for all three. He is still with the New Jersey Dept. of Transportation, now active in the environmental area, and is deriving a lot of real satisfaction, since there is a far more favorable public attitude. To conclude, Jack and Jermain are very active and enthusiastic citizens; extremely civic and family minded. I am pleased that I know them. Many thanks, Jack, for your long, fine, letter.

We have a very favorable report on **Emmy Norris,** through Christine. In general, Emmy's recovery from his earlier stroke is truly remarkable. He is at home, and busy at his prescribed therapy in exercise, and speech. I do believe that he is busier than he has been in some long time. Surely he has a real incentive. He enjoys reading, many house chores, constructive mechanical work, and he even attends Rotary every week. I submit that friends of Emmy might well drop him a line of encouragement. I can furnish his address. We all appreciate how helpful Christine is to our old friend. She really keeps me more informed than I can use. Our sincere thanks, Christine.

Now comes a brand new customer: **Maurice L. Brashears** (turned up by Bill Baur), now living in West Central Florida. Margaret and Maurice have five children; four living on Lon Guiland, and one in Rockville, Md. They must be rather well grown up, as there are nine grandchildren; golly, that's better than the class average. Won't every one of your fellas with more than nine grandchildren drop me a line with details? We can write a monthly sweepstakes on the progress of these second generation kids, and, the listing ought to change every month, as more and more appear. I fear, however, that I might become a candidate for the nut factory. To resume, Maurice worked for some years with the U.S. Geological Survey, then started his own firm of consultants, Leggette, Brashears, and Graham. Now that firm has started a Tampa office, and Maurice has moved to Tampa to run it. The firm's work has taken Maurice to many countries: South Africa, Australia, Surinam, Vietnam, and Ethiopia. The firm specializes in well water for large users, and, the reverse; anyone who has a flooded mine can get it dried up (sayeth not how). Many thanks, Maurice. We appreciate your fine letter.

We have two post cards from **Beau Whitton;** his son, Robert, is to return from his teaching job in New Brunswick, to help his father retire, which might well take another year. Now, some good news: Daphne has had her cataract operations, and has done well. I have the same job coming, maybe sooner. Beau says that a trip to England is in the offing. Thanks, Beau and Daphne. . . . Now for the Fund capsules: **Simeon Rosenthal** says that he has retired from the Boston Naval Shipyard, and has moved to Delray Beach, Fla. . . . **Bill Conant** spent the first part of his retirement in

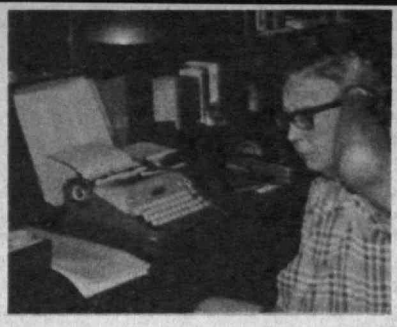
the Boston area, visiting his sisters, who have large families. He hoped to be in Miami in late February, or early March. I await developments. . . . **Leo Goodman** continues to be active as a consultant in nuclear and energy issues. His son, Maury, is working on his doctorate at the University of Illinois, Urbana; daughter, Lois, is a graduate of Radcliffe, University of Pennsylvania Law School, 1970, and now teaching law at Syracuse University; daughter, Joan, 1962 University of Michigan, 1965, Michigan Law School, now an attorney in the U.S. Department of Justice. Golly, there are plenty of folks smarter than I.

Gerard Kincade and Dorothy are planning a Mexico City trip on an assignment from the International Executive Service Corps (too early for the Fiesta). . . . **Jack Adelson** comes through with the family: son Robin is at the University of Chicago Graduate School, in Oriental Institute of Languages. Daughter, Sharon, is at the American University in Washington. Now, I must quote, "own A White Furniture Co., Inc., Boston." I quote because it is not clear if the name is white or if it is the color of the furniture. . . . From **Bill Huston**: "December 31, 1974 seemed like a good time to retire after 31 years in government service." He avers that it was a most satisfactory and rewarding career, especially the last 12 years, at the Goddard Space Flight Center. This was his activity in the conception, development, and launch and operation of seven major weather and earth resource satellites. He says that he and Dot intend to stay in Bowie, Md., and continue as a consultant in his chosen field(s). He got more than this on the card, which sets him up as a strong candidate as my successor. Comments are solicited, except from Bill. . . . **Dick Payzant** retired in July, 1974, and has moved into his newly-built home in Punta Gorda, Fla. Dick wishes to continue in engineering on a part-time basis. These capsules are most welcome, and are really appreciated, especially as they are a part of a much needed donation.

Our genial, and capable Class President, **Dayton H. Clewell,** was one of eight scientific men who participated in a December 16 State Department Seminar on energy self-sufficiency, in Washington. . . . From the American Institute of Aeronautics and Astronautics comes a notice of a top honor bestowed on **Ivan Getting.** He was elected a Fellow of the Institute, with this citation: "For the highest levels of leadership, judgment, and objectivity, he has consistently evidenced in support of aerospace programs and national issues." Ivan, your classmates, and, the Institute, are more than proud of you, and wish you the best.

From **Thomas C. George** comes, "Retired from Lockheed Engineering Flight Test Dept. in January, 1974. The last project worked on at Lockheed was the L1011 airplane. Since then I have been engaged in two or three small projects of my own."

We have no change of address this time. However, we have a far more alarming situation: those of us who have passed on. A phone call to Cambridge got a last minute notice into the May *Review* of **Charlie Bell's** passing. Charlie was a class officer for many years, and always a member of Reunion Committees when needed, and, withal, a dedicated alumnus, classmate, and generally a fine fellow, and a steadfast friend. Dang it all, I, for one, will miss him



Warren Henderson, '33, in a candid photo.

terribly, and, of course, so will we all. The alarming part is the fact that four other classmates have passed away: **L. Hart Cirker,** January, 1974; **August J. Kreuzkamp, Jr.,** June, 1970; **Kirtland Manley,** June, 1975; **Edgar W. Schulenberg,** February, 1975. To the survivors of these classmates we offer the sincere sympathy of our class. Although it appears to be a bit ghoulish, I wish to have you note that we have included in the above, the month and year of death, and this is done for more than one reason, but mostly to call your attention to the fact that one passing was not reported until five years afterward. Why not make such arrangements as are needed so that these affairs may be reported to the Institute as quickly as possible. We have a right to know, as surely almost every death has an effect on friends of the one most involved, and the Institute has a right to expect that the records be kept tidy. May I add another item: the form used by the Alumni Record Office has a space for the last year of Alumni Fund participation, and five notices of those who have passed on, showed that four of them had very recently made contributions to the Fund, showing that they were still loyal alumni, and still interested in the Institute.

That winds up the June story. Please note the address change of Ye Scribe to New Hampshire; saves forwarding. Leona and I send our best, and hope to see at least 50 '33ers at the March Mexico City Fiesta. — **Warren J. Henderson,** Fort Rock Farm, Drawer H, Exeter, N.H. 03833

34

I'm sorry that this month I have to report the loss of an unusually large number of classmates. A note from his widow tells that **Robert K. Kepner** died in January, after retiring, in April, 1974 from Warner Lambert. From the Alumni Office comes word that **Maynard A. Sayles** had died in February. Finally, on November 7 of last year, **Robert C. Moore** passed away from a massive heart attack. On behalf of all the class I offer condolences on these losses.

The Alumni Fund notes this time are all about retirements. The winner for brevity is **Stanley Bebler**: "Retiring as of April 1, 1975. . . . **W. Norris Parks** writes, "I retired June 30, 1974 from Newport News Shipbuilding and Drydock Co. after 40 years of continuous work. I do not plan to move from my present home."

George Bull and Mary Elizabeth have been traveling again — but this time not quite so extensively. But as always he faithfully sends along some news. George writes: "This winter our travels did not take us to distant scenes. We stayed in North America. We had a short stay in Atlanta with friends. Then we went to Disney World, but our main objective was to go to Texas and visit **Arthur Manson** and his wife Maureen.

"Mary Elizabeth and I spent a few days in Houston, sightseeing on our own and with Art. He owns and operates, among other interests, a small but thriving business making a specialized line of tough non-foamed plastics. We then drove to his home in Gonzales, Texas, where Maureen is an important official of the Texas State Welfare system. She specializes in cases involving child abuse and child care.

"Art's three sons all graduated from the University of Texas. The oldest, Arthur, is in business with his father. The second, George, is a floatation engineer for a boatbuilding concern and lives in Austin. The youngest, Richard, is in business for himself running a building maintenance service. Art and Maureen have two grandchildren.

"One evening in Gonzales, **William S. Matthews** came over to dinner with his wife Eleanor. He is retired from the Air Force, lives in San Antonio, and has two children.

"As planned, Art and I and our wives proceeded to the M.I.T. Club of Mexico City's 27th Annual Spring Fiesta. As it was my first time it was quite a memorable affair. There was an opening luncheon, tours of old churches, a trip to the great drainage tunnel being built, and a final Saturday night party at the home of Clarence Cornish, '24, who has been one of the spark plugs of these affairs for many years. I'm sure the *Review* will comment on the well-known guests who attended; Art and I were the only ones from '34. We stayed over a day, and then back to Gonzales where Mary Eliz and I started our homeward trek. On the way we visited the Truman Library in Independence, Mo. I can't say much for the general area, but it is in good taste and documents his life interestingly, with special emphasis on the White House years."

I always appreciate the regularity with which George writes about his travels. As a token of this appreciation, he will have the privilege of doing the notes for next issue. This great reward comes because a week from when this is written, June and I are off for six weeks in France and England. — **Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

35

At this time I am going to include some of the letters I have received as a result of the 70-odd letters I sent out as reunion reminders. But I will start with those who cannot attend. Here's the first one, from **Bob Forster** in Stockholm: "Thanks for your letter. Had one from **Ned Collins** enclosing copies of the letters that were being sent out. It appears to be a good effort and a good program. Sure hope you have good weather for the George's Island trip. Hope your spread-the-wealth program of 70 Class Reps and a committee of 25 pays off. Roughly two more months and it will be history — then you can relax. Say hello to everyone. Days are much longer — 12 hours plus. In June it will be 19-20 hours. Spring is not here yet. Winter was mild and no snow. But nights are below freezing — only a few degrees — and the

sun does not have a great deal of heat at 60°F. Have been to Finland twice, Oslo once, Brussells for a week, and am going to a meeting in Klosters, Switzerland, for a week. I will try but promise nothing. Have not joined a club yet. Also, we may want to travel. You can play golf until 10:30 at night in June and July."

