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Technology Review

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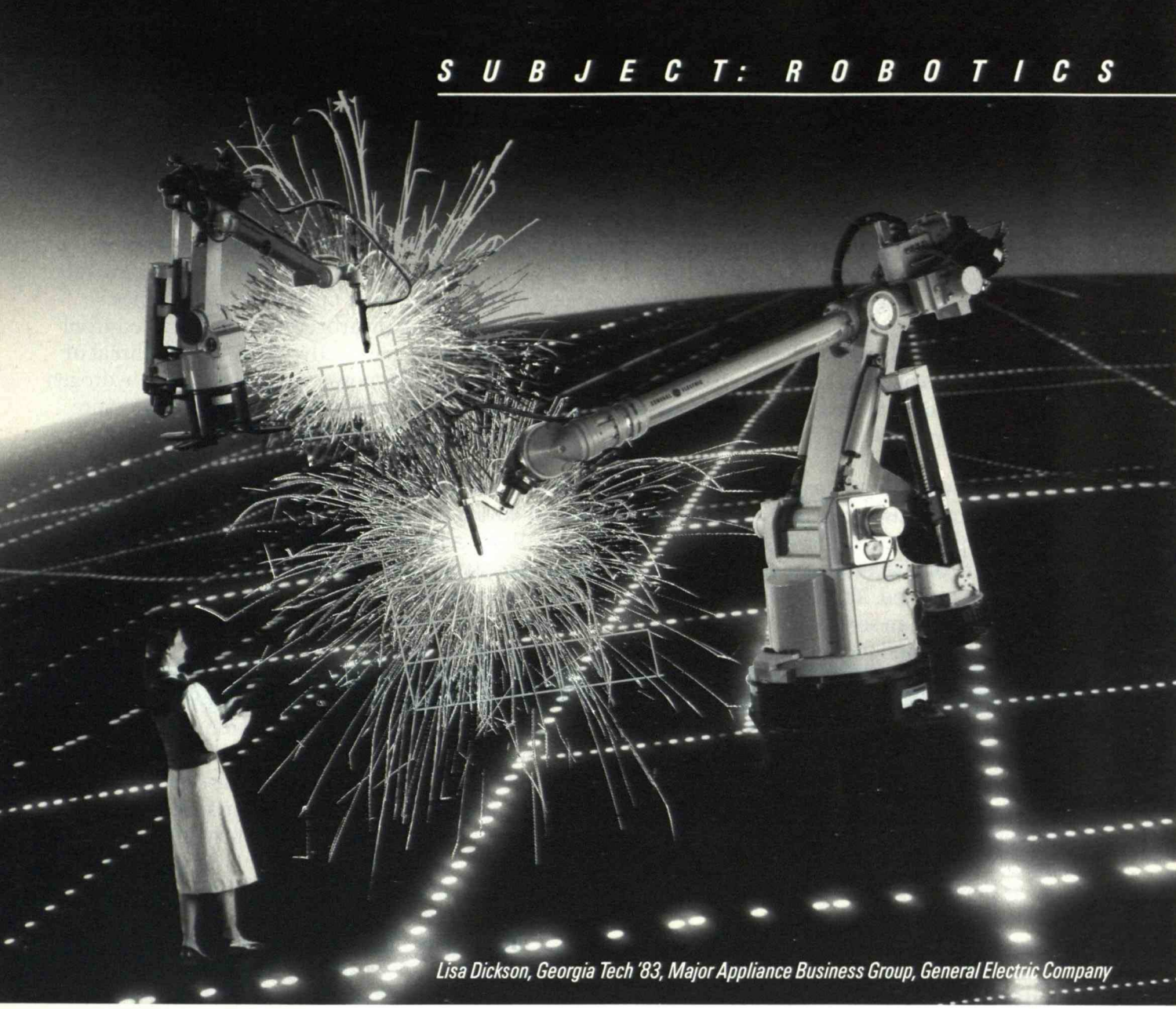
SUBJECT: ROBOTICS



Lisa Dickson, Georgia Tech '83, Major Appliance Business Group, General Electric Company

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The feasibility of turning sea water into electricity is being studied in fusion energy experiments at Kyoto University in Japan. The studies involve a Hughes Aircraft Company gyrotron, a microwave tube that uses a spiraling stream of electrons to produce extremely high power microwave frequencies. Fusion energy holds tremendous potential because its source of fuel (hydrogen) can be extracted from sea water. It could produce large amounts of power with little or no radioactive waste and no threat of meltdown or explosion. In fusion energy research, the gyrotron's high-power radio waves heat hydrogen particles (plasma) to temperatures of tens of millions of degrees. These particles fuse under pressure, causing a thermonuclear reaction that provides energy for driving steam turbines.

A new technique may expand the use of lasers in commercial and military applications. The approach, called optical phase conjugation, is considered a major advance in optics because it offers a solution to distortion problems that have limited the use of lasers. When a laser beam passes through a turbulent atmosphere or a severely strained optical component, the beam is distorted and the information it carries is degraded. The Hughes technique, however, forces the laser to retrace its path through the distorting medium so the beam emerges free of distortion. The method eliminates the need for complex electro-optical and mechanical components to correct the distortions.

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NASA's Project Galileo, which will explore the planet Jupiter later this decade, must arrive at a precise angle if it is to carry out its measurements of the chemical composition and physical state of the Jovian atmosphere. The Hughes-built probe will arrive at 107,000 miles per hour, fast enough to travel between Los Angeles and Las Vegas in nine seconds. If the probe hits at too shallow an angle, it will skip off into space; too steep, it will be reduced to ashes. Even at the proper angle, the probe will encounter extremes never before faced by spacecraft. In less than two minutes, much of the forward heat shield will be eroded by temperatures of thousands of degrees. With atmospheric entry forces reaching 360 times the gravitational pull of Earth, the 742-pound probe will take on a weight equal to an empty DC-10 jetliner. Project Galileo is scheduled to be launched from the space shuttle in May 1986 and to arrive at Jupiter in August 1988.

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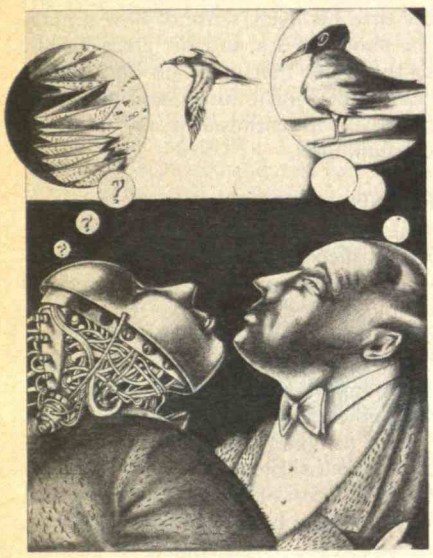

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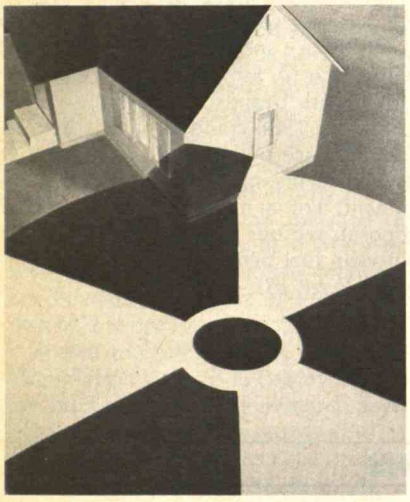

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Transitions

We begin the issue with reports of a loss and of a gain. The loss is that of Professor David J. Rose of M.I.T., a long-time friend and advocate, who died on October 24. The gain is that of Jonathan Schlefer, who is now the *Review*'s managing editor.

For more than a decade, despite inroads of emphysema, Professor Rose was an enthusiastic member of *Technology Review*'s Advisory Board and an ever-willing counsel to its editors. He pursued with what his faculty colleagues characterize as "enormous dedication" his sense of the fundamental indivisibility of problems such as energy and the environment, and he showed that our society's institutions have only limited ability to address holistic issues of this kind. Readers of *Technology Review* have gained immensely from his contributions, both to our pages and to the editors' understanding of issues that he addressed with so much passion.

Jonathan Schlefer brought an unusual background when he joined the staff in 1982—an undergraduate degree in Greek literature and mathematics, a graduate degree in architecture, and considerable writing experience—including Boston's *Real Paper*, the *Boston Globe*, and freelance contributions to *Technology Review*. We have discovered since then his lively sense of how a magazine should work and his great insight into the issues that motivate *Technology Review*. His contributions continue to be perceptive, his enthusiasm and commitment unlimited.

J. Schlefer

UPS AND DOWNS IN SPACE

It is nearly 30 years since the flight of *Sputnik* electrified the United States into a new concern for its progress in science and technology. Today when we think about technological competition, we focus on what we see not in the skies but in our homes—appliances, television, automobiles, and even computers made overseas. We tend to take for granted the achievements of space science, and even the shuttle. Indeed, most of us have hardly noticed how much is to happen in space in 1986, and how little is scheduled to happen thereafter—the message of Robert C. Cowen in this issue (*p. 12*). Gary L. Bennett provides some detail on the first of several "space spectaculars" to occur this coming year (*p. 80*): *Voyager 2*'s close encounter with Uranus late in January.

The year 1986 could also see a first attack on space pollution, a problem that has precedents in every terrestrial environment. For a novel and controversial proposal, see our forum contribution by Professor Joel Scheraga of Rutgers University (*page 18*).—*John Mattill*

STRATEGIC METALS FROM SOUTH AFRICA

In "How Critical Are Critical Materials?" (*August/September, page 38*), Joel Clark and Frank Field give prominent mention to the recent report of the Office of Technology Assessment (OTA) on that subject. However, the article implies that OTA supports closer ties to nations such as South Africa that now supply much of the world's strategic metals. To the contrary, OTA has urged a mixture of materials substitution, conservation, and diversification of supply to reduce dependence on any one nation. For example, increased use of Australian manganese could reduce dependence on South Africa.

Technology Review readers may obtain a copy of the 56-page summary of the OTA report by writing the Publications Office, Office of Technology Assessment, Washington, D.C. 20510. Copies of the full report are available for $17 from the U.S. Government Printing Office (GPO stock number 052-003-00979-0).

LANCE N. ANTRIM
Washington, D.C.

Lance N. Antrim was project director of the Office of Technology Assessment report on strategic materials.

"How Critical Are Critical Materials?" includes excellent analysis, obviously based on thorough research. The one flaw became evident to me when I heard former Defense Secretary Robert McNamara refer to the article on TV's "Crossfire." McNamara suggested that the authors said we don't need the minerals of South Africa. The table of contents, the lead-in summary on page 38, and the first two pages of text could well lead one to reach such a conclusion.

But a more thorough reading of the article reveals the authors' concern that the loss of South African minerals to the Soviets could lead to various unpleasant outcomes. For instance, Clark and Field point out that switching to other available materials would involve a long wait, and that developing new materials would require extensive R&D.

ROY RAYLE
San Antonio, Tex.

RADIOLOGICAL WEAPONS

In "Oppenheimer and the Radioactive Poison Plan" (*May/June, page 14*), Barton Bernstein seems to imply that because radiological warfare schemes "foundered" or were "not substantially pursued" during World War II, they were not pursued at all. The reader could end by believing that wise, moral officials quashed these "magnificent examples of military madness." Bernstein is obviously unaware of Lee Bowen's *A History of the Air Force Atomic Energy Program.*

Bowen indicates that in August 1946 Major General Curtis E. LeMay, then deputy chief of air staff for research and development, formally suggested that radioactive fission products be studied for possible use in offensive warfare. This idea appealed to the joint chiefs, the Research and Development Board, the Atomic Energy Commission, the Military Liaison Committee, and the Armed Forces Special Weapons Project (AFSWP). As a result, the AFSWP established a Radiological Warfare Study Group in February 1948.

In October 1949, the Army Chemical Corps began testing prototype weapons. Air force B-29s dropped four 2,000-pound bombs, presumably filled with radioactive material, near Wendover Air Force Base. The results of the bomb tests indicated that radiological weapons were less effective than surface-burst fission bombs for contaminating large areas. A Rand Corp. study in September 1950 reached a similar conclusion. As a result, research on radiological weapons was reduced but not eliminated.

The reason classical radiological weapons never entered the stockpile had nothing to do with moral repugnance. Rather, researchers found that atomic and hydrogen weapons were more efficient.

THOMAS B. COCHRAN
ROBERT S. NORRIS
Washington D.C.

The author responds:

I am pleased that my article spurred readers Cochran and Norris to summarize Bowen's account of chapter on early postwar radiological-warfare plans. However, I am puzzled by their assumption that I didn't know of Bowen's work. I first sought to have Bowen's volume declassified in 1978 and have used it in my research and writing. Chances are Cochran and Norris would not have access to the volume if I and some other scholars had not pushed to make it publicly available.

I have also stepped up efforts to secure other records on the history of radiological warfare. Important questions about the role of the weapons labs, the efforts of physicists and physicians, the goals of the military services, and other moral issues regarding this effort remain unanswered. The quest for radiological warfare did not end in 1945 but continued well into the Cold War. In fact, if thermonuclear weapons detonated at low altitudes are considered radiological weapons, we clearly still live with this spectre.

ANTITRUST AND COOPERATIVE RESEARCH

I take exception to Lawrence J. White's account of the Hydrolevel antitrust suit against the American Society of Mechanical Engineers (ASME), which was decided against ASME by the Supreme Court. (*See "Clearing the Legal Path to Cooperative Research," July, page 38.*)

I became executive director of ASME shortly after the event that led to the litigation. This event did not involve cooperative research in any way. It did not involve any of the officers of the society, but it did involve the former chairman of one of the committees of the society. ASME did not disparage the Hydrolevel device and does not issue product standards. However, ASME does provide performance standards. Also, ASME does not

Continued on page 17

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ROBERT C. COWEN

Will 1986 Be NASA's Last Big Year in Space?

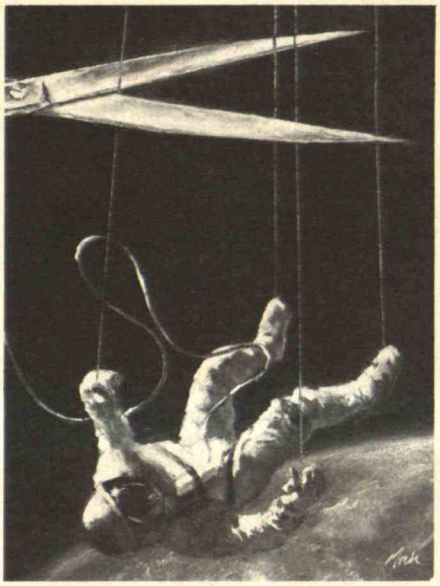
FOR NASA officials, September 11 was one of their agency's prouder moments. That was the day the *International Comet Explorer (ICE)* went through the tail of the comet Giacobini-Zinner. Because of budget cuts, NASA has no spacecraft in the international fleet now heading for Halley's comet. But by using ingenuity instead of money, NASA managed to make the first direct probe of a comet after all. Controllers at Goddard Space Flight Center used orbital manuevering rockets and slingshot-like boosts from the gravity of the moon to divert an aging Earth satellite, renamed *ICE*, into the comet's path.

NASA officials anticipate more such proud moments in 1986, which they characterize as a "year of intense space science activity." The agenda includes the first flight of *Voyager II* past Uranus on January 24, a journey that will provide humanity's first close look at that distant planet (*see page 73*). In May the Galileo-Jupiter mission will launch a spacecraft to study the giant planet from orbit and dispatch a probe into the Jovian atmosphere. The Hubble Space Telescope, which will provide the sharpest, clearest view of the cosmos ever, will begin its Earth orbit in August. And, of course, the space shuttles will continue ferrying important scientific experiments to and from outer space. Although these achievements are expected to come to fruition in 1986, they represent commitments made in happier budget years in the mid-1970s.

Unfortunately, leaner times prevail today. The current administration is under enormous pressure to cut the nation's budget deficit, and NASA is feeling the pinch. NASA officials have already decided not to include funds for the first direct rendezvous with an asteroid in the fiscal 1987 budget request. Because that $20 million mission was part of a carefully timed plan for planetary exploration, NASA's decision leaves many scientists skeptical of the agency's ability to carry through on long-term plans.

NASA felt it had to scrap the on-site asteroid survey to save funds for international space ventures that had been cut from previous budgets. For instance, Europe, Japan, and the United States are jointly sponsoring the International Solar Terrestrial Physics (ISTP) mission. A fleet of ISTP spacecraft will make a detailed study of the sun's energy output and the solar winds and their effect on Earth. The United States is also cooperating with France in an effort to orbit a satellite known as *TOPEX*, which will measure the topography of the ocean surface. This mission could furnish fundamental information about ocean circulation, a key factor in the Earth's climate.

Both programs had been included as new "starts" in last year's budget request, and both were deleted when congressional deficit-cutting measures mandated that the agency not begin any new programs. Hence, these programs top NASA's list of priorities. Furthermore, NASA does not want to reinforce its reputation for backing out of international ventures. NASA is now planning to include funds for the ISTP in its 1987 budget request.



America's space scientists may face leaner budgets and fewer missions for some time to come.

The European scientific community still hasn't forgotten the first time NASA reneged on a joint venture with the European Space Agency (ESA). NASA had agreed to supply one of two probes that would orbit over the poles of the sun, exploring the star's powerful effect on the Earth's magnetic forces. But NASA had to cut funding for its probe in 1981—a unilateral act that embittered ESA. Fortunately, the agency appears to have forgiven the United States and is proceeding happily with the launching of the *Ulysses*, as the single solar spacecraft is now called.

Nevertheless, our foreign partners' uncertainty about NASA's financial future could cloud other international ventures, including the permanent manned space station slated for completion in 1992. And even though NASA is clearly backing the *TOPEX* and ISTP missions, there is no guarantee that they will survive the budget-cutting process next spring.

Our European partners are also concerned about the U.S. military's involvement in NASA's shuttle program. NASA has agreed not to use the ESA-supplied Spacelab for any military purposes aboard the shuttle. The Strategic Defense Initiative Organization is planning to put several experiments aboard Spacelab, but the NASA/ESA agreement stipulates that they must be restricted to open, basic-research projects not directly related to weapons development. Only good behavior on the part of the United States in upholding its international agreements and maintaining a strong civilian space program will allay the Europeans' concerns.

NASA's budget has been running somewhat under $8 billion. Given the drive to hold down federal expenses, it is likely to remain in that range. Moreover, the space station will undoubtedly claim a growing share. Under these circumstances, it is hard to envision any major infusion of new money for space science.

Thus, 1986 may well be our last year of "intense space science activity" for an indefinite time. American space scientists must live with this fact of fiscal life. Their best hope for maintaining a broad range of scientific activity may well lie in participating in European, Soviet, and even Japanese space research. Europe and Japan are maturing as space-faring nations. Americans, who have long played host to space scientists of other countries, can profit by becoming their guests. □

ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.*

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MARSHALL I. GOLDMAN

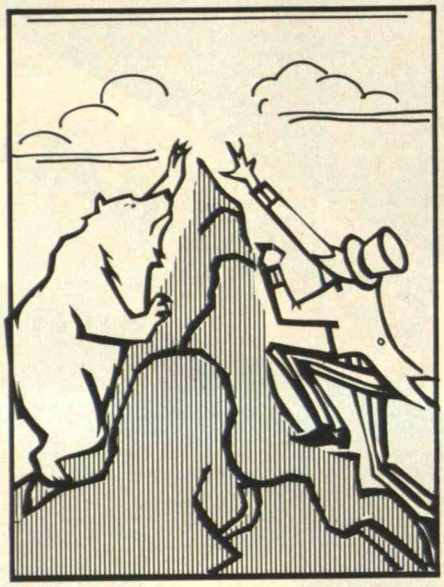
Why the Soviets Couldn't Walk Out—This Time

ONE of the most remarkable aspects of the Geneva summit conference was that it took place at all. If some of President Reagan's advisors in the Department of Defense (DOD) had had their way, the meeting probably would have been canceled. As these advisors see it, such talks tend to put inordinate pressure on the United States to make concessions because public opinion plays a much more important role here than in the Soviet Union. And in the euphoria surrounding even a modest agreement, these advisors fear that Congress will lose all interest in sustaining high military expenditures.

But skepticism about summit meetings is not limited to the United States. Many Soviet specialists also opposed the meeting with Reagan, although not necessarily for the same reasons. They were opposed because of what they viewed as his openly expressed animosity toward the Soviet Union and his intransigence on arms-control issues. They were concerned that such a meeting would humiliate Soviet leaders.

These Soviet advisors remembered what happened when then-General Secretary Yuri Andropov warned that the Soviet Union would walk out of the Geneva arms talks in 1983 if the United States installed Pershing II missiles in Western Europe. We did install the missiles and Andropov did walk out. The advisors also remember that the Soviet Union had recently warned that it would not resume discussions if Reagan persisted with the Strategic Defense Initiative, or Star Wars program. Given the unwillingness of the U.S. president to alter his course, many Soviet officials were doubtful the summit would even take place. Their pessimism increased as General Secretary Mikhail Gorbachev offered up one seemingly new arms proposal after another, only to have Reagan reject most of them before the summit.

Yet in the end the two sides were able to agree on a surprisingly large number of issues. The minor agreements to renew cultural and consular exchanges are not that important except as a way of clearing the air. The decision to allow Pan Am and Aeroflot to resume direct flights between the two countries is also a step in that direction.



The pressing need for economic reform in the Soviet Union kept Gorbachev at the bargaining table in Geneva.

Of more importance, however, is the agreement of the two leaders to meet again in the coming year—this time in Washington. Both sides also agreed to continue talks toward banning chemical weapons. If such talks prove fruitful, they could mean the demise of the Pentagon's controversial plan to build new binary, or two-stage, chemical weapons to replace our aging stockpile of unitary munitions. Both sides also agreed in principle to limit the number of missiles in different categories. However, the specific reductions for each category of missile carrier remain to be worked out.

Despite such gains, neither leader achieved a significant breakthrough on any major issues. The Soviets remain upset over Star Wars, and we are not happy about their treatment of Soviet dissidents ad their failure to withdraw from Afghanistan. Nonetheless, the meeting was a good beginning.

A Change of Heart

Yet even that modest success came as a surprise to many observers, who never expected both sides to narrow their differences as much as they did. After all, the months preceding the summit had been poisoned by a atmosphere of animosity and suspicion. But as many Soviet and American observers had already figured out, Reagan's actual negotiating stance was a lot more practical than his Soviet-bashing rhetoric had led the American public to believe. But what explains the apparent change of heart by the Soviet leadership?

Without access to the closely guarded minutes of the Politburo meetings, we can only guess about the Soviets' motives. However, it does appear that Soviet leaders want desperately to restrain the arms race and prevent the United States from embarking on its Star Wars effort. They fear American technology and worry that the United States, if unrestrained, will achieve some major breakthrough relegating the Soviet Union to inferior military status. In many ways they have more faith in our technology than we do.

Both civilian and military Soviet leaders have come to appreciate the fact that Soviet technological development is not what it should be. The Soviet Union has more engineers than any other country in the world, but it doesn't seem to be able to keep up technologically with its Western counterparts. I do not mean to denigrate some impressive accomplishments of Soviet science, especially in space. Indeed, the Soviets have translated their abilities in engineering and science into a very potent military capability. In the past, they have always seemed to pull abreast, and in some cases even ahead, of the United States in weapons systems, even though they may take longer to develop the weaponry and it may be somewhat more primitive.