W. Whitney Stueck wrote from Old Saybrook: "Thanks for your letter about rowing at Reunion. I think I could still pull an oar, but would probably jump my slide on the first stroke and catch a crab on the second. It seems doubtful that I will attend the reunion. I am doing a lot of traveling, flying myself all over the country and trying to pick up a few orders, which is not easy right now. My wife has very bad arthritis and couldn't possibly make it. When I'm not traveling or working, I try to keep up with the maintenance on a huge old house built in 1780 which we inherited from my mother. This takes most of my weekends and evenings. We have a small branch operation in Utah managed by my son. I manage to get in a little skiing when I am out there, and have enjoyed some good summer back-packing in the Uinta Mountains. I often think of our crew expedition to the White Mountains, which was the birth of my interest in mountaineering. I haven't had time to do anything spectacular, but enjoyed rock climbing and winter camping for many years and still do a little. While most of our class seems to be thinking of retirement, I seem to get busier each year. Even the skiing has been curtailed the last few years, and sailing seems to be completely out. I'm thankful that my health is reasonably good except for a few aches and pains now and then. I'm sure I can't make the whole reunion program, but if I can get to any of it, I'll be sure to join you at the boathouse Sunday noon."

James Libby wrote from Hockessin, Del.: "This will have to take the place of my being there at our 40th, I guess. I had planned to make it, even to the extent of talking it up in my Christmas notes to **Thonet Dauphine, Roy Whitney, Henry Kimball** and **Jim Parker.** But since then a conflict has come up that we can't ignore. I don't have any family ties in Swampscott now, but my number two daughter and her husband have bought a house in Cambridge, so we get even closer to M.I.T. when we visit them. As you know, the campus has changed and expanded since the early 30s, but it seems to me that the atmosphere is the same. It would be fun to be there with the group we were associated with 40 years ago. Since Henry and Ellie are now living in Manchester, I am sure that they will be able to make it. Thonet tells me that he has been put on one of the committees, so he and Nathalie will be sure to be there. Although I have not heard from him directly, I understand that **Randy Antonsen** is in Boston with Cabot. I guess the only other classmate I hear from, besides yourself in the class notes, is **Leo Beckwith,** who drops me a note about every year. It was a pleasure this year to have the alumni fund contributions applicable to the sailing fleet. In my graduate days sailing was one of the more enjoyable of the extra-curriculum activities. In addition to Ann, my older daughter, Mary, is also married and living in Berwyn, Penn. She has two children — a girl and a boy. Helen has an opportunity to see them about once a week, I somewhat less. Our youngest, at 26, is David, who works in the computer center at the University of Iowa, Iowa City. We took a week off last fall to visit him and to see that part of the country for the first time. You deserve a lot of credit for keeping the class notes going with relatively little assistance by way of contributions. But the notes are always the first thing I turn to in *Technology Review*. I know the reunion will be a great success; we'll be thinking of you." Many thanks for your very nice letter, Jim, we'll miss not seeing you. I'm delighted that you read the notes. As of this writing in late April registrations are past the 65 mark and coming daily. Hope you didn't miss it. — **Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

The first item this month is of the untimely death on April 11 of **William W. Garth, Jr.,** at his home in Concord, Mass. Details are based on a brief notice in the *Boston Herald Traveller*.

Bill was a pioneer in the application of modern technology to the graphic arts industry. He was a founder of Photon, Inc., which produced one of the first high-speed phototypesetting machines; more recently he has been founder and (at the time of his death) President of Compugraphic, Inc., whose offices and plant are in Wilmington, Mass.

Bill was a member of the Corporation of Northeastern University, of the M.I.T. Alumni Advisory Council, and of the St. Botolph Club (Boston), the University Club (New York), and the Concord Country Club. He has recently been a member of the Concord Finance Committee and a Trustee of the Home Savings Bank (Boston).

Bill is survived by his wife Sarah (Sally), a daughter (Mrs. Susan G. Comstock of Andover, Mass.), two sons (William W. IV and Granville C.), and two grandchildren. Memorial services on April 15 were at the Trinity Church Episcopal in Concord.

Contributions to the Alumni Fund have also brought news to your hungry secretary. **Ruth (Humphrey) Perkins** writes that in addition to having been promoted to Assistant Professor she has edited two books published by Simon and Schuster. She doesn't give any details but since she has turned from Architectural Engineering to Math, I assume the books are in the latter field. . . . **Harold Nutt** reports that he retired after 36 years with the Naval Ship Research and Development Center a year and a half ago. He was then Technical Director of the Annapolis Laboratory. Shortly thereafter he became a Research Professor of Engineering at George Washington University specializing in gas turbines. . . . Another retiree, **Bill Orrison,** retired from the Air Force Civil Service a year or so ago and the next day started work with Wolco Corp. designing and supervising construction of a new 32-acre manufacturing plant. Bill and his wife, Mary Elizabeth, have two daughters and a son who just completed a residency at the Mayo Clinic. He hopes to attend our 40th. . . . **Larry Kanters** writes: "Happy to report I have fully recovered from a heart attack in June, 1973, but staying with the regular exercise routine — a half mile swim almost every day — as it keeps me in shape for the long ski season here in the West. In between I still work at 'Gamble-Skogmo' our of Minneapolis."

The preparation of the new Alumni Directory has belatedly brought the sad news of the death of **Frederick W. Locke, Jr.** in February, 1973; that of my predecessor as Class Secretary, **Jim Leary,** in May, 1974; and of **Jackson H. Cook** in September, 1974.

As you can see, your Secretary did make it up from the bottom of the Grand Canyon. As a matter of fact I found walking down much more difficult than hiking back up. It wasn't too hot on the first of April! — **Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, Conn. 06091

37

At the end of 1973 after 31 years of federal service, **Alvin J. Garber** retired from the Federal Power Commission and is now doing some consulting. . . . **Josiah Heal** just celebrated his 60th birthday and "feels kind of ancient." He says business is good and they are constructing a 50,000 sq. ft. plant. This spring he plans a flight to Europe including a trip down the Rhine by boat, a bus trip around Switzerland, and then a short side trip to Munich. . . . **John Nugent** recently retired from the Charles S. Draper Laboratories (formerly Instrument Laboratories at M.I.T.). John has been with the Laboratories since 1948. . . . **Edward V. Corea** reports his job for the Navy at General Dynamics Quincy Shipyard comes to an end with the settlement of the Navy contracts; rather than move to a different job out of state, he plans to retire after 32 years with the Navy. . . . In April your Assistant Secretary had the pleasure of visiting **Albert Shulman** and his lovely wife, Rachel, in Hartford, Conn. He is still playing tennis and is busy managing his real estate and gentleman's farm in Vermont. They both looked great.

Joseph Robert Fischel passed away on Wednesday, February 26, in Miami, Fla., at the age of 59. He is survived by his wife, Georgietta. His family requested that memorials be given to the M.I.T. Alumni Fund Class of 1937. We all send our deepest sympathy to Georgietta and their family. — **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester M. Klashman,** Assistant Secretary, 198 Maple St., Malden, Mass. 02148

38

One of my delights is to find out the class of 1938 is really not as old as the statistics indicate. I have a note from **Harvard K. Hecker** who writes that he "recently climbed Kilamanjaro, the highest point in Africa, reaching the top — 19,340 ft. — on February 26, 1974. It takes 3½ days up and two days to return. Top is not snow but glacial ice; top is superbly beautiful."

John A. Petroskas writes that he "is still optimistically working in the steel industry, making a product cheaper than pedigreed dried pasturized cow manure. Further, steel does not have to be fertilized." . . . By the time this reaches you Alumni Day will either just be in the offing or will have already taken place. Were you aware that **Ed Hadley,** as a member of the Alumni Day Committee, had an important role in the planning for this occasion? . . . I got a note from **Jock McGillivray.** I am not sure whether this is a

sales pitch or a corporate directory, but this is what he is doing: District Manager, Pittsburgh Testing Lab, Tampa; President, McGillivray Lamp Co.; Bay City Equip. Co; New Safety Harbor Inc. . . . **Dick Henderson** reports: "During 1974 business travel took me to England, Germany and Holland. I do not anticipate any slackening in the work load in toxicology and environmental hygiene for years to come." . . . Another young fellow in the class is **Charles Curtze** who writes: "After retiring as Deputy Chief of the Navy's Bureau of Ships in 1965, I went to the drafting board to finish the contract plans and specs for a 43 ft. aluminum auxiliary cruising ketch, moved to Germany as Project Manager during construction, and am owner-skipper when commissioned. I sailed the Atlantic and am awaiting spring thaws to continue the journey."

The end of class notes are always the hardest part to write. I received word that Mark Wilson, age 24, son **Al Wilson,** died recently of cystic fibrosis. This is the second event like this that has happened to Al and Carol. Our deepest sympathy goes to both of them. However, what most of you do not know is that Al has spent a great deal of his spare time on behalf of the Cystic Fibrosis Foundation.

A recent communication from Lillian **Hier** states that her husband **Lloyd** died last year. He had been with the Rutland Savings Bank for many years, serving as Secretary and Treasurer. — **A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

39

Hilda and I spent a pleasant evening during January with Billie and **George Cremer.** George was just about to chair the annual spring seminar for "Advanced Joining Technology." He has some stimulating adventures to tell about, including contributions to the X-15 and solving the problems connected with heating vehicles on re-entry to the earth's atmosphere. George showed me some metallic micro-balls which may play a part in harnessing the energy created during hydrogen fusion, and channeling the energy so it can be useful and constructive for humans.

At Aptos, California we visited briefly with Maisie and Bob Fife, '40. Bob practices general law in the area and it was fun to see two (of their five) children — now all grown.

I visited briefly by phone with **Phil Bush,** who has been Vice President of Kaiser Engineers for many years. His long-time assignment has been to head up the nuclear energy design and construction division, but now his responsibilities have been increased to include ecology and related projects.

Sir **William Hawthorne,** a former member of the M.I.T. Corporation, a visiting professor of engineering at M.I.T., and professor of engineering at Cambridge University, England, has been elected to become honorary fellow of the American Institute of Aeronautics and Astronautics. — **Hal Seykota,** Secretary, 14650 Island Dr., Jacksonville Beach, Fla. 32250

40

We are indebted to Drew University for an article on **Joseph Bransford.** Some excerpts: "Bransford is atypical of the University's students. . . . For one thing, he is a grandfather, nine times over. Hearty, cigar-smoking, decisive, he also conveys the classic image of an American corporate executive — which is hardly strange, since prior to his retirement two years ago he was senior Vice President for Administration and a Director of Western Electric Corp. . . . R. G. Smith of Madison, his advisor, saluted his efforts in a difficult casebook course on Constitutional law last semester with an 'A'. Smith, who at 61 is several years younger than his student, thinks the former Bell System exec 'fits into our classes here beautifully.' [Students] like him because he does not try to be one of them but remains himself. On the other hand he has made efforts to fit in. 'I don't try to be the former executive around here,' he said, 'just another student trying to learn something. Trouble is, every time I wear my black pullover, the people in the bookstore take me for someone from the theology division.'

"As an Air Force intelligence officer in Germany after World War II and throughout his 40-year career with Western Electric, Bransford remained a fascinated observer of public affairs at every level. Retirement hasn't changed that. He's an enthusiastic member of Summit's 'Old Guard,' a group of retired professional people who meet weekly to hear speakers of note and discuss current events. He is presently chairing a fund drive for the Summit chapter of the American Red Cross. Though he has no timetable for completing his M.A. in urban studies he's been toying with the thought of continuing on for a doctorate. 'I've always been curious about areas I was not directly involved in,' he points out. 'Besides, I thought I'd like to see whether at my age I can keep up intellectually with these young kids'. Don't worry, Ma Bell. He can."

Dick Orth writes: "As a volunteer for the International Executive Service Corps I completed an assignment in Lima, Peru last year for a company rebuilding TV picture tubes. Now I am scheduled to go to Quito, Ecuador for another assignment." . . . From **Larry Jones** comes the advisory: "A period of jury duty gave rise to several poems and a few forecasts; nevertheless my daughter has decided to seek degrees and a career at law. I've explored some aspects of 'the Law' (i.e., language associated with 'mathematical feedbacks') towards finding information balance points, using biological models to guide me." . . . From **H. Tyler Marcy** comes: "Appointed by the President to post of Assistant Secretary Navy (research and development). Began duties in Washington in October, 1974. Had been self-employed '72 to '74 and had been with I.B.M. 21 years before that." . . . **Fred W. Hammesfahr** has been elected President of Hydrocarbon Research Inc., a Dynalectron subsidiary. Previously Fred was Executive Vice President of PVO International.

This leads me to include one of my own poems, a triolet composed at M.I.T. and never before published: "f = ma, that's all you learn at Tech. There you have no time to play, f = ma. You always have to say to get the right effect f = ma. That's *all* you learn at Tech." I hope you will pardon my reminiscing as I complete 25 years as Class Secretary. They have been enjoyable years on the whole with many high points and some low ones. This year I had the pleasure of taking off from work one hour every two weeks to teach fourth graders poetry. The poems have been of my own choosing, mostly 19th century and early 20th century poets. In 25 years I believe the '40 column was missing from the *Technology Review* just once — and that was because I submitted the copy too late. Whether the column has been thick or thin, interesting or dull has been more on your doing than mine, since the column has been basically what you have written or on occasion not written. The two people I learned the most from at Tech, Prof. F. Alexander Magoun, '18, and Track and Cross Country Coach Oscar Hedlund, both died during the 25 year span. While I was younger I was left of center. My views have not changed but I no longer can be classified as left of center. However, I have learned that many things are gray rather than black or white. Still racism is evil whether it be white or black. To my successor, good luck and remember our class slogan "Life Begins with '40" — **Alvin Guttag,** Cushman, Darby & Cushman, 1801 K St., N.W., Washington, D.C. 20006

41

We are pleased to learn that **David Saxon** was named 14th President of the University of California. David earned both his B.S. and Ph.D. at Tech and joined the staff of the M.I.T. Radiation Lab in 1944. He spent the 1956-57 academic year at the Neils Bohr Institute of Theoretical Physics in Copenhagen on a Guggenheim Award, and in 1960-61 received both a Fulbright Award and a Guggenheim Foundation Grant and spent that year at the University of Paris. He is married to the former Shirley Goodman of Portsmouth, N.H. They have six daughters. . . . **Cal MacCracken** writes that his 75th patent has been licensed to I.T.T. to form their new division, I.T.T. Ice Rinks. The new roll-out Icemat system brings refrigerated rinks within the price of everyone. He is now working on roll-out solar collectors. . . . **George Palmer, Jr.** is located in Cleveland as Principal Surveyor for the Great Lakes in charge of shipbuilding and repair for the American Bureau of Shipping. . . . Best wishes to **Alan Surosky** who informs me he has remarried and is moving to Clearwater, Fla. . . . **Knut Johnsen,** with P.P.G. in Lake Charles, La., says he is Energy Conservation Coordinator for P.P.G.'s Industrial Chemical Division at Lake Charles, La. He and his wife Gertrude are the proud grandparents of five grandchildren. He gets back to his native Norway and to Gertrude's home in Boston on their vacations.

The bad news is that we have to report the passing of **Alan W. Baum,** 2425 Sage Road, Houston, Texas 77027, and **Julius Friedman,** 171 Riverside Dr., Winnetka, Ill. 60093. Our sympathy to their families. — **Henry Avery,** U.S.S. Chemicals, 2863-600 Grant St., Pittsburgh, Penn. 15230

42

Bill Yocom has been with Bell Labs for the last ten years working on Microwave tubes, optical relay lines, thin film technology and submarine cable systems. . . . **Eric Wormser** has started his own consulting engineering firm, Wormser Scientific Corp. in Stamford, Conn. Eric has had 25 years experi-

ence in corporate management and is planning to be active in the application of solar energy to the heating and cooling of buildings and other structures. . . . **Don Stein** had made what he describes as his "last (?) job change." He had joined the Military Sea-lift Command (D.O.D.) as Director of the Ship Concept Development Division. Don writes that "as fast as I learn the everyday acronyms and abbreviations, new ones are promulgated, but I shall overcome." . . . **Albert S. Knight, Jr.** has joined our growing group of retirees. He will have no trouble keeping busy with his interests in studying astronomy, traveling and playing the organ. We congratulate him and wish him well.

With the June issue we usually go into a summer slump on news. The news has been so sparse in the past few months that I don't see how it can slump. Let's hear from you all and best wishes for a pleasant and healthy summer. — **L. K. Rosett,** Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

45

It is with great remorse and personal sorrow that we report the death of **Chick Street** on Friday, March 21 after a severe bout of cancer. To those of you who knew Chick as an undergraduate, one need not add that Chick, **Jerry Patterson** and I were inseparable as we struggled through Course XIII. Jerry and I will both vouch that Chick carried more than his share of our collective work load! Following graduation, Chick spent two years at David W. Taylor Model Basin, then 12 years with the Factory Mutuals; in fact, it was Chick that got me involved in the same organization in early 1949.

For the past 13 years Chick has been actively involved in yacht design, and small boat construction; first with Anchorage (the dinghy), then Pearson Yachts, and finally on his own. You will recall that I reported in a recent issue that Chick had just had built, in East Boothbay by Paul Luke, an aluminum hull racer which, unfortunately, will never have its designer at its helm. Chick is survived by Helen Marie (née Lawrence), his bride of 26 years, plus two daughters, Ann and Sarah, both in their early twenties. I am certain that Helen Marie would appreciate hearing from any of you that might be so inclined — 125 Governors Dr., East Greenwich, R.I. 02818.

The following note has just been received from **Marshall Byer**: "Since seeing you at our 25th Reunion a few things have happened. My wife, Helen, died of cancer in 1972. In 1973 my first wife, Dorothy, and I were remarried. We are still living in Vestol, N.Y. I'm still holding down the job of Manager of Packaging Assurance, I.B.M., Endicott, N.Y.

"One of our twin daughters, Deborah, is working in Binghamton, N.Y. Her twin sister, Judith, is married and living outside Toronto. She just made us grandparents: a baby girl. Our youngest daughter, Linda, is with the Class of 1977, Cornell University, School of Veterinary Medicine. Not an engineer in the bunch. — I don't think we can make it in June but we'll be thinking of you."

Walter E. Borden was recently named Manager of Planning and Analysis in the Fabrics Division of Exxon Chemical, U.S.A. This change means that Walter and family will be moving to Atlanta, Ga., later this month.

A recent lead article in the *New York Times* concerned itself with the acoustical corrections that are to be made in the Avery Fisher Hall in Lincoln Center, New York City under the direction and supervision of **Cyril M. Harris.** . . . Recently **Dick Battin,** Associate head of the N.A.S.A. Army Programs Department at the Draper Laboratory was appointed Special Advisor to the Aeronautical Systems Division, Advisory Group (DAG) of the Air Force.

The whys and wherefores of our successful 30th Reunion will be covered in an early Fall issue — have a pleasant summer. — **Clinton H. Springer,** Secretary, Box 288, Cranfield Rd., New Castle, N.H. 03854

46

Joseph U. Kauffman, Jr., '44, writes that he operates a service shop for G.E. and Westinghouse motors in the Baltimore area. A branch distribution outlet connected with his concern handles G.E. and Westinghouse motors and controls for the Delmarva eastern shore area of Salisbury, Md. . . . **Robert F. Lathlaen** is President of W. J. Barney Corp., general building contractors, who do various commercial, industrial and major institutional construction, specializing in health facilities construction. Last year Bob was appointed Chairman of the Special Contracting Methods Committee of the Associated General Contractors of America. . . . A nice note arrived from Iceland advising that **S. Halldorsson** and his family were so pleased with the 25th Reunion in 1971 that they are already planning to attend in 1976.

We regret to report that **David J. Tobin** of Hinsdale, Ill., died on May 8, 1974, and **George A. Philbrick** of Cotuit, Mass., died on Dec. 1, 1974. Until next time — **Russell K. Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126.

47

Gina, the children, and I just returned from two weeks of golf and tennis in South Carolina. The weather was rather windy and cool which at least is my excuse for rather poor results. The year, however, has just started so by the time you read this there should be great improvement by all. . . . **Walt Kern** writes that daughter, Jill, is still iving in the French-German group at M.I.T. . . . **Abbot Fletcher** has a daughter at Maine, son at Yale, and younger daughter at Bath, Maine Junior High. The family sloop, *Majek,* won the Gulf of Maine Ocean Racing Circuit in 1974. Congratulations to you Abbot. . . . **Bob Creek** has been elected to his sixth term as school board President and was successful in selling his voters on a $22 million bond issue which is really good selling these days. He now has one out of college with three to go. Drop a line. — **Dick O'Donnell,** Secretary, 28516 Lincoln, Bay Village, Ohio 44140

48

I write these class notes while waiting for a flight: my apologies for missing two recent columns. The national economic recession has forced all of us to increase our efforts to

Ben C. Ball, Jr., '48

keep our businesses operating as effectively as possible.