However, even Pentagon officials concede that American technology is moving at such a rapid pace that the Soviet Union may be falling behind. And the Soviets cannot necessarily use stolen technology to narrow this gap. In an official DOD study warning about the massive Soviet effort to steal our technology, defense officials acknowledge that "the USSR's prac-

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ILLUSTRATION: ELIZABETH SLOTE

tice of reverse engineering . . . may soon run into problems." As U.S. and Japanese integrated circuits become more complex, the report says, Soviet efforts to copy such circuits "will require not only much more sophisticated Western equipment but also much more time . . . causing their overall microelectronics gap with the West to widen."

Soviets Must Revamp Their Economy

Senior Soviet military officials realize that the failure of the Soviet Union to keep up in the technology race has serious military implications. In a remarkably candid interview in May 1984—undoubtedly a major reason for his dismissal a few months later—Military Chief of Staff Nikolai Ogarkov warned that "the rapid development of science and technology in recent years will shortly make possible even more destructive and until now unknown types of weapons based on new physical principles. Work on these new types of weapons is under way in a number of countries—the United States, for example." From the context of his statement, it seems clear that Ogarkov does not include the Soviet Union in the "number of countries." This is not to deny that Soviet scientists are actively pursuing new military technologies. However, in Ogarkov's view at least, Soviet scientists have had trouble keeping up with the extremely fast pace of progress in higher technologies.

Negotiating an arms-control agreement that would halt or even slow development of U.S. military technology would be an important achievement for the Soviet Union. In addition to giving his military some breathing space, Gorbachev seems determined to revamp the Soviet economy and restrain the military's access to Soviet economic resources. He seems to feel strongly that the Soviet Union must make its economy more innovative, productive, and efficient to keep up with technological developments in the West and Japan. Failure to reform the economy at this juncture would have serious military as well as economic implications for the Soviet Union.

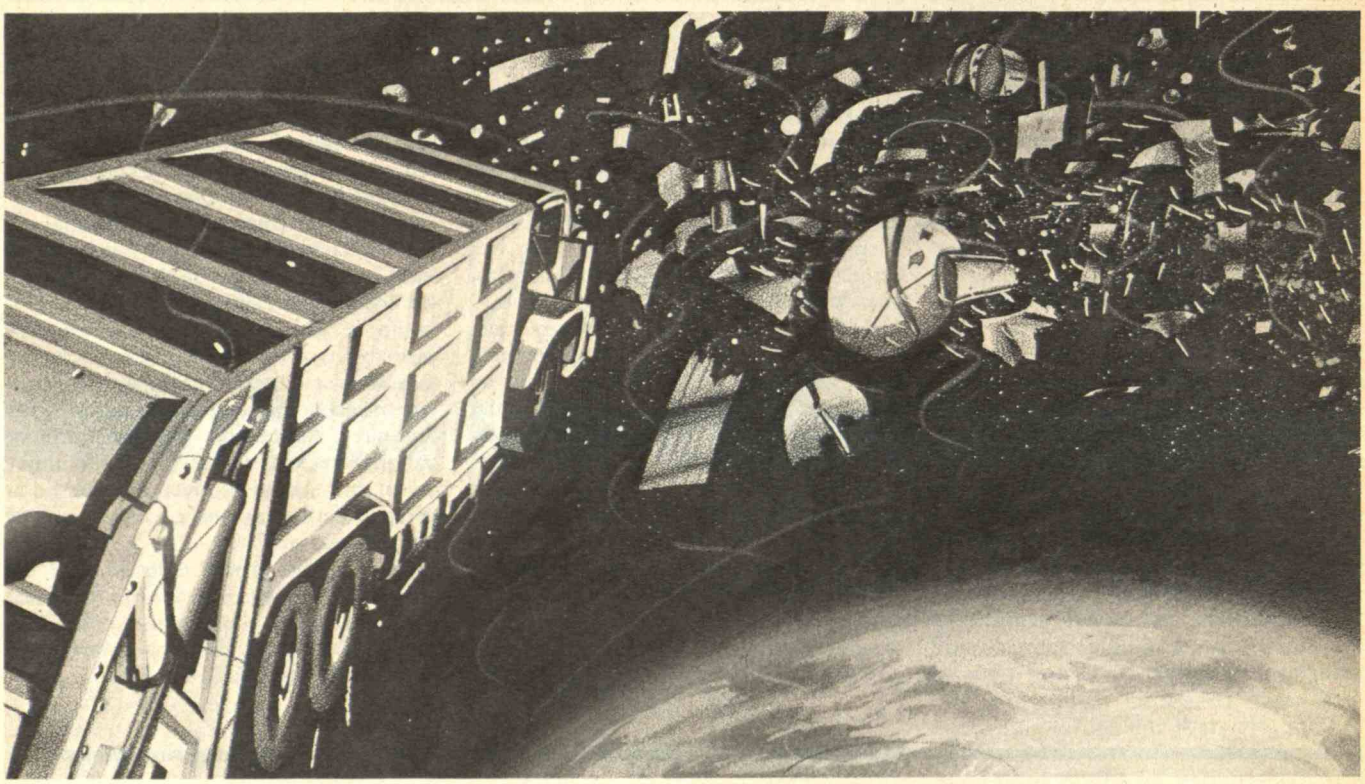
If nothing else, Gorbachev had to gain at least a standoff at Geneva. Without that, his generals would undoubtedly insist on commandeering an even greater share of the country's resources.

The Soviet chief faces a dilemma. As important as military might is to him, he must nonetheless rein in the more unrestrained members of his military-industrial complex. In the long run, Gorbachev probably would agree with Frederick Engels, who said that "nothing is as dependent on economic conditions as an army and navy. Armaments, personnel organization, tactics, and strategy depend above all on the stage of production achieved at the given moment and on the means of communication."

Thus, to be strong, it looks as if the Soviet Union must restrain itself, at least for now. As much as anything else, that may explain the modest accomplishments at Geneva last fall. □

BY JOEL D. SCHERAGA

Curbing Pollution in Outer Space



Two years ago, a piece of cosmic junk smashed into the windshield of the space shuttle Challenger. Fortunately, the fast-moving fragment only pitted the glass. A larger object might have crashed through, killing or injuring the Challenger's crew members. During the *Skylab* scare in 1979, the 85-ton spacecraft plummeted to Earth and scattered large chunks of debris across areas in Australia that, fortunately, were not densely populated.

The amount of useless and potentially dangerous debris in outer space is rapidly becoming a major international problem. Between 10,000 and 15,000 objects have already been discarded in orbit, including dead satellites, spent fuel boosters, and garbage jettisoned from spacecraft. Several million metal fragments from experiments and explosions in space (including anti-satellite tests) also drift in various orbits up to several hundred miles above Earth. These small metal fragments travel at 17,500 miles per hour and can cause serious damage if they collide with a manned spacecraft or satellite. The pollution problem is becoming so serious that the American Institute of Aeronautics and Astronautics predicted in 1981 that the risks posed by debris will make space unacceptable for human use within a decade.

JOEL D. SCHERAGA is assistant professor of economics at Rutgers University and a visiting assistant professor at Princeton University. He worked at the Jet Propulsion Laboratory in Pasadena, Calif., for two summers and writes on the economic problems of colonizing space and the use of geosynchronous satellites.

Property Rights in Space

At present, we have no way of tackling this growing menace because there are few international laws governing activities in space. Unlike the ocean, where disasters are governed by international maritime law, space is a legal wasteland where countries have no property rights and few legal responsibilities. If, for instance, the United States conducts a laser test that scatters metal fragments in a near-Earth orbit, our government cannot be held responsible should those fragments damage another country's satellite. Only by clearly establishing property rights in outer space can this problem be resolved.

Pollution in outer space is only going to get worse. Commercial launch services cheaper than those available during the 1960s and 1970s have made it easier for other countries to establish a presence in space. Virtually anyone can now place a satellite or experiment package in orbit. National governments and large corporations are particularly anxious to launch geosynchronous communications satellites because they can transmit a continuous flow of information between any two points within their range.

NASA's space shuttle and the European Space Agency's Ariane rocket are already competing for public and private customers. Japan, China, and India have all built and successfully launched rockets. France is working on its own mini-shuttle, and the British are developing a space tug. Even private firms such as OTRAG, a German firm, and Space Services, Inc., a U.S. company, have begun to build and market their own rocket systems.

With these new ventures, and the U.S. decision to go forward with anti-satellite tests, the amount of debris in space will only multiply. The United States has often dumped trash in space by accident and indifference. However, unlike the Soviet Union, it did not deliberately smash its own spacecraft for military testing pur-

ILLUSTRATION: SALLY WERN COMPORT

Pollution may make outer space unacceptable for human use within a decade.

poses—until recently.

As Challenger's experience showed, space debris puts the lives of astronauts in jeopardy every time they enter space. Space debris also threatens to interfere with the performance of scientific experiments or even to accidentally destroy them. Radio astronomers had to grapple with this problem as early as 1963, when the U.S. Air Force conducted Project West Ford. The military launched small needles into an orbit 2,300 miles high to act as passive reflectors and experimental radio transmitters. Astronomers were concerned that the needles would interfere with their observations. Many of these needles are undoubtedly still in orbit, and radio astronomers must take them into account when designing their experiments.

Large objects that accidentally reenter the Earth's atmosphere also endanger both lives and property. Space debris in near-Earth orbits does not remain aloft forever. Because of perturbations from the Earth's gravitational field and pressure from solar radiation (or "solar wind"), its orbit slowly decays. Although friction causes most objects to burn up when they reenter the upper atmosphere, larger objects may reach the Earth's surface. That is precisely what happened to *Skylab*: unforeseen atmospheric bulges produced by solar storms caused it to hurtle to Earth before NASA could devise a way of boosting it into a higher, more stable orbit.

A Radiation Threat

Nuclear-powered satellites that orbit at low altitudes pose an even more serious threat to the earthbound population. While most U.S. satellites are solar powered, some Soviet satellites contain small nuclear power plants. These power units are sealed in heavy containers unlikely to completely disintegrate when they reenter into the atmosphere. Hence, they could contaminate the Earth's surface.

Cosmos 954, a nuclear-powered Soviet spy satellite that crashed into the Canadian wilderness in 1978, dramatically demonstrated this fact. The Soviets were reluctant to help track the satellite and locate its fragments, undoubtedly because of its sensitive military nature. The Canadian government eventually retrieved the radioactive debris from the satellite after an expensive cleanup effort over a large area.

The international community has made a limited effort to resolve the pollution problem under the auspices of the United Nations. The two superpowers, other industrialized countries, and Third World nations that attended the International Convention on Registration of Objects Launched into Outer Space drew up some agreements. These require that all countries register satellite launchings with the U.N., and that they report identifying features and general functions of their satellites along with data about their orbits. This information is useful to other countries launching satellites into coincident orbits, and it also alleviates the problem of confusing harmless satellites with space weapons or missiles. Also, countries that attended the 1972 Convention on International Liability for Damage Caused by Space Objects agreed to pay for any damages caused to any person or property by a space vehicle that inadvertently reenters the atmosphere.

Unfortunately, these agreements are unenforceable—as the crash of *Cosmos 954* showed. Not only were the Soviets reluctant to help track the satellite as it reentered the earth's atmosphere, but they initially refused to pay for any of the retrieval or damage costs caused by its crash. They later paid one-fifth of the cleanup costs.

Private Property in Space

All this pollution results from the failure to establish property rights in space. Because no one owns locations in space, the cost to any nation or commercial user of occupying and polluting a section of space is zero. Assigning property rights to countries would make them responsible for any debris in their sections of space. The United Nations, which now oversees all matters concerning space, could distribute space locations through a simple auction or a system based on need and technological capability. Once assigned, these rights could be bought or sold. The owners of orbits or orbital slots could also charge other countries for their use—in much the same way that states impose tolls on the users of highways.

Such an approach would be inequitable: the wealthiest nations would end up with the most property rights in outer space. That is one reason why Third World countries have so vigorously rejected the idea of establishing private property in space. They were the prime movers behind the 1967 Outer Space Treaty, which forbids countries from appropriating any regions in space and establishing private property. This treaty has been ratified by 107 countries, including the Soviet Union and the United States.