Between 1968 and 1973 one of our divisions quadrupled in business volume to $15.2 million. Since 1973 I have been spearheading a corporate program to install manufacturing, inventory control, and engineering procedures required by a company of this size. In February, 1975, this division along with six other Bendix divisions were consolidated into a new company — Facet Enterprises, Inc. Bendix has signed a consent decree with F.T.C. promising to sell Facet prior to November, 1976. Since three of Facet's divisions are former FRAM divisions that I worked with, I have left FRAM and joined Facet which is headquartered in Tulsa. Gloria plans to start looking for a house in Tulsa sometime next fall after our youngest child begins college.

Between manufacturing and personnel changes, and working 700 miles away from home for weeks at a time, I have slipped on writing the class notes and answering letters from classmates. I still have not arranged to send the yearbook from our 25th reunion to the many people who sent in their biographies, but did not attend the reunion. At this time I don't even see the light at the end of the tunnel, although I can measure a tremendous amount of accomplishment and the resources are available to keep going at the same pace.

Gloria and I are proud of Amy's winning a National Merit Scholarship and her acceptance at Yale and Radcliffe. Next Fall Amy will join Larry and Cliff in college.

Dick Howe who is now class of '51 added his name to the roster of our Freshman Section. Dick says he was the skinny redhead. Now his hair isn't very red and he is at least as husky as he remembers me in 1945 (192 pounds). Dick lives in Camp Hill, Penn., and his lab is part of the Pennsylvania Department of Transportation. Dick's piece of the action includes looking after about 25 people and seeing that many thousands of samples of cement, gravel, stone, etc., get tested each year. Most of Dick's time is taken up with classifying the 256 producers of aggregate used in asphalt pavements for their pavement polishing potential. Limestone is quarried in Pennsylvania and many of the black-top roads have crushed limestone in the asphalt (Dick calls this bituminus concrete). The higher the traffic count the faster the stone is exposed and polished, the sooner the pavement becomes slippery when wet. (Gravel and granites which are available and used in New England don't polish.) So, Dick has become very popular because most of the quarries produce limestone which can be used only in pavements that will have less than 1000 vehicles per day.

Dick, I don't know how far it is from your home in Camp Hill to Pittsburgh, and I suggest avoiding the roads with polished limestone, but you may want to make the trip and congratulate our classmate, **Ben Ball.**

Ben has been elected a vice-president and officer of the Gulf Oil Corporation. Ben has been Director of Corporate Planning Analysis and Coordination in Pittsburgh since 1973, and will head the new Planning Research Department responsible for corporate-wide planning research and for the development of planning methods.

Ben joined Gulf in 1949 at its Port Arthur refinery. He transferred to Gulf's U.S. Refining Headquarters in Houston in 1959 as an operations analyst and in 1965 was named Director of Cost and Economics. In 1970, Ben was appointed Director of U.S. Planning for the Gulf Oil Company.

Reginald Stoops has moved to Gainesville, Florida to become president of a small company that manufactures large fiberglass sandwich panels for structural applications. Business is good and Reginald is currently preparing for a trans-Atlantic passage on an 86-ft. schooner. The appeal for the sailing fund at M.I.T. hit him at the right time. . . . **Bruce Morrell** retired after 23 years in the Air Force, but with 32 years of creditable time counting reserve and army time. Bruce's last assignment was Colonel in charge of Development and Acquisition of the engines for the Air Force's very successful F-15 Fighter. Bruce is now director of development of a large plot of land near Colorado Springs. The land is planned for industrial and commercial development. — **S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

49

In Rio de Janeiro, fall is upon us: the sun is rapidly tilting to the north, and several recent days have been cool and less humid. A plume of white smoke is calling attention to the figure of Christ on Corcovado as I write these words — otherwise, it's a beautiful cloudless day.

There is practically no activity this month — only four news notes. The first two are from Technology Fund envelopes, currently the favored form of communication for our class. **Maurice E. Shank** reports that he and his wife Virginia are M.I.T. coxswains, who met at the sailing pavilion and became engaged while sailing an M.I.T. dinghy. . . . **Leon Kraft**'s daughter, Teves, is practicing in Bedford, N.H., after graduation from the Penn School of Veterinary Medicine. His son, Gordon, is finishing up a Ph.D. in electrical engineering at the University of Connecticut.

George N. Hatsopoulos has been named a Fellow of the I.E.E.E. "for contributions to classical thermodynamic theory, and for research and development on the thermionic conversion of heat to electrical energy."

A news bulletin from the Insurance Institute for Highway Safety reports that its president, **William Haddon, Jr.,** appeared as a witness to oppose the D.O.T. proposals to downgrade the present and proposed bumper standards — evidently the automotive repair shops were losing too much business, or some such. . . . That's all for now. Best wishes to all. — **Frank T. Hulswit,** Secretary, c/o A.D.L., Acorn Park, Cambridge, Mass. 02140

50

Jack Bedell tells us that he is currently project manager in the commercial development and fabrication of glossy metal alloys at the Allied Materials Research Center. . . . **Jim Staikos** has been a resident in Athens for several years and works as Managing Director, Arthur D. Little in Hellas. But with the phase-down of operations in Greece, he has been increasingly involved in A.D.L. activities in the United Kingdom and elsewhere in Europe and the Middle East. He also acted for the educational council in Athens. . . . **Edward J. Young** reports that his daughter, Ann, was ranked #1 in Colorado for girls 16 and under in tennis, and #2 in intermountain competition. . . . **Donald A. Harnsberger,** as of January 1, 1975, has relinquished responsibilities as Managing Director of Cooper-Vulkan Kompressoren G.M.B.H. to devote full time to Cooper Industries activities in the U.S.S.R. as U.S.S.R. Operations Manager — however, he will continue to reside with his family in Dusseldorf for the time being, working as a "commuter" to Moscow.

Effective February 1, **Kenneth E. McVicar** and **Herbert D. Bennington** have been named to new positions at the Mitre Corp. Ken, who has been appointed Vice President and General Manager of Bedford operations, will be responsible for the management of the four technical divisions and support personnel making up Bedford operations. Herb, who was appointed Vice President and General Manager of Washington operations, will be responsible for the management of the four technical divisions and support personnel making up Washington operations. — **John T. McKenna, Jr.,** Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

53

Dear Fellow Class of '53ers: At least some of you deadbeats are beginning to come to life and drop poor ole Marty bits and pieces of news. Remember, I'll (and I hope *Technology Review*) print anything — it's the *new* generation and times, you know. (Ask your kids if you don't.) . . . Ole **Jay Berlove** sprang from the dead (didn't he always?) and wrote the following: "Just a short note of encouragement to the best Class Secretary that the Class of 1953 ever had. I am alive and well in Rochester (along with a wife and two sons), and as can be assumed from this letterhead involved in Electric Equipment Co. [Ed. I don't know, but I assume that Jay means he is in charge of poker, bridge, billiard and other games of "chance."] If I get to Pittsburgh (which may occur in the next year), I will give you a call." By the way, I should point out that this prominent and rich wiseass addressed the letter as follows: Martinius Wohl, Esq.; 7520 MissCarriage Lane; Pittsburgh, Pa. 15221 — and it still got to me. . . . A notice arrived which announced that **Tom Faulhaber** is now President of R. E. Case and Co. of Boston, Inc. (What do you folks do, Tom?) . . . **Bud Edelman** wrote that his "son started M.I.T. this year. THAT is when the passage of time really hits you between the eyes! I got involved in the Education Council, which is very interesting." [Ed. Frankly, *I* think the passage of time *really* hits you when you are dating a girl and suddenly realize that she wasn't even *born* when you entered M.I.T.! Oh, well. Lock up your daughters, dear friends.] . . . A squib appeared in *MATRIX* (bimonthly publication of the MITRE Corp., at Bedford) on **Wolf Haberman.** According to Wolf, his project (which is part of the Air Force's overall program for external physical security) "is at the forefront of this technology. We are now procuring for the Electronic Systems Division advanced development models for systems that will be tested right here at MITRE this year — systems that are truly state-of-the-art." . . . The March issue of *The New Yorker* spread news about a classmate, **Henry Kloss** (the K of KLH), on a page and a half (plus or minus, to you quibblers). In a sense, the first sentence sums up their feelings about Henry in saying, "Up in Cambridge, Mass., Henry Kloss is doing for television what his Brattle Street neighbor Edwin H. Land has done for photography." The article is too long to properly cover here (though makes for good reading), but deals for the most part with his new invention, the VideoBeam 1000-A, a two-part color television set consisting of a projection unit and a screen which is *only* 4¼ ft. high and 5⅔ ft. wide. Apparently Henry's factory (which I presume is Advent, which he founded and is now President of) produces a hundred of these jazzy $2700 sets a week, and he personally feels his invention happens to be the first hi-fi TV set. To quote him, "My machine is expensive, but it's designed for home use, even though it's helping bars a lot at the moment. Let's see what the next twenty years bring."

Oh, yes, **M. Wohl**'s fourth book, *Para-Transit: Neglected Options for Urban Mobility* of which R. F. Kirby is the senior author, is now "hot off the press." But don't bother buying it (since I don't get any royalties from it); rather, write for the next one (say, in six to twelve months) which will be a fairly non-technical book attempting to put urban transportation into perspective; and, hopefully, a *big* seller. (My shrink, girls, house, favorite restaurants, wine cellar and poker friends need or will enjoy the money.) Well, so much for my tooting my own horn. . . . A note from the M.I.T. bigwigs notes that **Kent Hansen** had a change of appointment to Professor and Acting Head of the Department of Nuclear Engineering at M.I.T. for four months beginning February 1, 1975. . . . The latest word on **Pete (Fortney) Stark** — our own M.I.T. Congressman and owner of a bank before entering Congress — is that he was just appointed to the House Ways and Means Committee with special responsibility for banking and financing reform. . . . **Ed Kingsbury,** a Draper Staff member, recently was honored by N.A.S.A. for his service on one of its Blue Ribbon Committees at the George C. Marshall Space Flight Center in Alabama. Ed, along with Herbert Singer, received Group Achievement Awards for participation on the Attitude Control Anomaly Team. Their main objective was to examine problems in Skylab's faulty large Control Moment Gyros, which are responsible for the control of spacecraft attitude. . . . Well, that's all for this month. Drop me a line. — **Martin Wohl,** Secretary, 7520 Carriage Lane, Pittsburgh, Penn. 15221

54

Wally Boquist reports between trips to

Kwajalien and Hawaii that the class directory will be published and distributed in early summer. Late changes (including phone numbers) should be sent directly to him at Technology International Corp., P.O. Box 309, Bedford, Mass. 01730, and would be most appreciated. Wally's hectic traveling schedule includes a summer study in La Jolla, Calif., and Alaska in August. . . . **Stan Kolodkin** is now President of Xenergy Inc., a new Massachusetts-based firm that provides professional energy reduction services to industrial, commercial, public and residential facilities. . . . **Ron McKay** has been regional manager of consulting services at Bolt Beranek and Newman's Los Angeles office for the last five years. His group provides services in architectural acoustics, industrial noise control, and community transportation noise planning. Ron and Sally have two sons, Ken, a high school junior, and Andy, who is finishing junior high. . . . **George Dormer** is assisting companies and financial institutions with problem loans, workout situations, and financing from his office at 815 Fifth Ave., in New York City.

With the energy crisis, noise pollution, and economy being addressed as above, it follows that one of our classmates would be doing something about food shortages. **Lou Mahoney** was made Refinery Manager at Revere Sugar in November, and by April was ready for a well-earned break as he and Marie visited Rome, Italy. It may be only a coincidence but sugar seems more plentiful now, Lou. . . . **Henry Hirsch** was recently elected Vice President and member of the Board of Directors of the Kentucky Gerontological Society. . . . **Dick Hayes** has been named Vice President, advanced business concepts in the business and product development group of Xerox Corp., and **George Schwenk** got his Eagles in the Army Reserve.

Howard Brody is Professor of Physics at the University of Pennsylvania and is "quite active in academic affairs: Committee on Instruction, Undergraduate Affairs — Physics, etc., etc." He will soon embark on an experiment at the accelerator in Batavia, Ill., commuting from home in Cherry Hill, N.J. Family includes 19-year-old Liza, a freshman at the University of Colorado, Victoria, entering Pennsylvania in September, Dardre entering junior high school, and wife Lois, who substitute teaches and writes the family's letters. Thanks Lois. — **Dave Howes,** Box 66, Carlisle, Mass. 01741; **Chuck Masison,** 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney,** 14 Danby Rd., Stoneham, Mass.

55

The Power Systems Group of Combustion Engineering, Inc. announced the appointment of **Robert N. Duncan** as director of fuels and materials development. Bob joined C-E in 1972 as manager of core materials. Previously he was manager of fast reactor fuel development at General Electric Co. He is a registered professional engineer in California, and Vice Chairman of Nuclear Fuel Technology Subcommittee of the American Society of Mechanical Engineers. The Duncans live in Granby, Conn.

Ernest D. Strait received his second award of the Air Force Commendation Medal for outstanding achievement while serving as a technical advisor to the U.S. delegation during land negotiations in the Marianas. He is assigned to Hickam A.F.B., Hawaii, where he is director of operations and maintenance for Headquarters, Pacific Air Forces. . . . Among Draper Lab staff members who have been honored by N.A.S.A. is **Herbert Singer** of the Component Development Dept. He received an Achievement Award for his participation in the Attitude Control Anomaly Team, which examined problems in Skylab's faulty large Control Moment Gyros, which are responsible for the control of the spacecraft attitude. National Portion Control, Inc., has appointed **Mario deFigueirdo** to the position of Vice President of Marketing. He has chief marketing responsibility for the company's brands and marketing programs, and he will continue to direct the research and development department. Dr. deFigueirdo and his wife Mildred reside in Glenview, Ill.

Theodore G. Papastavros has been elected Vice President, Operations, of Ionics, Inc. in Watertown. He was formally Operations Manager for the firm, and he is currently completing requirements for a M.A. in business administration at B.U. . . . **Roger Reiss** has returned to engineering to work at Stone and Webster in Boston, Mass. He and Robert Rohner, '54, have been doing consulting work in petrochemical and energy research and development, particularly in connection with advanced developments for process and energy-related projects. . . . The University of Bridgeport announced the election of **Henry B. DuPont III** to the position of Vice Chairman of the Board of Directors. . . . On a personal note, **Hal Stubing** wrote that he visited Doug Willis, '56, last December. Doug, his wife Shirley, and their two children Andy and Allison live near San Diego, Calif. . . . Recently entering academia is **Bruce D. Wishwell** who is now Dean of Engineering and Skiing at Colorado R & R. You may be unaware that Bruce lost his last position as reform-minded warden of the Massachusetts Home for the Morally Muddled as the result of one of his reform programs. Despite intense electioneering by Bruce and his staff, the inmates voted, albeit by a close margin, to dismiss the warden and all guards. Bruce reports that there was no bitterness, and that there was a need for financial cutbacks, but that it was a high price to pay for ones convictions. Many of the inmates left, too. — **Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

59

Congratulations to **Nam Suh,** recently promoted to Professor in the Department of Mechanical Engineering at M.I.T. After completing his S.M. degree at Tech, he received his doctorate from Carnegie and was a member of the faculty of the University of South Carolina before being appointed Associate Professor at Tech in 1970. His principal fields of interest include the mechanical behavior and processing of materials, materials engineering and manufacturing technology. . . . The *Wall Street Journal* recently noted that **Joe Zimmerman** was named Group Vice President, digital systems and material and electrical products at Texas Instruments in Dallas.

From the mailbag, an annual hello from **Bob Polutchko** in Colorado where he is completing six years of work on the Viking Project (Mars Lander Mission). You may recall that last year Bob suggested that Denver would win the Super Bowl. It's good to see that he has recovered from the high altitude effects in that no such prediction was made this year.

Richard Sullivan has recently moved to England as Managing Director of the London office of McClelland Engineers, a consulting firm concerned with geotechnical studies for offshore platforms. . . . At the Jet Propulsion Laboratory in Pasadena, **John Andrews** notes that he is on field assignment from General Electric Space Division in Valley Forge and is providing technical support to the Mariner-Jupiter-Saturn 1977 missions.

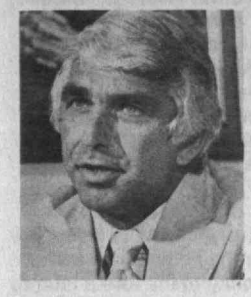
I recently met **Jim Hurley** at the April Alumni Advisory Council meeting in Cambridge at which the M.I.T. Leadership Campaign was announced. Jim had flown in From Chicago where he is active in alumni activities in support of the Institute and maintains a busy workload as an investment executive with Blyth Eastman Dillon. . . . That's all for now. Remember, we do want to hear from you and it only takes a short note to **Phil Richardson,** 180 Riverside Dr., New York, N.Y. 10024; **John Amrein,** 770 Greenwood Ave., Glencoe, Ill. 60022; **Bob Muh,** 907 Chantilly Rd., Los Angeles, Calif. 90024; **Adul Pinsuvana** at 49 Seri Rd., Seri Village, Hua Mark, Bangkok, Thailand; or myself, **Allan Bufferd** at 8 Whitney Rd., Newtonville, Mass. 02160

60

Auguste E. Rimpel, Jr. writes: "For the past one and a half years, I have been Deputy Project Director with Arthur D. Little, Inc. on a major project in Brazil to reorganize the largest public-owned integrated steel company in Brazil. I expect to continue my residence in Brazil through June, 1975." . . . From **Peter S. DeFoe:** "Recently formed my own company, DeGill Corp. Our offices are in Golden, the plant in Boulder, Colo. We do technical printing for engineers and architects, and also mold special silicone rubber gaskets." . . . From **Norman Vadner:** "Living in suburban Philadelphia and working for Boeing Computer Services as District Planning Administrator."

Mark R. Pratt writes: "Currently Department Head, Chemicals Technical Dept., Exxon Chemical Co., in Baytown, Tex." . . . From **Tony Fazzari:** "I am now Assistant to the President of Coalcon, a joint venture of Union Carbide and Chemical Construction Corp. Coalcon recently received a $237 million government contract to build a plant demonstrating the conversion of high sulfur coal to clean liquid fuel, a key step towards energy self-sufficiency. Sheila and I are expecting our third child in March." . . . **Susan E. Schur** has been elected by the Boston Junior Chamber of Commerce as one of the ten outstanding young leaders of 1975. She is presently cochairing a national effort to complete the $750,000 endowment for a professorship honoring Ellen Swallow Richards. . . . **Hugh Morrow III** has been appointed Supervisor of Technical Information for Climax Molybdenum Co., a division of A.M.A.X., Inc. . . . **Hersh Markusfeld** has been elected Vice President and Senior Actuary of Fireman's Fund American Life Insurance Co. — M.L.

A Theoretician Looks at Reality: Organizations That Resemble Swiss Cheese



Warren Bennis, '55

"A Money Man, Academic Manager, Father Figure, Public Relations Man, Political Man, and Educator. In short . . . a messiah with a good speaking voice."

Such a man would make a good university president, you say? You're right: this prescription is written by one — Warren G. Bennis, Ph.D. '55, now President of the University of Cincinnati.

Stepping briefly away from academia, he has a chance to look at himself as a practitioner of what he once so effectively preached as Professor of Organizational Behavior in the Sloan School of Management at M.I.T. (1959 to 1957). He records in a kind of "double-entry diary" of theory vs. practice, he said during an interview with Nancy Foy for the autumn issue of *European Business.*

Dr. Bennis has changed his thinking with his role. He is now more critical of organizational specialists or advisers — including some of his own work. "Most social science writing about men in institutions," he writes, "suffers from a sanitary concern with causality, coherence, and a search for pattern which rarely exists except in the mind of the observer. The result is false, at times destructively so. Those elements of confusion, chance, ignorance, stupidity, recklessness, as well as the many amiable qualities of man, are simply not reckoned with; they are selectively ignored."

Dr. Bennis now concludes that social scientists and organizational experts lack a very close observation of what life is really like. "Consultants sometimes embrace the elegance of correlations without comprehending the real consequences — of being believed." "Were it my due to be believed, I would not be so bold," he quotes from Montaigne.