A more equitable solution, suggested by India, would allow the United Nations to award each country a specific number of orbital locations. The sizes of the awards would be based on a formula established through international negotiations. Developing countries would receive a minimum number of property rights. Such an approach would ensure that Third World countries that could not afford to buy sections in space in a free market would not completely forfeit their right to use it. Of course, international policymaking bodies such as the United Nations are heavily influenced by the Soviet Union and the Third World, and they might be tempted to cut inequitable political deals.

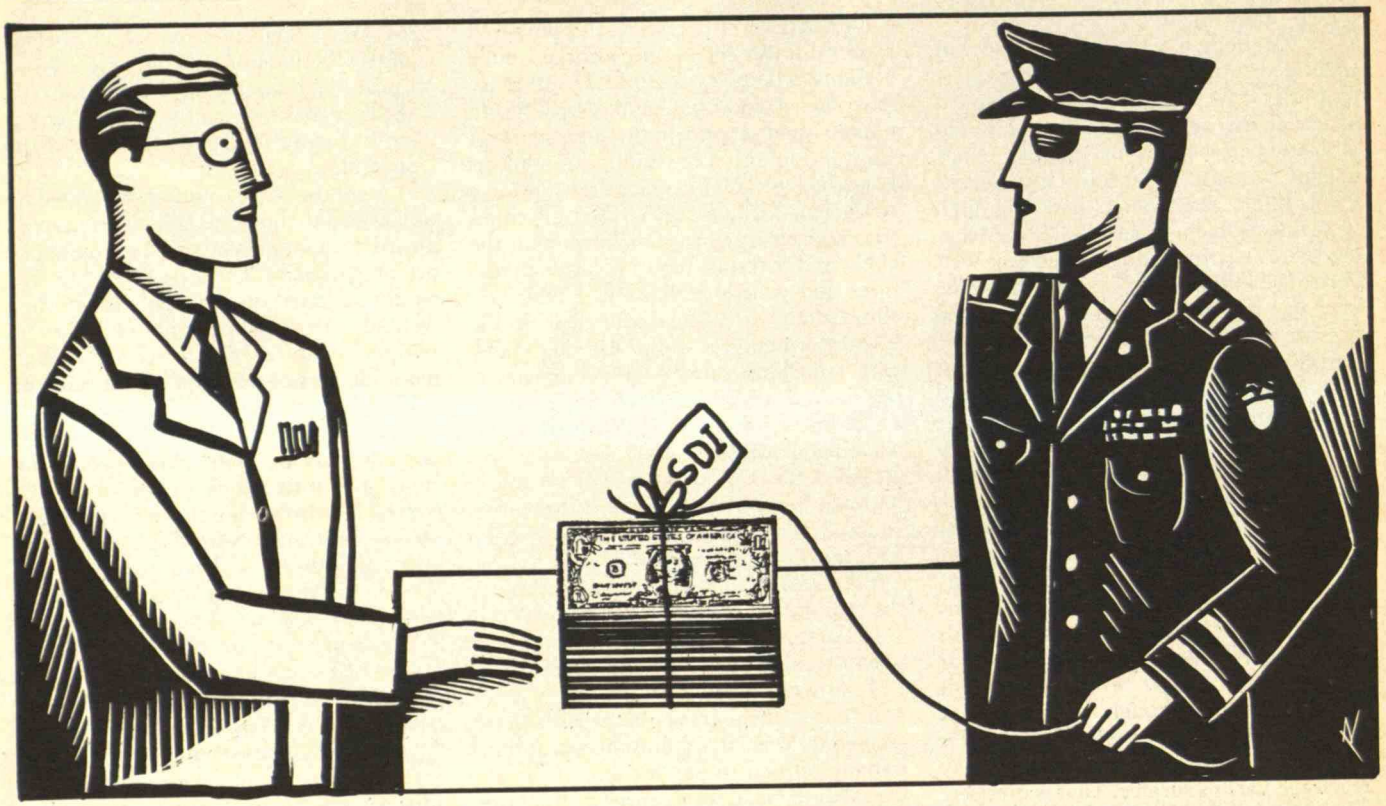
The reluctance to establish property rights means that any nation or commercial entity can pollute and overexploit any section of space. The demand for slots for the geosynchronous satellites—spaces that are limited to prevent interference between adjacent satellites—is rapidly increasing. Nations now occupy these slots essentially on a first-come, first-served basis. They therefore have an incentive to acquire as many orbital slots as quickly as possible at the prevailing market price of zero. Whoever gets there first can take it for nothing. This outcome is neither efficient nor equitable.

An approach that recognizes the value of outer space, unambiguously defines property rights, and permits the free exchange of those rights guarantees that space resources will at least be used efficiently. Through free exchange, the country that values a location the most will eventually own it.

The task of establishing and enforcing property rights in space will not be simple. Different methods for defining property rights will have to be debated, and a workable system of determining the number of orbital locations each country can use must be hammered out. Perhaps a system of bidding or even taxation could be developed. But if the challenge of establishing property rights in outer space is pursued in a spirit of world peace and cooperation, then the outcome will surely be preferable to the current free-for-all in space. □

BY VERA KISTIAKOWSKY

Should University Researchers Accept SDI Funding?



THE announcement by the Strategic Defense Initiative Organization (SDIO) that it would spend about 5 percent of its budget on university research has started an intense controversy over the merits of the campus R&D program. Such concerns, however, are not new. The debate over the impact of military research on campus has become increasingly heated over the past four years. Faculty opposition at Caltech, for instance, prevented the institute's Jet Propulsion Laboratory from setting up an army think-tank there.

Such opposition has occurred because of the steady increase in the percentage of federally funded R&D devoted to military programs—from 50 percent (its level from 1970-80) to 67 percent in 1985. The administration's budget request for fiscal year 1986 included an additional increase for military research programs, bringing the military's share of the total R&D budget to 72 percent.

The SDIO was established in 1984 to carry out a program of research, development, *and* demonstration of the weapons technologies needed for the president's Star Wars defense against intercontinental ballistic missiles. Experts in various fields have widely criticized this defense concept, raising questions about its technical feasibility, strategic usefulness, and effect on the arms race. A recent report by the Congressional Office of Technology Assessment concludes that "a strategic defense which could assure the survival of all or nearly all U.S. cities in the face of unconstrained Soviet nuclear offensive forces does not appear feasible."

The branch of the SDI program that administers university research—the Office of Innovative Science and Technology (SDIO/IST)—has met opposition on campuses throughout the United States. Hundreds of faculty, staff, and students at more than 60 universities, including Cornell, Princeton, University of Illinois, Caltech, and M.I.T., have signed pledges not to accept SDIO/IST funding.

The situation is not a simple one. The proposed freeze of support for basic and non-military applied research in the fiscal 1986 budget makes the opportunity for SDI funding particularly compelling. So far scientists and engineers have submitted more than 3,000 "white papers," or preliminary research outlines, to SDIO/IST. The university researchers who wish to participate usually cite a variation of: "SDI is wrong, but by taking the money for my research, I will be putting it to good use." Occasionally one is told: "This is the only remaining source of funding for my research area." Even less frequently one hears: "The technologies could result in a useful addition to our national defense, or at least contribute positively to the U.S. position with respect to the Soviet Union."

There are four general reasons for opposing SDI funding at universities: the political implications of accepting such funding; the possibility that the program will lead to classification or other restrictions on research; the distortion of national research priorities; and the impact of such mission-oriented research on universities. Military support of university research for other purposes may also have these effects. However, the SDIO/IST funding is of special concern because of the large increment of support it represents, and because so many members of

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ILLUSTRATION: ANTHONY RUSSO

the scientific and technical community oppose the SDI program.

The Politics of SDI

The political implications of universities' accepting SDI funding have received the most public attention. The presidents of M.I.T. and Caltech have each made strong statements disclaiming the implication by SDIO that accepting research grants shows institutional support for SDI. However, it is not clear that such disclaimers are effective. As members of SDIO have pointed out, the universities are certainly giving their consent and administrative support to SDI research grants awarded to their scientists and engineers, and to applications for further support. Since in all cases (except the "white papers"), grant proposals and contracts must be signed by a member of the university administration, the university is involved. The university—not just the individual research group—receives overhead funds and provides services for these projects.

At best, the distinction between this kind of "support" and institutional support will appear fuzzy when the SDIO makes its annual case for funding to Congress. Active participation by the university research community will certainly be used as a sign of support for SDI.

Under the Reagan administration, the question of classification and other restrictions on research has become a thorny problem for the many universities with a tradition of open research. The issue is not an academic matter: the free exchange of ideas and information is one of the major sources of our country's great strength in research.

SDI funding is in a specific R&D category that is normally classified because it is used for weapons systems. However, a memo issued by the SDIO in August, and a White House policy statement made in September, both state that SDI university research will be treated as basic research and will not necessarily be classified. Nevertheless, neither document rules out the possibility that the research will ultimately be classified or subject to any other restrictions.

SDIO/IST officials also suggest that professors in charge of SDI research, and possibly even some graduate students, may have to obtain security clearances. This will give them access to all relevant sources of information, including studies from industrial and government laboratories doing classified research. Such a requirement, of course, could prevent foreign students—who at M.I.T., for example, make up about one-third of the graduate student body—from participating.

Funding for SDI could distort national research priorities, lead to classified research on campus, and even threaten academic freedom.

SDI research will be carried out primarily by consortia of universities and industrial and government laboratories. So how can research done on university campuses be separated from what is carried out elsewhere in order to keep it unclassified?

SDIO officials have themselves commented that it may become necessary to later classify initially unclassified research. They maintain that such research could be transferred to another facility if the university does not accept the change. However, this raises the concern that university research programs established with SDIO/IST funding may be abruptly terminated, leaving graduate students stranded in midthesis. Ultimately, universities may be forced to choose between accepting classified research and losing substantial funds.

Furthermore, the Reagan administration has dramatically increased the number of research fields considered militarily sensitive. Participation and publication in these fields is subject to restrictions under the Export Control Act, the Freedom of Information Act, and various administrative orders. So even if the research is unclassified, the SDIO may impose restrictions on who can participate and on what may be published in the open literature and discussed at open meetings. The Department of Defense (DOD) has already imposed such restrictions in a number of cases. At the last minute, for instance, the DOD did not allow scientists to present 43 of the papers submitted to the March 1985 meeting of the Society of Photo-Optical Engineers in open sessions.

Distorting Academic Priorities

SDI funding could cause lasting damage to the health of U.S. science and technology by distorting research priorities. The increasing percentage of R&D devoted to the military has already altered the profile of U.S. research.

The description of the SDIO/IST handed out to university representatives last March contains a clear statement of its purpose: "Mount a mission-oriented, basic research program that drives the cutting edge of the nation's science and engineering effort in a direction that supports existing SDI technological development thrusts and points the way for future new initiatives."

There is no pretense here that the SDI program supports free basic research carried out by independent researchers. This is intended to be a highly structured program with funding for only 17 narrow research areas. And the funding for small independent research groups will be short-term. Among the areas targeted are advanced electronic systems, advanced electrochemical power sources, laser satellite networking, optical sensors, ultra-short-wavelength lasers, space science and technology, and ultra-high-speed computing.

Research proposals will be judged on how well they fit into these areas, and only secondarily on scientific merit. The result will be funding quite out of proportion to the scientific community's interest in such projects, in terms of both basic research and non-military applications. Many people cite the possibility of "spinoffs" to civilian technologies as a reason to support SDI, but it is not necessary to do research on a 5-megawatt laser to develop a laser suitable for brain surgery. A civilian agency could directly fund research on the surgical laser for a minute fraction of the cost of the 5-megawatt laser.

Because of these funding priorities, many more of the next generation of scientists and engineers will receive their degrees in these narrow fields. This will produce a disturbing long-term change in the nation's research priorities.

Continued on page 17

Artificial Intelligence:

Summary:

GTE research in Artificial Intelligence has produced exciting results in several areas of knowledge-based systems. In addition, research is under way to teach computers to learn by themselves, much as humans do.

It's extremely tedious and difficult to teach a computer to respond to specific problems in an intelligent way.