The administrator confronts problems — and gains insights — not found in management books. "There's nothing more important than timing," Dr. Bennis told Ms. Foy, "and that's one thing I never touched on in my theoretical life." He poses questions: "How do you start a new team? . . . How do you set things up so the loss of a key man doesn't damage the organization?"

"Consensus Is a Chimera"

He criticizes the new theories of motivation because they "sound very much as if all people are alike; even with a 'Theory Y' orientation it is now clear to me that not all people will respond to the same treatment in the same way. . . ." It is a wrong assumption, he thinks, that unanimity can be achieved. "Consensus is a chimera, a folk dream. It really is impossible. Consensus is based on trust, and trust is based on face-to-face interaction. But the overworked top man, with all his constituencies, cannot *meet* everybody face to face. There has been a fragmentation going on. . . . You can't negotiate with people you don't have time to meet."

He has observed the workings of power: "There's a trade-off between efficiency and what is euphemistically called 'corporate responsibility,' which often means the iron hand of public opinion." New environmental protection and equal opportunity laws can result, thinks Dr. Bennis, in judicial overkill. "There comes a time when the organization may resemble Swiss cheese — invaded by these outside forces to the point that it can end the local autonomy of the organization."

A "Truth-in-Administration" Policy

Dr. Bennis puts great value on interpersonal relationships. They affect organizational effectiveness; they have regularities, and they cannot be understood through conventional theory, he says. The degree of interpersonal trust between superior and subordinate, the degree of power held by the subordinate, and the degree of the subordinate's ambition dictate the validity and frequency of upward communication within a large company.

Dr. Bennis has turned his attention now to the challenge of identifying "those problems and those symbols that will be seen as a reward, or as something useful, to infinite numbers of groups, all at different phases of developing their own group identities." He says that "we need to identify those which make people feel like they belong to one organization."

One conviction held by Dr. Bennis pervades his analysis of the university and his own work as university president: to be successful, any bureaucracy must establish a "truth-in-administration" policy. American institutions are faced with an increasing credibility gap, he says; they must communicate more openly, more humanely. The demand for candor — although occasionally painful — makes it harder for a university to hide behind defensive or self-serving euphemisms. □

61

William Jouris writes: "Presently I am a nuclear engineer designing shielding for components in nuclear power plants. Beth and I miss New England very much and hope to return to the Boston area sometime if the job market improves there. The twins, Brian and Lisa, are now 3½ and are doing fine." Bill's firm, Fluor Pioneer, Inc. seems quite proud to have him and fills us in about his past history. They say that he used to be an administrator at Woods Hole Oceanographic on Cape Cod and that his background is in health physics reactor operations, dosimetry and so on. Good luck on the new job Bill. . . . One new job that recently opened up around here was taken by **Fred Salvucci.** We have a new governor (Dukakis) who appointed Fred as the new Secretary of Transportation. (He had been the Boston mayor's transportation advisor for the last three years.) Congratulations, Fred.

Congratulations also go out to **Walter Loveland** who is now promoted up to Associate Professor of chemistry (with tenure) at Oregon State University. . . . More huzzahs go out to **Charter Harrison** who sent us news of the birth of one Hillary Harrison about a year and half ago. News travels slow from Seattle where the Harrisons live in an "old, by Seattle standards" house. Charter's brokerage business is treating him well, he reports.

John Kogan is still living in Boston. He writes that he is "working as a management consultant for Arthur Andersen and Company, a C.P.A. firm." . . . Well, thats all the news currently in hand. Any missives from you will be warmly appreciated. People in our class and in adjoining classes are interested in how you are doing. Let them know by writing to me (at no obligation to you) — **Andrew Braun,** 464 Heath St., Chestnut Hill, Mass. 02167.

62

William A. Pearlman received his Ph.D. in Electrical Engineering from Stanford last September and his wife, Eleanor, and he moved from Menlo Park, Calif., to Madison, Wisc., so he could take a job as an Assistant Professor in the Electrical and Computer Engineering Department at the University of Wisconsin. After 11 years in industry in the San Francisco Bay area, he tells us the transition is difficult, but certainly hopeful. . . . **David S. Stare,** his wife Gail and their two children, Kim (11) and Terry (4) let us know that the wine business is great. Dry Creek Vineyard, which he founded and at which he is the winemaker, produces some of California's best wines. . . . **Robert M. C. Burns** has a second book, *Home, Inc: The Hidden Wealth and Power of The American Household,* which will be released by Doubleday in August. Other activities include a monthly article in *Boston* magazine, newspaper columns and a nationally marketed personal finance newsletter.

Donald M. Dible, who is the founder and General Partner of the Entrepreneur Press and author of *Up Your OWN Organization! A Handbook on How to Start and Finance a New Business,* lets us know he has edited and published a new book titled *Winning the Money Game,* which is a seminar in book form with the expert counsel of 14 top business leaders. — **Gerald L. Katell,** Secretary, 7 Silverbit Lane, Rolling Hills Estate, Calif. 90274

63

Just a short column this month with a few notes and some news releases. Haven't had any interesting letters in the last few weeks.

Tony Doepken reports that he joined Phelps Dodge Cable and Wire Co. of Yonkers, N.Y., as Director of research and devel-

What Happens Psychologically When You Change Jobs?

Michael Brenner, '57

"I wish the restlessness inside would go away. I want more challenge. I need more responsibility, and I want to feel as though I've 'arrived'." The decision to search for a new job begins a period of exhausting inner debate and self-questioning. And changing direction — refining job objectives — is especially difficult. "Frankly, I didn't really know what I wanted to do six years ago," recalls Michael Brenner, '57, in an article in the October issue of *MBA* magazine. He recalls his emotions: The prospect of search was an unpleasant one — "the personnel agency people who are out to make a fee, the effort involved in closing one door and opening another."

He remembers that the psychological effects of the change involved a "pattern of unproductive energy": "Trying to involve myself fully in a job I no longer liked was a strain. The weight of personal financial obligations seemed heavy. The tensions spilled over into my mood at home. Everything I did seemed to be ruled by the contrapuntal emotions that were operating in me."

From his own experience and through extensive contact with other job-hunting men and women, Dr. Brenner developed principles that he believes govern the psychological process of changing jobs. "I have observed that for about five of every six M.B.A.s the search for a new job is self-generated. Less than 20 per cent are forced into a job change by being fired or laid off. Even for those who actually change jobs, two out of three are voluntary."

He feels that conflicting needs of stability and change (as described by Desmond Morris in *The Naked Ape*) cause two opposite situations: "The urge for maintaining the status quo leads many people to remain in jobs longer than a reasonable assessment of their career objectives would dictate. Conversely, the need for change leads others to leave a job before they have developed its full potential. The proverbial job-hopper is often caught in a pattern of satisfying an exaggerated desire for change for its own sake."

After several years as a placement and recruiting consultant, Dr. Brenner thinks the most job transition in a professional's life is likely to occur between the late 20s and early 30s. "Typically, the 20s are characterized by a desire for achievement that is measured by the standards of others, such as parents, peers, and institutions," he says. "In the jargon of David Riesman, the 20s are 'outer-directed.' The 30s are a period in which standards of achievement are internalized and dependent on one's own values — in other words, 'inner-directed.' M.B.A.s contemplating a job change should be aware of where they stand in their adult development."

On the emotional level, some dissatisfaction usually precedes the decision to change jobs. A resulting inner turbulence begins to build up "a head of steam." That accomplished, the final commitment to make a change is often prompted by a specific event — of relative insignificance. "For example, a peer may buy a new stereo system and thereby bring to the fore a latent dissatisfaction with one's own compensation."

But it's not always a garden of roses from there on. Accepting a new job often revives "classic fears of rejection by parents or siblings when independence was sought. . . . In many cases the psychic pain of leaving a job prevents the development of commitment to the new position."

The final "so long" isn't easy. There are temptations to procrastinate — the problems of leaving a comfortable routine for an unknown one; symptoms of moodiness and fatigue. "Stress on one's personal life is usually unavoidable," says Dr. Brenner, and "The psychological effects of job changing may drain off more energy than does the job search itself." But understanding all these things helped Dr. Brenner when he made his big move into executive recruiting several years ago, and since then, he thinks, that understanding has helped him help many others.

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opment. He's still concerned with transmission of electric energy underground. . . . **Alvarez de Toledo** is head of the Science and Technology Division, Directorate for Science, Technology, and Industry of the Organization for Economic Cooperation and Development (O.E.C.D.), based in Paris. . . . **Bejar H. Shemdin Agha** was recently granted U.S. Patent number 3,652,753 on the flow of liquid polymer in non-circular spinneret holes, in the manufacture of man-made fibers, especially nylon. . . . **Norman C. Peterson** was re-elected executive vice president of Rayifax Corp. on Dec. 5, 1974.

Steve Reznek sent a note which fills us in on his recent history. After grad school at M.I.T., Steve went to Europe in 1968. He spent one year in Denmark and one year in England. He now has a Danish wife and a blond, blue-eyed son of one year. Steve has been working in environmental protection both with the E.P.A. and currently with the National Commission on Water Quality. The Rezneks are living in Bethesda, Md. . . . **Paul Berger** writes that he received a Ph.D. in Applied Physics from Harvard in 1970 and joined the United Aircraft Research Laboratories in East Hartford, Conn. Paul has worked on a variety of laser-related problems. He and his wife Eleanor have three daughters ages eight months to eight years. The Bergers recently visited M.I.T. during a trip to Boston and ate lunch at the Student Center. Paul writes that life appears to be more pleasant for the student now than he remembers it.

Allen Clark and his family recently returned from seven months in Kenya, East Africa. The Clarks did quite a bit of camping in the game parks when Al could get away from work. The note concludes, "It's really thrilling to see so much wild life that is free to roam. The country is beautiful and we really enjoyed the trip." . . . **Henry Nau**'s first book was published last October. The title is *National Politics and International Technology: Nuclear Reactor Development in Western Europe*. It is published by Johns Hopkins University Press and sells for $12.50. Henry says he wishes the royalties were as big as the title. . . . **Alan Marty**'s first daughter, Victoria Anne, was born November 23, 1974. Alan is now in the Navy as a commander in the Medical Corps. He is chief of Thoracic Surgery, Naval Hospital, Port Hueneme, Calif. . . . I recently met Bob Ratner, '64, who I'm sure many of you remember. Bob is married, living in the Palo Alto, Calif., area, and is working at Stanford Research Institute.