Despite this, GTE has created several workable systems, which are in the field now.

But training a computer to respond to analogous or unexpected situations —teaching it to *learn*—is a very different challenge. And this is one of our long-range programs in AI research.

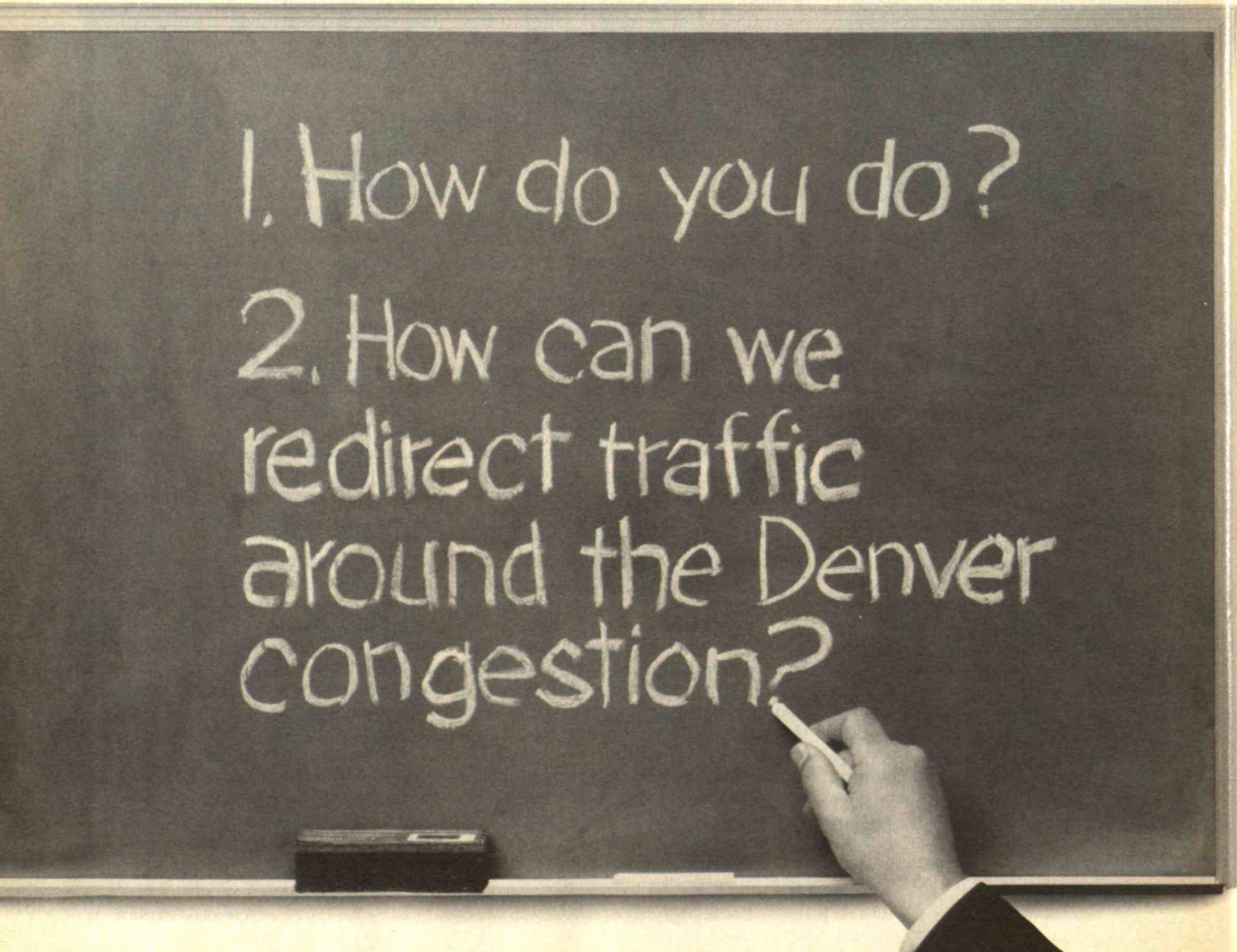
The ultimate brain-picking.

The Expert-Systems version of AI is literally the result of programming the experiences of experts into a computer.

Once these human reasoning processes have been codified, the computer has the information it needs to mimic the experts' responses to an immense variety of problems.

COMPASS (Central Office Maintenance Printout Analysis and Suggestion System) is an Expert System we devised for telecommunications. It is being phased into field use to monitor switch per-

Which of these questions is easier for a computer to answer?
The apparently simple greeting is loaded with semantic traps. On the other hand, the complex question relating to traffic redirection can be tackled by Expert Systems.



reality and promise.

formance, diagnose problems and recommend corrective actions in large communications networks.

Say hello to FRED.

The proliferation of databases and their integration in a large information system is increasing computer uses. Increasing user friendliness is becoming all the more necessary for computers to be used by less skilled operators.

GTE has developed FRED (Front End for Databases), which enables operators to frame information requests from multiple databases, in plain English. FRED untangles the request, breaks it into segments the computer understands—and provides the data, in plain English.

For its next evolution, we are teaching FRED to approach several databases at once (rather than one at a time), and put all relevant data into a single reply.

The nature of thought.

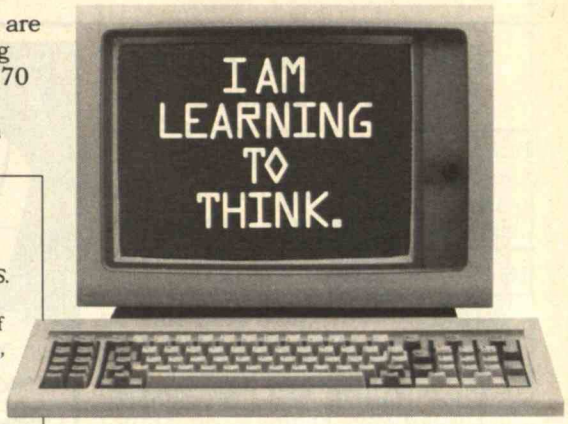
Another of our AI research directions is basic, long-range research into ways of teaching computers to learn for themselves, through experience and/or inference.

This involves research into such an area as the way children learn, as well as deep studies into the nature of decision-making itself.

Much remains to be discovered, of course—but the promise of true machine learning is perhaps the most exciting in the entire computer field.

The outcome of these projects—some near-term, some more in the future—will be to make the computer a far more useful and friendly tool for an immense variety of industrial and human problems.

The box lists some of the pertinent papers GTE personnel have published on various aspects of Artificial Intelligence. For any of these, you are invited to write to GTE Marketing Services Center, Department AI, 70 Empire Drive, West Seneca, NY 14224. Or call 1-800-828-7280 (in New York State 1-800-462-1075).



Pertinent Papers

"COMPASS: An Expert System for Telephone Switch Maintenance," S.K. Goyal, D.S. Prerau, A.V. Lemmon, A.S. Gunderson and R.E. Reinke, Expert Systems: The International Journal of Knowledge Engineering, *Vol. 2, No. 3, August 1985. pp 112-126.*

"Selection of an Appropriate Domain for an Expert System," D.S. Prerau, AI Magazine, *Vol. 4, No. 2, Summer 1985; pp 26-30.*

"A Natural Language Interface for Medical Information Retrieval," G. Jakobson, C. LaFond, E. Nyberg and V. Shaked. Third AASMI Joint National Congress on Computer Applications in Medicine, May 1984, San Francisco, California. pp 405-409.

Computer Experience and Cognitive Development, *R.W. Lawler. Ellis Horwood Limited, Chichester, U.K. (1985). (Summary of book.)*

"The Learning of World Models by Connectionist Networks," R.S. Sutton and B. Pinette. Proceedings of the Seventh Annual Conference on Cognitive Science Society, 54 (August 1985).

"Training and Tracking in Robotics," O.G. Selfridge, R.S. Sutton, A.G. Barto. Proceedings of the Ninth International Joint Conference on Artificial Intelligence, 670 (August 1985).

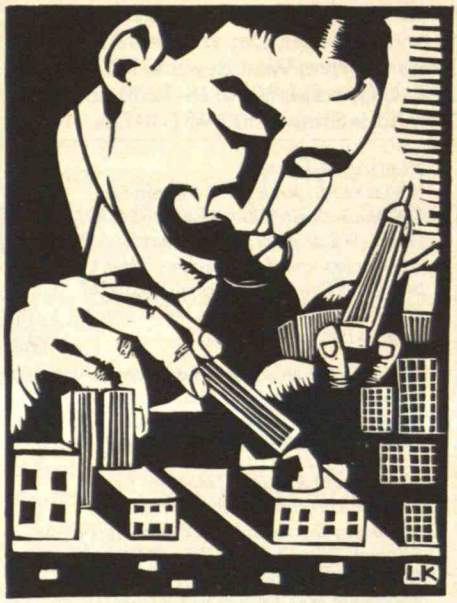
GTE

Technological Utopians, and the Social Effects of Television

Technological Dream Worlds

Technological Utopianism in American Culture
by Howard Segal
University of Chicago Press, $14.95

Reviewed by Rosalind Williams



Start this book with the illustrations. You will see a skyscraper-on-its-side—a double-decker concrete snake that slithers over hill and dale and disappears over the horizon. The "New Utopia schoolhouse," high on a tree-studded hillside, looks like a gigantic light bulb in a hexagonal socket. The "new era model city," composed of 239 concentric circles, including a factory circle and a hotel circle, orbits a three-tiered central building that resembles a wedding cake. And the spired and domed town mansion of "Reciprocity"—perfectly symmetrical and devoted to some ill-defined public use—looks like a Roman basilica plunked down in rural Ohio. The only human figure you will see among these images, other than the antlike dots crawling below vast housing projects, is the heroic demigod "Man Corporate," incongruously boasting a handlebar moustache and a fringed sarong. He strikes a Roman pose of muscle-bound meditation while gazing at a small globe, pondering how "he will penetrate the confines of space, and make it deliver up its secrets and power."

Howard Segal's *Technological Utopianism in American Culture* is a thought-provoking study of the 25 men who generated these and similar images. Only two of the visionaries are reasonably familiar: Edward Bellamy, the reclusive Massachusetts journalist who wrote the phenomenally successful book *Looking Backward,* and King Camp Gillette, inventor and marketer of the safety razor. These utopians were romantic engineers who laid out dream worlds with compass and straight-edge, and whose ruling passions were efficiency and planning. Living from the 1880s to 1930s, they shared a fascination with the technological innovations that cascaded from the second industrial revolution.

Corporate capitalism was displacing entrepreneurial capitalism in this late-nineteenth-century epoch. The technological utopians resembled proponents of other reform movements of the period, including supporters of drives for scientific management of homes and factories and other forms of social engineering. Although "Man Corporate" would eventually emerge in a business suit rather than a sarong, both the technological utopians and their more conventional mainstream counterparts preached the same gospel: "Let's get organized." Organization was the master key that would unlock the potential—and solve the problems—of rapid technological change.

Technological Lunacy

Segal began his book as a dissertation, and its imposing academic apparatus—a chapter of definitions, a long bibliography, and copious notes—will delight scholars but may intimidate others. However, the proverbial general reader should not be put off, for Segal articulates an important and timely theme: he shows how attempts to create technological rationality can mutate into a kind of lunacy.

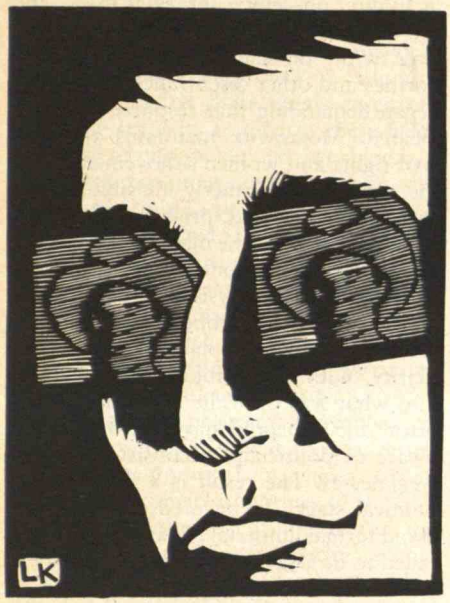
The 25 technological utopians were not like Captain Ahab of *Moby Dick*, hitching rational means to a mad end. Instead, their irrationality was to believe that technological progress would magically generate social progress, and to ignore past evidence of human fallibility. These visionaries assumed that if society provided tidy apartments, "on-time" or "reliable" subways, and clean parks for all its citizens, then everyone would be content, selfless, and reasonable. If society built a city of 239 concentric circles with a public building in the middle, as one utopian assumed, then human aspirations would similarly become focused and centered.

Although by no means mainstream socialists, the technological utopians implicitly criticized the individualistic, competitive ethic of American capitalism. In their view, pursuit of self-interest led not to the progress of humankind but to "the human drift," as Gillette put it in the title of one of his books. The utopians' favorite image was of an "industrial army" of highly organized and motivated workers selflessly serving a higher cause. The high degree of planning would, in Segal's words, "produce not a sense of faceless impersonality but, on the contrary, a sense of community." Effective social organization would not magically arise from the sleight of an "invisible hand," but only from a conscious search for the common good. If alive today, the technological utopians would probably be fans of Japanese-style cooperative capitalism.

More traditional utopians have tried to foster social cohesion by setting up small, static communities resembling walled medieval towns or country villages, and Segal describes such efforts. For example, in 1824 Robert Owen established a model community at New Harmony, Ind., based on an ideal of 300 to 2,000 people. Owen's contemporary Charles Fourier suggested 1,600 inhabitants in his utopian "phalanstay." The technological utopians, by contrast, envisioned much more gangling, complex social units. According to Segal, these dreamers sought to "carefully integrate urban, suburban, and farm land in their schemes," which were composed of "countless interlocking and hierarchical local, regional, and national units." One technological utopian aptly labeled his dream of the future "a cityless and a countryless world." This ideal "middle landscape" combined clean, small-scale, scattered industries with gardens of intensive agriculture, all bound together by elaborate networks of telephones, pneumatic tubes, moving sidewalks, and subways.

Segal persuasively argues that the ideal of decentralized yet interlocking units has in fact shaped the American landscape. For example, Shaker Heights, Ohio, was built as a commuter suburb blending efficient transportation with semi-rural tranquillity and beauty. New York's Cen-

ILLUSTRATIONS: LESTER KANTUREK



tral Park was designed to be a careful urban blend of walkways, playgrounds, and fields. And the Tennessee Valley Authority made a regional effort to integrate cities, suburbs, towns, and farms into a comprehensive whole. However, Segal also notes that as utopias get more sprawling, they also become harder to realize. A few intrepid believers can establish model communities, but it's difficult to organize an entire region, not to mention a collection of regions.

The people who now build utopias are usually developers with ample resources who are satisfied with building little pockets of pseudo-utopia—a zippy airport, a towering housing development, an ergonomic "office of the future," a brilliant shopping mall. Yet these constructions simply prove that efficient communications and organizations can float free from meaningful social change. As Segal concludes, our society has constructed the externals of technological utopias here and there, but it has not encouraged the utopian values of selflessness and social cohesion. Still, technological utopianism remains a significant exercise in social thought. For all the limits of their answers, these visionaries raised a basic question we still face: how to relate technological progress to social progress. □

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The Social Effects of Television

No Sense of Place
by Joshua Meyrowitz
Oxford University Press, $22.50

Reviewed by Michael Morgan

Advertisers routinely try to determine whether media's messages "get through" to their intended audiences. Social scientists, in turn, study the results, often presumed to be negative, of people's exposure to media's messages. Our society has long debated whether television's messages inspire imitative violence, and whether they perpetuate negative stereotypes or shatter cherished ones. Many people are also concerned about the messages television conveys about sex, drinking, and politics.

Yet few people stop to consider the possible impacts of the technologies of electronic communication themselves, apart from the messages they convey. Of course, one well-known exception was Marshall McLuhan, who argued that the effects of electronic media have little to do with their content. But despite his work, most people assume that electronic technologies act as neutral carriers.

In *No Sense of Place: The Impact of Electronic Media on Social Behavior*, Meyrowitz makes no such assumptions. His book is one of the most ambitious, refreshing, and provocative attempts to expand our understanding of communications technologies. As one rarely says about such works, it is "a good read," even where it fails.

Meyrowitz argues that electronic media allow us to "be" anywhere, and that when we are everywhere we are nowhere at all. This creates problems because people's physical location plays a major role in shaping their behavior and their interpretation of others' behavior. Behavior appropriate in some contexts simply makes no sense in others. Yet electronic media break down the distinctions among situations, and the social rules for behavior become ambiguous and unworkable because the public has "no sense of place."

According to Meyrowitz, print media help maintain social fragmentation because they target audiences with distinct interests, perspectives, and skills. Readers do not become fully homogenized and society's ranks of authority remain intact.

Electronic media, in contrast, erode traditional social boundaries by trying to appeal to the broadest possible audiences. When different social groups share common situations through television, their separate identities begin to break down.

Television also homogenizes society by blurring the distinction between people's private, "backstage" behavior and their public, "onstage" roles. This allows viewers to find out more about the opposite sex and other age groups, with the result that the differences between men and women, and between childhood and adulthood, become less clear.

Meyrowitz relates most of the social changes in the last three decades to TV's influences. The first television generation grew up observing striking inconsistencies between society's professed ideals and television's vivid scenes of racism and war. As a result, young people in the sixties denounced hypocrisy and publicly displayed formerly backstage behaviors such as nudity, obscenity, informal dress, and the expression of deep emotion. Moreover, with "no sense of *their* place," minorities and other disenfranchised groups began demanding that resources be reallocated. Meyrowitz maintains that the civil rights and women's movements, and the attempts of formerly invisible groups such as the disabled, prisoners, and gays to claim a piece of the mainstream pie, are all legacies of electronic media.

The author's analysis of the impact of electronic media on politics is particularly incisive and helps explain Reagan's popularity. With a "newfound ability to peer into what was once the backstage of political life," people have become more aware of politicians' inconsistencies and weaknesses. The result is a reconfigured political stage. To succeed, leaders must avoid formal, imperial behavior (as Nixon failed to do), yet they must also avoid extremely informal, low-keyed behavior (as Carter failed to do). Reagan projects the appropriate middle style, embracing both tuxedos and cowboy boots—"an 'imperial' president who chops his own wood."

Not all of Meyrowitz's evidence is equally convincing. For example, he suggests that television's "demystification" of those in authority has contributed to the steady decline in the public's confidence in those running U.S. institutions. He cites Watergate as the quintessential example. However, he is apparently unaware of research showing that heavy viewers have *more* confidence in U.S. institutions.

In the final analysis, form and content cannot be fully separated. Most people are exposed to similar messages most of the time not only because of the technology, but also because the advertisers who finance most electronic media seek the largest possible audiences. The effects Meyrowitz describes probably would not occur if the messages were not mass-produced for a heterogeneous public, or if people sat around watching test patterns. Furthermore, Meyrowitz tends to ignore the fact that the private behavior television presents is a representation of people's actual behavior—and viewers do not experience it first-hand. Still, Meyrowitz's attempt to illuminate the impact of electronic technologies is an important effort in a neglected direction. □

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CONTINUED FROM PAGE 11

At the universities themselves, many graduate students will be faced with working on an SDIO/IST project or failing to find support for their thesis research. Graduate students trained in these fields will have to choose between working in a weapons program or not using their training. Furthermore, because of the close links with classified laboratories, participation in such mission-oriented research will reduce the openness and freedom of inquiry that have characterized campus research groups. Such involvement will undoubtedly produce a much broader change in the academic climate.

Once the SDI programs have been established, universities will have a vested interest in continuing them. They are likely to become explicit supporters of the SDI program regardless of its merit and the implications for national security.

What can be done? Many administrators and faculty take the position that it would be an abridgement of academic freedom to deny individuals the right to apply for SDI funding, even if that support itself leads to abridgements of academic freedom. Thus, individual scientists and engineers have taken the approach of signing a pledge not to accept SDI funding, both to show their commitment to finding other sources of support, and to demonstrate the lack of support for the program in much of the scientific community.

Universities should also play a role by pointing out to their faculties the possible problems inherent in SDI funding, and by making it clear that the university will not lower its standards of academic freedom in an effort to retain this funding. Universities should also vigorously support efforts to find alternate sources of research funding, and they should lobby in Washington to decrease SDIO/IST funding to a level commensurate with a sensible research program for the fields involved.

A much more modest level of funding for such research would be enough to quiet fears that we are relinquishing our advantage to the Soviet Union in these areas. A more modest program would certainly produce an international climate more conducive to arms-control negotiations. Finally, it would not distort our system of research support, which is based on scientific merit and academic freedom. And it would allow us to preserve our country's research excellence. □

A different viewpoint will be expressed in the next issue.

CONTINUED FROM PAGE 3

have member firms; it has only individual members. ASME never contended that as a nonprofit body it could not be sued.

Hydrolevel did not charge ASME with freezing it out of the market and thus raising the costs of selling its devices. Hydrolevel did accuse a competitor of obtaining a letter from ASME through the conspiracy of several ASME members. The competitor used the letter to disparage the Hydrolevel device. This then placed ASME, legally, into the framework of a participant in a conspiracy. One must study the majority and minority opinions of the Supreme Court to understand the extremely narrow basis for its decision.

The lesson for cooperative research or most any other activity in which technical societies engage is that all activities must be kept as open and public as possible.

ROGERS B. FINCH
New York, N.Y.

The author responds:

I did not mean to imply that the ASME case involved cooperative research. (As I indicated in the article, I am not aware of any successful suit directed against a cooperative-research effort.) Rather, I meant to illustrate how a cooperative organization that controls a key variable for an industry could be used to make life difficult for a maverick firm. Certification was the issue in the ASME case; a crucial piece of R&D might be the issue in a case involving cooperative research.

As for the nonprofit issue, I can only offer the following sentences from the Supreme Court's majority opinion: "In addition, ASME contends that it should not bear the risk of loss for antitrust violations committed by its agents acting with apparent authority because it is a nonprofit organization, not a business seeking profit. But it is beyond debate that nonprofit organizations can be held liable under the antitrust laws."

CORRECTION

It was reported in our October issue (*page 30*) that Genentech and Eli Lilly planned jointly to market a synthetic human growth hormone (hGH) when approved by the Food and Drug Administration. Actually, the two companies intend independently to market different versions of synthetic hGH.

DRIVING AMERICA DOWN ROADS WE'VE NEVER BEEN BEFORE.

General Motors is on a journey to a far-off place just around the corner. the 21st Century. With the help of its thousands of scientists, designers and engineers, GM is embarking on an odyssey into the unknown. Roads paved with scientific and technological wonders that might seem like science fiction. But at GM, they're reality. Now. Lasers that probe body structure as no man's eyes ever could. Electronic navigation systems that tell you where you are and how to get where you're going. But the road doesn't stop there. The 21st Century lies dead ahead. GM is leading the way there by adding new dimensions of electronic wizardry and computer expertise to its vast worldwide resources. Today's GM is evolving into a GM the future will demand. Bolder. Daring. More responsive. Speaking a new language. Venturing in new directions.