News releases: **Joseph Nemec** has been named managing officer of the Foster D. Snell Division of Booz, Allen and Hamilton. Dr. Nemec is a Vice President of Foster D. Snell and is based in Florham Park, N.J. The firm does chemical product and process development. Prior to joining Booz, Allen and Hamilton in 1970, Dr. Nemec was a member of the faculty at McGill University. . . . Under the auspices of the Boston section of the I.E.E.E., **Robert Purdy** presented a seminar on Advanced Radar-Signal-Processing Techniques and Devices. The seminar was held on March 25 at the Raytheon Missile Systems Division in Bedford, Mass. Dr. Purdy has been at M.I.T.'s Lincoln Labs since 1968, working in the design and analysis of signal processing systems for radar applications. . . . The American Council of Learned Societies has granted **Kenneth Friedman** funds to pursue research on the thermodynamic foundations of biology. Dr. Friedman will work at the Free University of Brussels in this field which is a scientific frontier between the areas of physics and biology. He is currently an associate professor of philosophy at State University College in Oswego, N.Y., where he teaches philosophy of science and logic, and history of science.

Enjoy your summer. — **Mike Bertin,** Secretary, 18022 Gillman St., Irvine, Calif.

64

Shalom '64!

Regrettably, this month's column includes notice of the passing of a classmate, **Melvin N. Oliven.** Mel, who held an instrument rating as a pilot, was killed (on or about March 6, 1975) when the Cessna 182 he was flying developed mechanical problems and crash landed into the roof of an unoccupied warehouse. Mel had been involved in post-doctoral research at the University of Iowa Department of Physics and Astronomy. He is survived by his wife Carol, two sons (Kent, seven, and Everett, five), and his parents, Mr. and Mrs. Walter Oliven of New York.

Earlier this month (April) we had a nice visit with Ellen and **Gary Walpert,** and daughter Tara, who spent an evening at our home during too brief a visit to Massachusetts. There isn't too much new news from Gary and Ellen (as Gary was class hero just a month or two ago). They are *still*

waiting to move into their new condominium in Tarrytown; but I'm sure the waiting will have been worth it, because the pictures and the floor plan looked beautiful!

Daniel F. Blossey has been named Manager, Exploratory Imaging Area for Xerox Corporation's Joseph C. Wilson Center for Technology in Rochester, New York. . . . Another classmate, **David Fahrland,** has also begun a new job at Digital Equipment Corporation in Maynard, Mass., in the Micro Products Development group. . . . Our previous class secretary, **Ronald Gilman,** is quite busy as he is now on the Board of Directors of the Memphis and Shelby County Bar Association for 1975. He lectured on the topic of "Formation of a Corporation" at a Tennessee Bar Association mid-winter meeting. . . . **Robert M. Johnston** is now practicing Opthalmology in Leesburg, Va., after being certified last May. . . . California is the home of **Kraig W. Kramers** and his wife Jean and their three daughters. Kraig has been appointed Director of Corporate Planning for Fibreboard Corporation, San Francisco, Calif. . . . A new book has just been published titled, "Theory and Application of Digital Signal Processing," which was co-authored by **Lawrence Rabiner.** . . . **Michael Rubin** is an Assistant Professor teaching in the School of Management at Boston College. He just received his Ph.D. from Stanford this past January. Michael is married to Amy (Kateman) Rubin, and has two children, Adam, eight, and Jennifer, six. The family now resides in Newton, Mass. . . . **Robert A. Weinberg** is an Assistant Professor, teaching in the Biology Department at M.I.T. He is also doing research in the M.I.T. Center for Cancer Research.

That's it for news for this month. In order to write this column, we must hear from all the members of the class. Please write and, when you are writing, remember to donate to the Alumni Fund. Remember, M.I.T. needs your generous donations! — **Steve Schlosser,** Secretary, 15 Apple Hill Rd., Peabody, Mass. 01960

65

There seems to have been a sudden spate of Alumni Fund envelopes which, with the letters for the reunion questionnaire make for a reasonable column this month. One more and I'm done!

Wayne Wilner has moved to Del Mar, Calif., to be one of the first two employees at Burroughs' new Advanced Systems Development Organization. Wayne says that Del Mar has a hostility to growth and that he knows that when he moved in, someone else moved out. . . . **Christopher Ebbe** left the Air Force in July, 1974 and traveled around the country visiting friends and looking for a job. He is now employed as a clinical psychologist by the county of San Bernardino, Calif. . . . **Phil Smith** is still the Financial Director for Brand-Rex Co. and reports that he is enjoying New England again. . . . **Rich Amster** sent a long letter in response to the reunion mailing. Rich is now living in Vienna, Austria. He says that for the past three years he has been cruising back and forth, and flying around Europe alternating between work (mostly with computers) and vacations of six months or more. Rich says our March reunion mailing took a month to reach him via his father in Tucson. Rich has been working for a year and a half for the part of I.B.M. World Trade that sells and services computers in Eastern Europe. Hence, while he calls Vienna home, he spends most of his time in Prague, Warsaw and Ljubljana. Rich works in Systems Engineering and reports that there is work for almost any kind of computer specialist in Western Europe, and that you can get by speaking only English. He has not yet had a chance to use his law degree from Suffolk University but will have time for that when he gets back to the United States. That will be after a break in his I.B.M. work for a 6 to 12 month Mediterranean cruise or an overland drive to India. I have Rich's address for anyone interested in either venture or in other help on his side of the Atlantic.

The **Mark Hansons** have a second daughter, Rebecca, born last January. Mark recently finished developing an on-line shop floor control system for Digital Equipment. . . . **Tom Hedberg** has been appointed Treasurer of KETRON, Inc., an operations research consulting firm of 100 professionals serving the military, socioeconomic and commercial markets. . . . **Peter Sexton** started the new year by joining the Materials Research Center of Allied Chemical in Morristown, N.J. He is part of a team developing amorphous metal alloys and says he is looking forward to the reunion. . . . **Dan Diamond** has joined Chomerics, Inc. of Woburn, Mass., as Marketing Manager. . . . **Martin Thomas** has moved from marketing research to Venture Marketing Manager at Scott Paper and is enjoying applying some of his theories. The Thomases enjoy camping in the spring and fall and may range from Maryland to Massachusetts this year. . . . Patty and **Charles Gitomer** and the three kids are enjoying Houston. Charles is working for I.B.M. and filling his free time working on a Ph.D. in business administration at the University of Houston. . . . **Ed Strauss** has just opened a law office. . . . **Bill Brody** will finish his tour at the National Heart Institute this summer and then head west for San Francisco . . . **Pat Winston** has been appointed Director of M.I.T.'s Artificial Intelligence Laboratory.

We just had the big Patriot's Day parade initiating the bicentennial celebration today. Quite a show. My new place in Lexington is about 20 yards from the parade route and a half mile from the Lexington Green. It's worth seeing while you are all here for the reunion. — **Steve Lipner,** Secretary, 15 Russell Sq., Lexington, Mass. 02173

67

Having graduated from University of Pennsylvania Law School and passed the Pennsylvania state bar exam, **John Child** is now associated with a patent law firm in New York City. After graduating from M.I.T., John attended Oxford University for three years and received a Bachelor of Letters in Politics. . . . **Ray Giglio** recently became a homeowner, to the detriment of his hiking and skiing. Ray has been studying alternate energy sources for a local power company. . . . **John Ruth** has been assigned to the Tactical Air Command at Elgin Air Force Base, Fla. . . . **Yupo Chan** is Assistant Professor of Civil Engineering at Pennsylvania State University. . . . **Francis Walsh** and Linda Anne Lawn honeymooned in South America after their November wedding in Lynnfield, Mass. Francis has been a management consultant with Temple, Barker, & Sloane, Inc. in Wellesley Hills since he graduated from Harvard Business School in June, 1973. . . . **Rod Peterson** is with the Commercial Ship Division of Newport News Shipbuilding and is in charge of handling and warehousing all the cryogenic materials for the liquid natural gas carriers under construction. Mary Kay retired as director of the local mental health association in order to give birth to their first child, Colin Stuart, born April 20, 1974. Proud Papa attended the arrival as a Lamaze coach. . . . **Bob Bosler** and Paula Korngold of the University of California at Santa Cruz were married last November. Bob and **Jerry Udinsky** both work at Oakes College of the University of California at Santa Cruz. Jerry is Assistant Professor of Economics, and Bob is Assistant Provost. . . . **Ross Corotis** has been promoted to Assoc. Prof. of Civil Engineering at Northwestern University.

Chandler Stevens is organizing a new science advisory function for the Massachusetts Legislature. He hopes to involve faculty and alumni from M.I.T. and other universities and technical institutions in Massachusetts. . . . **John Gowdy** is Associate Professor of Electrical Engineering at Clemson University. . . . **Neil Steinmetz** is in training in radiology at Peter Bent Brigham Hospital and is living in Brookline with his wife Ruth and their twin sons, Jon and Adam. . . . After receiving a Ph.D. in Physics from Princeton in 1974, **John Ritsko** started working in basic solid state research for Xerox in Webster, N.Y. . . . **John Foss** has returned to M.I.T. to work for a Ph.D. in Physics. He is a graduate student representative to the Committee for Educational Policy. — **Jim Swanson,** Secretary, 669 Glen Rd., Danville, Calif.

68

The first item of the month is that after 3½ years, half your class secretariat has rejoined the civilian world. After keeping the world safe for democracy by studying seismology and nuclear test detection for the Air Force in Alexandria, I am moving a few miles up the road to the Institute for Defense Analyses (another institute!) in Arlington, Virginia, near the Pentagon. **Gail** will continue working at Analytic Services, Inc., an Air Force "think tank" in Falls Church. Our other big news is that we sold our first sailboat and bought a 1967 Morgan 24 which we are keeping near Annapolis and plan to use a great deal now that it has warmed up. . . . While in Vietnam doing Ph.D. dissertation research on the economy of rural households, **Karl Hella** met and was married to Do Tuyet Nao last October. . . . **John Hrones** married the former Cynthia Gay Knowles on July 8, 1973. Cynthia is a 1968 graduate of Simmons and is an elementary school librarian in Brookline. Since August, 1973 John has been working for the Digital Equipment Corp. as a software development engineer in charge of MUMPS for the PDP-15. They are living with their Saint Bernard in a nice old Cape Codder in Needham.