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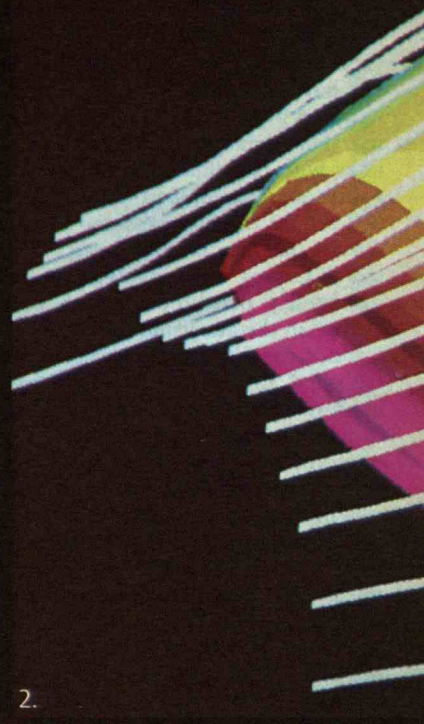

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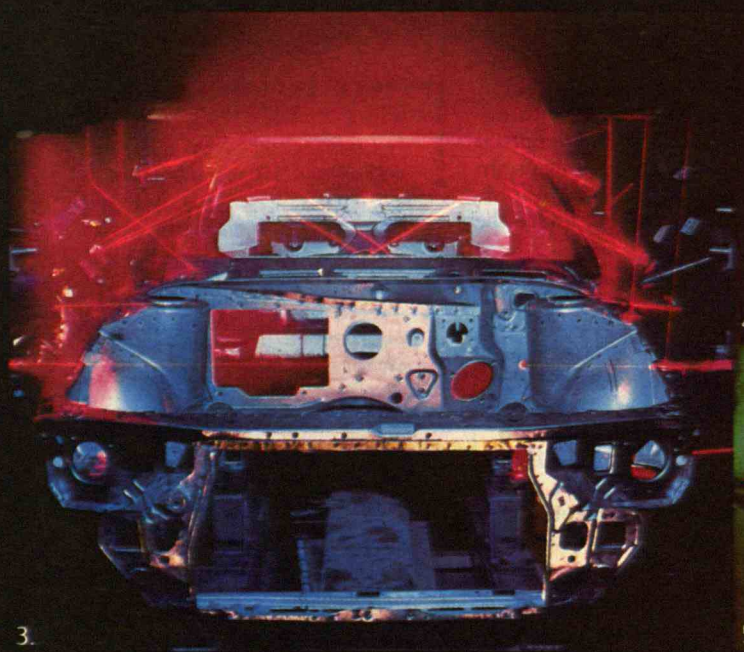

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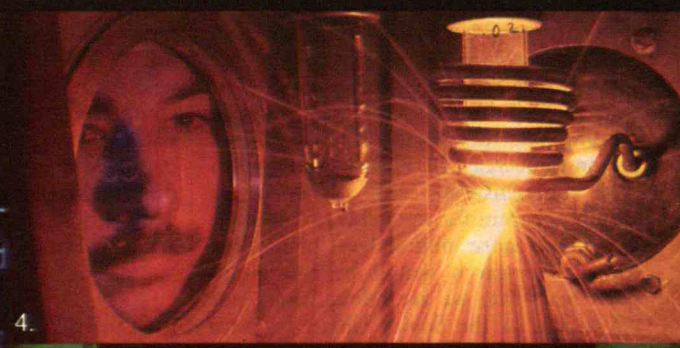

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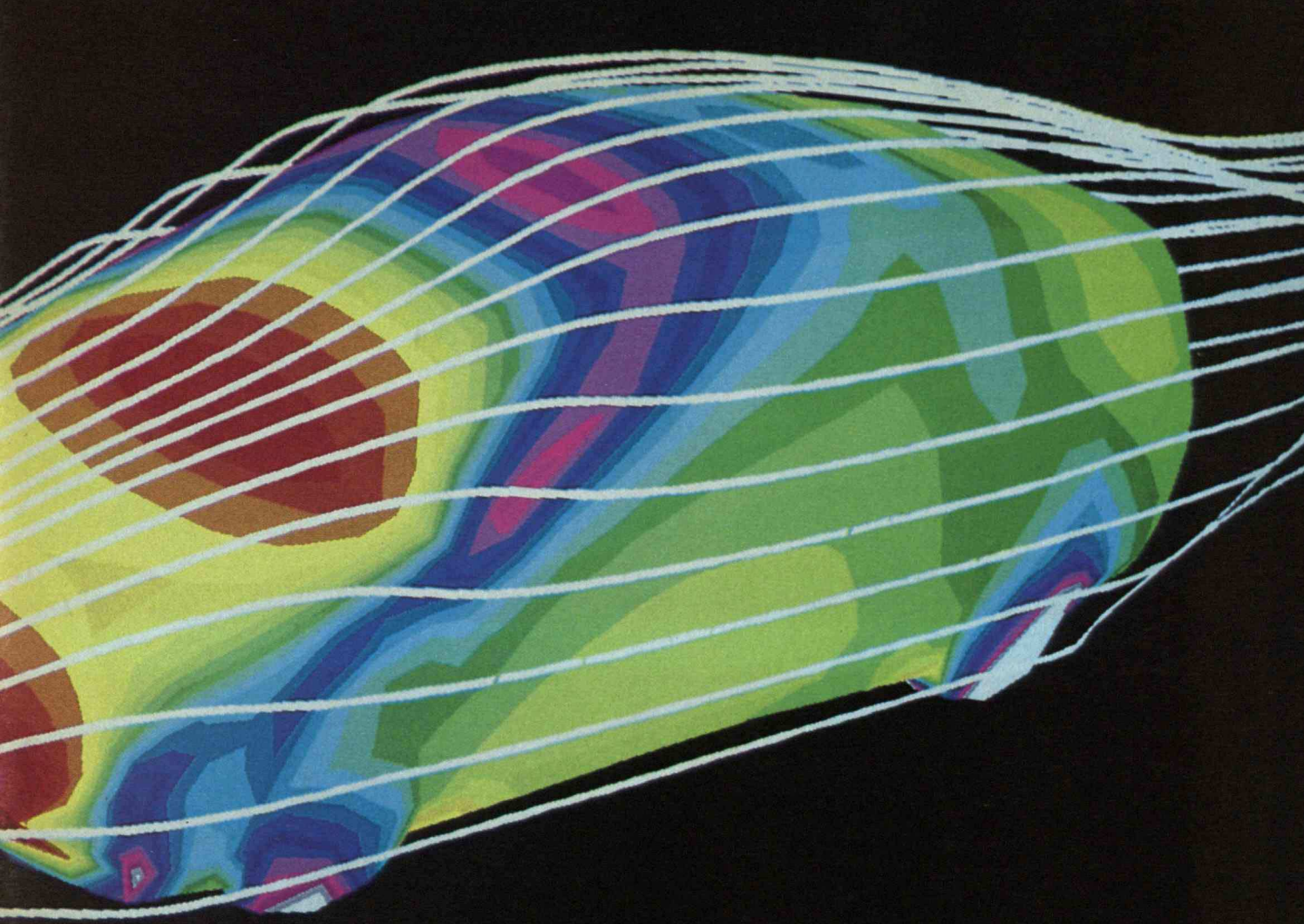

NCE NOT FICTION

GM

1. ACC (ADVANCED CONCEPT CENTER). Where engineers and designers work together to predict how people will live in the future and what kind of vehicles they'll need.
2. COMPUTATIONAL FLUID DYNAMICS. Computer-simulated aerodynamic modeling that generates more fuel-efficient designs in weeks instead of months.
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4. MAGNEQUENCH. A new material for manufacturing smaller, lighter, more powerful magnets that will revolutionize motor-driven parts in your car, and could lead to fewer parts, better performance, durability and fuel economy.
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6. ELECTRONIC POD SYSTEM. Advanced electronic driver information clustered on and around the steering wheel for accessibility to maximize eyes-on-the-road driving.

6.

Dangers of the Arctic, spectres of the past, and quandaries of geophysics.

In Search of the WANDERING MAGNETIC NORTH

An icy wind tore at my jacket as I descended from the jet in Resolute Bay in Canada's Northwest Territories, well inside the Arctic Circle. When I placed my skiis in the entry of a small hut half buried in the snow, I noticed that their plastic wrapping had already become brittle.

"The weather is holding," said Bruce Johnson of Bradley Air Services, a private company operating charter flights in the Arctic. "We'll take off for the pole as soon as you get into your Arctic gear and we get the plane warmed up."

Arctic gear already? The transition from California to the frigid north was too abrupt. I was shivering but unready to accept Johnson's advice to bundle up.

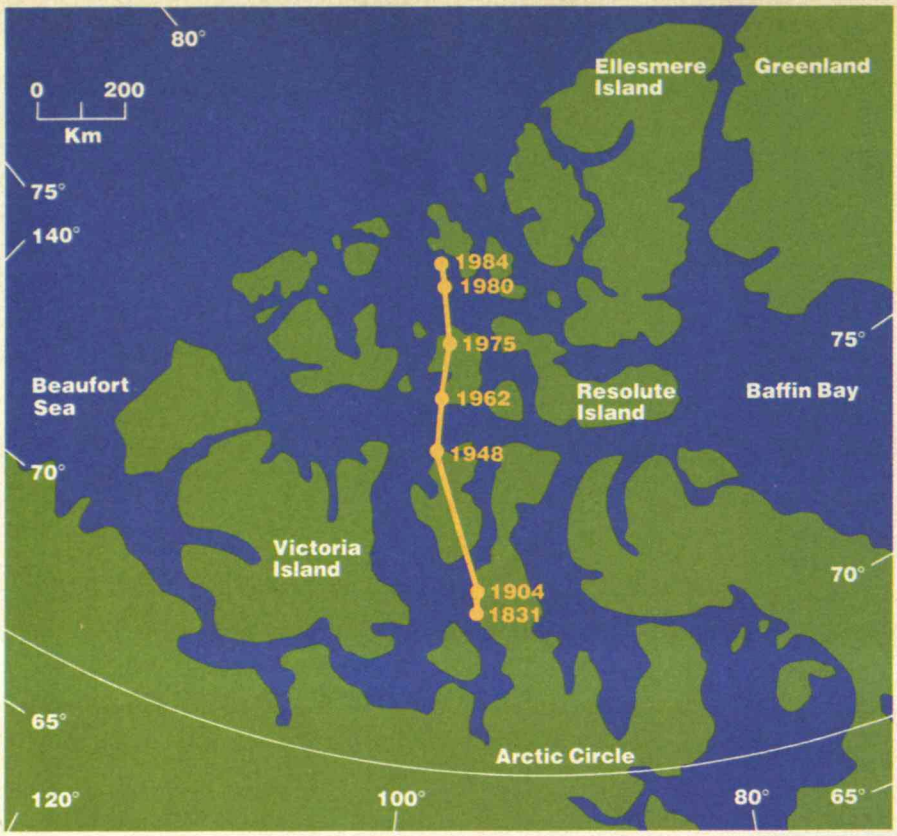
"Long Johns, parkas, everything—in layers. You'll need it for survival," ordered Skip Voorhees, our leader. He operates Special Odysseys out of Medina, Wash., taking small groups to the Arctic.

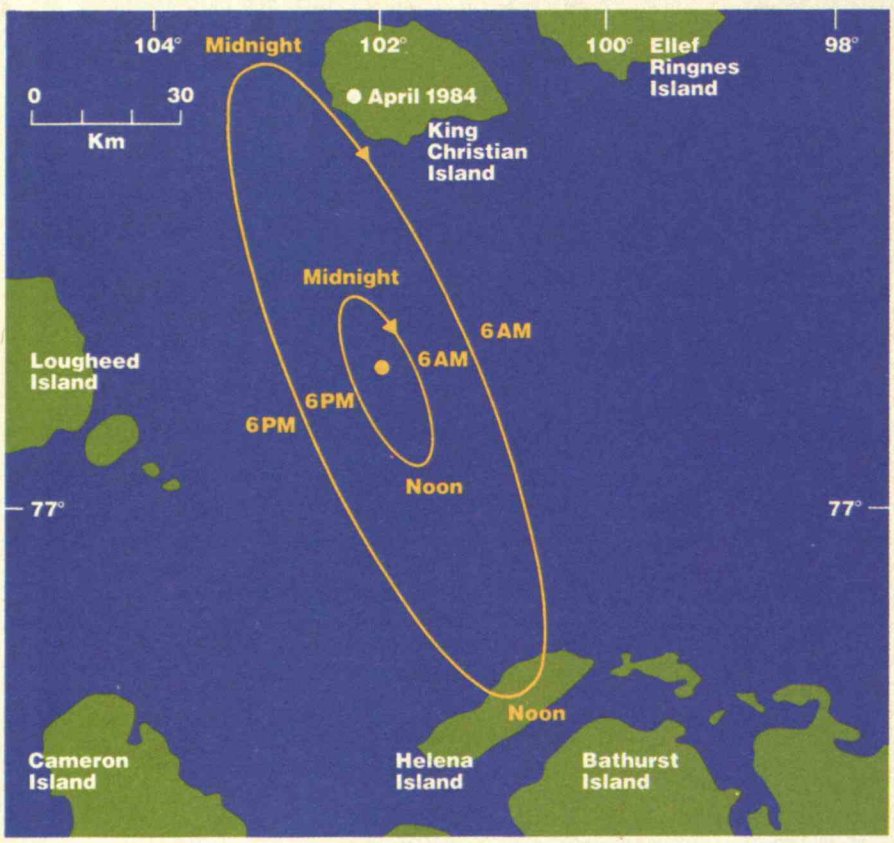
Survival? I hadn't thought about that. I had come for adventure, as well as to fulfill a long-time interest in finding the wandering magnetic North Pole and frivolously to ski around the world in four minutes at the North Pole. While I knew about the dangers—the polar bears, the cold, the sudden and violent storms—survival sounded grimmer now. A notebook, two pocket compasses (which were already erratic), two cameras, and a pair of cross-country skis seemed woefully inadequate for this trek across the vast frozen region.