Don Baker married Linda Scott in August, 1972 in Arkansas. For the next two years he worked on a Master's in Ocean Engineering at the University of Massachusetts. He's now working at the Virginia Institute of Marine Science on a cheap, expendable,

remotely tracked bouy using the Omega navigations system. . . . Jeanni and **Dennis Sager** dropped us a note to announce the birth of their daughter Lauren on May 31, 1973. They are living in Reston, Va., while Dennis is working at MITRE Corp. . . . From **Susan Weiss Liebman** we hear of the birth of Michael Kevin Liebman on December 6. . . . **Ken Wong** has been appointed pro at The Court House Byron Sachar, an indoor raquetball facility in Creve Coeur, Mo. (near St. Louis). Ken is number three nationally in doubles play and has placed seventh in national singles racquetball. . . . **Tom Penn** has been appointed Manager of Business Development for the Buckeye Pipe Line Co. in Radnor, Penn. . . . From New Mexico we hear that **Don Batchelor** and family spent the winter at Los Alamos while Don was doing his thesis research. They kept busy on weekends exploring Indian ruins, hiking over mesas, and climbing mountains.

John Kasarda recently founded Parthenon Systems, Ltd., specializing in minicomputer systems and application software. Although currently based in New York, John hopes to return eventually to Boston. . . . John Fadum, '67, is doing research and writing papers about general relativity, gravitation theory, and manned space flight. He hopes to work for N.A.S.A. in the area of manned space flight and is interested in hearing from classmates with similar interests. . . . In 1973 **Ron Merrill** received a Ph.D. from the University of Oregon and then went on to a postdoc at Syracuse. He is now teaching at the Rochester Institute of Technology. . . . **Richard Handler** is moving to Saranac Lake where he is joining three other Internists in practice. . . . Finally, **Peter Groot** left New York recently when his employer went bankrupt. In a year and a half he was mugged only twice (and one of those even resulted in a conviction). He is now working as a consultant while he looks for steadier work. — **Gail** and **Mike Marcus,** Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22403

69

Well sports' fans summer is here and set forth below is the latest information on our class:

Erik B. Anderson writes that Helen and he welcomed a new member to the family January 21 — Vanessa Elizabeth. Erik is still working on a N.A.S.A. contract to develop noise abatement equipment. . . . **Richard M. Barnes** is "living happily in Columbia, Md., with Sher and two little girls." He's taking part-time courses toward a Ph.D. in math sciences at Johns Hopkins. . . . **Donald Collins** finished his internship at Duke University and is presently a physician at the Indian Health Service Clinic in Shawnee, Okla. He was married last February to the former Nora Shearer. . . . **David Cane** is living in Sudbury and refurbishing a house. He's working at Digital designing memory systems. His spare time is spent watching, along with his wife Aleta, their developing five-month-old daughter. . . . **Ben T. Huie** reports that he is alive and well on the West Coast. He was married in June, 1971, to June Ellen Sota of San Josa, Calif. . . . The **James P. Kornbergs** are enjoying life in the snowy Vermont mountains (or at least they were when they wrote). Jim finished his Sc.D. at Harvard in February, 1974, in Environmental Science and Engineering and is expecting his M.D. from Dartmouth in June, 1976. He's hoping to stay at Dartmouth after that to work in the areas of environmental medicine and respiratory disease. . . . **William Oscar Maddaus** has been on special assignment in Santiago, Chile, assisting the government there in planning for water resources development.

A March 5, 1975, press release from the office of Congressman Gilbert Gude (R-Md.) states that "Attorney **Mark Mathis** of Chevy Chase, Md., has been named by Representative Gilbert Gude, R-Md., as Minority Counsel of the House District of Columbia Committee. Mathis will serve Gude, who is ranking Republican on the committee, and other members of the Republican minority." . . . **Steve Rothman** writes that his wife Millie gave birth to their first child, Deborah Lynne, on March 7. The Rothman family size now stands at six including the Siamese cat and two large Collies. Steve is still working as Project Manager on the recently announced PDP-11/70 at Digital Equipment Corp.

Kenneth L. Zwick, '68, announces that his family's first child, Tara Allison, was born on August 7, 1974. He is now Technical Manager for On-Line Systems, Inc. in Philadelphia, Penn. He is expecting to graduate from the Temple University Law School-Evening Division in June, 1976.

That's all for now folks. Keep those letters and postcards coming. — **Peter Peckarsky,** 950 25th St., N.W., Wash., D.C.

70

By the time you read this, spring *may* have come to Boston (it was still winter in early April), and M.I.T. will be in full gear preparing for Alumni Day and class reunions. Our Fifth Reunion should be a lot of fun, and the more classmates who attend, the more fun it will be. Don't miss it!

And now for the news: **Lonnie C. Von Renner,** who finished law school at Georgetown University in 1974, is a law clerk to Federal District Judge Murray M. Schwartz, District of Delaware. . . . **C. Gordon Hunter** recently had an article published in the *American Journal of Obstetrics and Gynecology,* vol. 120, no. 6. The article was entitled, "Efficacy and Acceptability of 15(S)-15-Methyl-Prostaglandin E_2-Methyl Ester for Midtrimester Pregnancy Termination." . . . In July, **James C. Liang** will begin an ophthalmology residency at the University of Illinois Eye and Ear Infirmary. His wife, Jocelyn, is working on an astronomy doctorate at the University of Chicago. . . . **Oscar D. Asbell, Jr.,** and his wife, Kathi, are still in Northampton, Mass., working, respectively, at Kollmorgen and Franklin Co. Hospital. Oscar has completed six courses towards an M.S.M.E. in the University of Massachusetts' evening masters program. His main extracurricular activity has been "harassing the local bunnies with a brace of beagles." (And practicing alliteration?) . . . **Lim-Ming Chui,** currently the United States' second-ranked table tennis player, was scheduled to compete against Edward Ma, current champion of Hong Kong, on January 13 in a match televised live on WCVB-TV (Channel 5, Boston). Chui, who is Eastern U.S. champion, is a member of the U.S. National Table Tennis Team which in 1972 squared off against the visiting Chinese team. He has won several U.S. Open and Closed Table Tennis Tournaments in the last seven years; and is the author of a November, 1971 *Esquire* magazine article: "How To Play Like the Chinese Champion." Chui and his five-man U.S. team were also scheduled to join the Peoples Republic of China and 100 other countries in the World Championships in India in February. (Sorry, I don't have the results of these matches. If any of you do, let me know.)

Brief and to the point: **Eric K. Clemons** writes that he is "surviving, and will ultimately get his Ph.D." . . . And, with a mournful note, **Paul Burstein** writes, "I'm *still* at Wisconsin, *still* working on a thesis (I hope), it's the beginning of February and last night it was *still* 15 below zero." . . . **Nicholas G. Escott** was married in May, 1972 to the former Deborah Misner of Woodburne, N.Y., and Brandeis University. They have one child, Vanessa, who was 13 months old in February. Nicholas, who graduated from McMaster University Medical School last June, is currently doing an internship in Hamilton, Ontario. . . . **Donald M. Simmons** is the father of a son, Jeffrey, born October 2, 1974. Donald has moved from Cambridge to New York for a new job in economic planning and analysis for Fairfield-Maxwell, an international shipping and finance concern. . . . Paula and **Rich Nagy** have a son, Mark Stephen, who is now just over a year old. All three are continuing to enjoy their Colorado tour of duty. . . . More word on **Joel S. Davis'** political activities: At the University of Colorado, where he is working on a Ph.D. in astro geophysics, he is president pro tempore of the Executive Council — a position analogous to "Speaker of the House." In local politics, Joel placed third in a special election for Boulder City Council, and he plans on running in the regular municipal elections next November. . . . And last, but not least, Mr. and Mrs. **James F. Pelegano** have announced the birth of a daughter, Janine Marie, on February 16. Weight: 7 lbs, 13 ozs. . . . That's all for this month. Hope to see you at the reunion! — **Laura Malin,** Secretary, 82 Monroe St., Apt. 1C, Somerville, Mass. 02143

74

Gary Raymond is working with his father as a manufacturing engineer and helping with the considerations for an in-plant computer. . . . Jack Goldberg, '73, is working for Grason-Stadler Co. (General Radio) in medical instrumentation. Jack is living in Stow, Mass. He says: "I like the country life." . . . **Doug McCrae** is currently teaching children as a private tutor around the Boston area. He also teaches frisbee part-time. Speaking of frisbee, Doug says that John Kirkland is now with the Harlem Globetrotters — John does a frisbee show during half-time. . . . **Andy Nourse** is now working for General Systems in Watertown, Mass., as a computer programmer. . . . **Paul Schindler** is currently working for United Press International, Boston office. He writes: "(I) spent spring vacation in Jamaica, during which time I doubled my lifetime input of rum."

And how did you spend your spring vacation? This column is getting shorter and shorter — **Dennis Dickstein,** 23 Howard St., Cambridge, Mass. 02139

New heat-recovery heating/cooling units will burn less energy in your building!

Introducing McQuay's new Hi-Line SEASONAIRE® water-to-air heat-recovery unit. It's a heat pump that not only provides year-round heating/cooling, but also helps pay your energy bill. The unit does this by recovering heat from any area of the building that requires cooling; the recovered heat is then transferred to areas that require heating.

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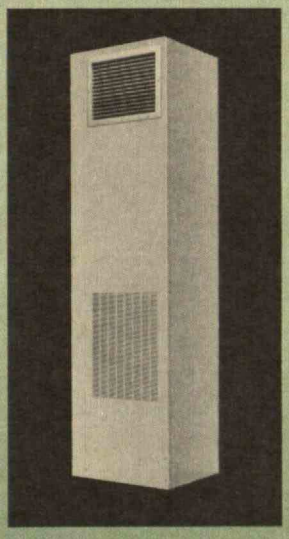
Heating BTUH	C.O.P.*	Cooling BTUH	EER**
9,600	2.7	9,000	8.3
17,600	2.7	18,000	8.7
26,600	3.1	24,000	9.2

*Coefficient of performance **Compressor and fan motor

These new units are very quiet, too. So they're ideal for places like hospitals, nursing homes, office and apartment buildings. They also save on both field-supplied labor and materials because we ship them with all risers for condenser water and drains, and with all internal control systems. The units are self-contained, too, and they can be stacked one above the other in multi-story buildings, each independent of the others. So if a malfunction should occur, only one unit is affected: the rest keep on operating.



And here's another plus: there's plenty of design freedom for the architect because units with finished cabinets are well-suited for use either in new buildings or in remodeling jobs. (Unfinished units can be specified for built-in applications.)

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