My companions included tall, balding Ham Lokey, an Atlanta lawyer who had been to the South Pole; Armand

BY LADISLAW REDAY

Members of the author's expedition to the North Pole pass an iceberg beside Canada's Ellesmere Island.





Above: Since the nineteenth century, the magnetic North Pole has been moving northward. Below: In addition to its slow annual variation, the magnetic pole moves daily in an elliptical course, 100 km or more from end to end. The outer ring represents movement on a "disturbed" day, the inner ring movement on a "quiet" day. Scientists expected the pole to be at King Christian Island in April 1984.

Singer, professor emeritus of history at the University of West Virginia; and Steven Tabb, an adventurer from Tennessee. My wife, Peg, with her notebook hidden in her huge fur parka, was patiently snapping photos. I wondered if we would see any of the American, Canadian, and Soviet scientists said to be prowling around probing secrets from the north.

Our Twin Otter airplane with wheels protruding below the landing skis looked frail and insubstantial. The Canadian pilots had pulled padded wraps off the engines and were warming up the plane for takeoff. The immensity of the icy Arctic region was subduing.

The Importance of Magnetic North

Since the beginning of civilization, people in the Northern Hemisphere have marked north by Polaris, the star around which all the others in the night sky seem to revolve. However, celestial navigation has its drawbacks—the north star is not visible in daytime or on cloudy nights. As early as 1100 A.D. sailors were using magnetic compasses to find magnetic north, which, at least in recent centuries, has been relatively close to true north. In 1600 Sir William Gilbert, an English astronomer, proposed the radical theory that the earth itself is a huge, permanent magnet.

When schoolchildren put iron filings on a sheet of paper over a magnetized bar, the filings organize themselves into lines that emerge from one end, or pole, of the bar, spread out around its middle, and return to the other pole. These lines indicate the orientation of the forces at each point in the magnetic field. By analyzing the direction of the earth's magnetic forces, the German mathematician and astronomer Carl Friedrich Gauss showed conclusively in 1838 that the earth's magnetism comes primarily from its interior.

Scientists accepted the theory that the earth contains a powerful, permanent ferromagnetic core for generations despite certain anomalies. One was that the permanent magnet had a way of wandering. In 1635 the English astronomer Henry Gellibrand plotted the changing position of the magnetic North Pole from observations taken in London over the previous 50 years. The declination of magnetic north—the angle between it and true north—had changed by seven degrees.

Despite such variations, the importance of magnetic north over the next four cen-

We could see the tattered remnants of the ill-fated Franklin expedition, preserved for over 140 years.

turies could scarcely be exaggerated. With charts corrected for declination at points around the earth, mariners used compasses to chart their course. They also, of course, used the chronometer to tell the time and the sextant to mark the angle between celestial bodies and the horizon. With this information they could calculate their location.

When I passed my exam for my master mariner's license during World War II, the magnetic compass was still a prime navigational instrument, though larger vessels and aircraft were using the gyrocompass, in which a spinning wheel maintains a given direction. Several radio systems now allow navigators to ascertain their location and heading by analyzing signals emitted by stations at known locations. The Loran (long-range navigation) radio system is primarily used along the coast; the Omega system is less accurate but has global coverage. In additon, since 1968 six U.S. Transit satellites have been transmitting signals that navigational equipment can use to compute location to within 100 meters.

However, magnetic north remains important. The traditional magnetic compass, sextant, chronometer, and star charts still serve as a backup for all navigators. Infantry in the field, small craft and planes, surveyors, and explorers often rely primarily on these instruments, as they cannot carry cumbersome electronic navigational systems and power sources. Furthermore, the earth's constantly fluctuating magnetic field affects all radio signals. The more scientists learn about geomagnetism, the better navigators can correct for its effects.

True North

Before heading for the magnetic pole, our group wanted to touch down at geographic north. Not so many decades earlier, our predecessors had endured months of deep cold as they trekked to the pole with dogsleds. In 1909 two Americans—Admiral Robert E. Perry and Dr. Frederick A. Cook—led competing expeditions to the North Pole. Both groups depended on the magnetic compass—erratic at best in the Arctic—to track their locations, as well as on the chronometer, sextant, and "dead reckoning," which entails calculating how far one travels in a particular direction. The two explorers could not agree on who reached the pole first, so the National Geographic Society arbitrated their dispute. The society finally declared for Perry, but whether the decision was correct—and whether either one reached the pole at all—remains in doubt.

The northernmost community in North America: Grise Fiord, Northwest Territories, Canada (76° 2′ N). The 90-odd Inuit inhabitants fish and hunt polar bears and seals.

Just as it affected these explorers, the changeable and violent Arctic weather poses dangers to those flying a small plane. "This is no walk in the park," warned our leader, Skip Voorhees. He eyed my skis dubiously as we leaned against the wind and walked toward the Twin Otter, which looked frail in the heavy gusts.

"You know about pressure ridges?" he inquired.

I shook my head. There was so much about the Arctic I did not know. Pressure ridges of ice, I found, arise as the restless, frozen Arctic Ocean moves in a vast clockwise circle around the North Pole. The ice continually breaks open in cracks or "leads" of open water. As huge ice cakes collide with tremendous force at these leads, piling up or sliding under one another, they create massive ridges up to 30 feet high. These pressure ridges present as great a danger to planes trying to land on the polar ice cap as they once did to the early explorers' dogsleds.

"Are you saying we may not be able to land?" I asked.

The leader shrugged. "Whether we can get up there at all depends on the weather, and where we can land depends on ice conditions. We have to refuel somewhere on the polar ice cap or else in the air." The latter would involve emptying large drums of fuel carried inside the cabin into the plane's tanks—a procedure that could start a fire.

With this warning, the five of us took off in the Twin Otter, flying over rough, ice-caked water whipped by the wind into a greasy-looking foam. We swept past Beechy Island, which is just below the tortuous, chancy Northwest Passage to the Pacific—a route navigable only in summer, when there is open water.

Below us we could see the tattered remnants of the long-lost camp and wooden grave markers of the ill-fated Franklin expedition, preserved in the Arctic's desert-

dry conditions for over 140 years. That crew seeking the fabled Northwest Passage had perished trying to struggle over the ice to a fur-trading post at Hudson Bay. Recently scientists dug up one of the perfectly preserved bodies and photographed, studied, and reburied it.

Moments later we saw two magnificent polar bears out on an ice floe, stalking seals that must surface from the ocean depths to breathe. The Arctic was revealing some of the secrets—which include the wandering magnetic pole—that it has hidden all these centuries.

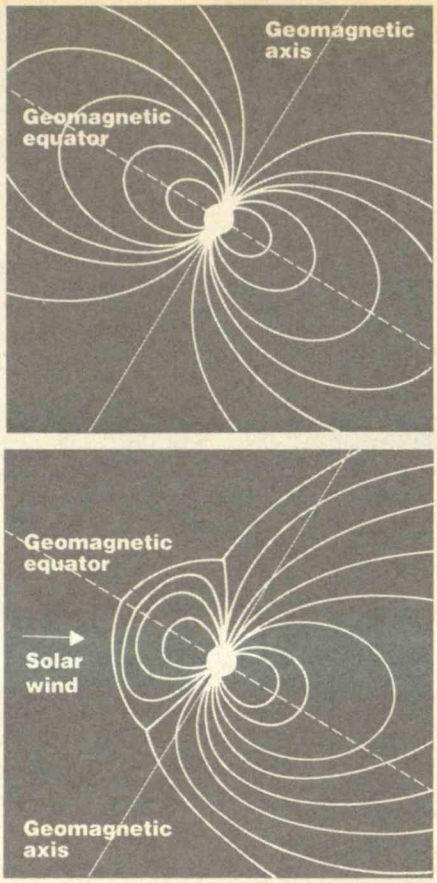
In bright evening sunshine we landed at Grise Fiord, Ellesmere Island—at 76°26′ N latitude the northernmost community in North America—to stay overnight. We slept in prefabricated wood houses that supply ships bring in for the native Inuit. They use igloos only while out on the ice traveling or hunting seal, Arctic fox, narwhale, and polar bear.

The next day while flying over the icy Ellesmere island we spotted a herd of musk ox pawing through the snow for tundra vegetation. Alarmed, they formed a tight protective circle as we skimmed to a landing at Eureka Fiord, 80° N, a Canadian weather station.

"Don't pat the dogs, they're wolves," cautioned Skip as we debarked from the plane. But they were afraid and wouldn't let us get near them. Greg Baumann, the chief of the Eureka station, claims there have been no proven cases of wolves attacking humans. He tried to coax them to come in for scraps.

Later, to refuel at Tanquary Fiord on the northern tip of Ellesmere Island, 81° 35′ N, we had to dig fuel drums out of the ice and snow where they had been cached. It was now 500 miles to the geographic North Pole. The clear weather was still holding at −37° C with an unknown chill factor. We crowded six drums of fuel into the cabin of the plane. The Twin Otter would barely reach the pole before needing to be replenished.

As we flew over the perpetually frozen Arctic Ocean, a fantastic pattern of white filigree lacework spread out below. The vast ice and snow had broken into pressure ridges, icebergs, and ice islands and was laced with leads of dark seawater, some only feet across and some as wide as rivers. Polynas, or lakes of open sea water, also formed where the frozen Arctic had broken open—only to start to freeze again instantly.



Top: This simplified model shows the magnetic lines of force that emanate from the earth. Below: In reality, solar winds—charged particles from the sun—distort the geomagnetic field.

We watched the dashboard as the computer readouts of satellite navigational data crept toward 90°—true north. Lights corresponding to tanks of fuel blinked red, indicating each was empty. The coordinates went to 89° 50′ and counting. Suddenly we were over 90°, and the pilot circled back for a touchdown. The ice looked ominously rough as the Twin Otter slowed to a stall, the air-speed indicator honking a warning.

We touched at 90°—the top of the world.

The pilot yanked on the throttles. We bumped hard and slowly crept back into the air. No landing was possible here—as even our inexperienced eyes told us. The pressure ridges of ice were at least three feet high. We tried to land in a new spot with the same results.

"Fuel and a cup of coffee," yelled the pilot, calling something over his shoulder about "Tri Turbo." He was looking for a landing strip with a camp—apparently frequented by the mysterious Tri Turbo—or at least for a solid, smooth spot to land and refuel. But we saw no such place on the seemingly endless ice cap. Freshly frozen leads or polynas can support a plane when the ice is 18 inches thick, but you cannot tell from the air how thick the ice will be.

The copilot finally crawled over us to reach the drums of fuel at the back of the cabin and began banging open the frozen bungs with a screwdriver and hammer. We feared a spark, but the row of red fuel indicators told us it had to be done.

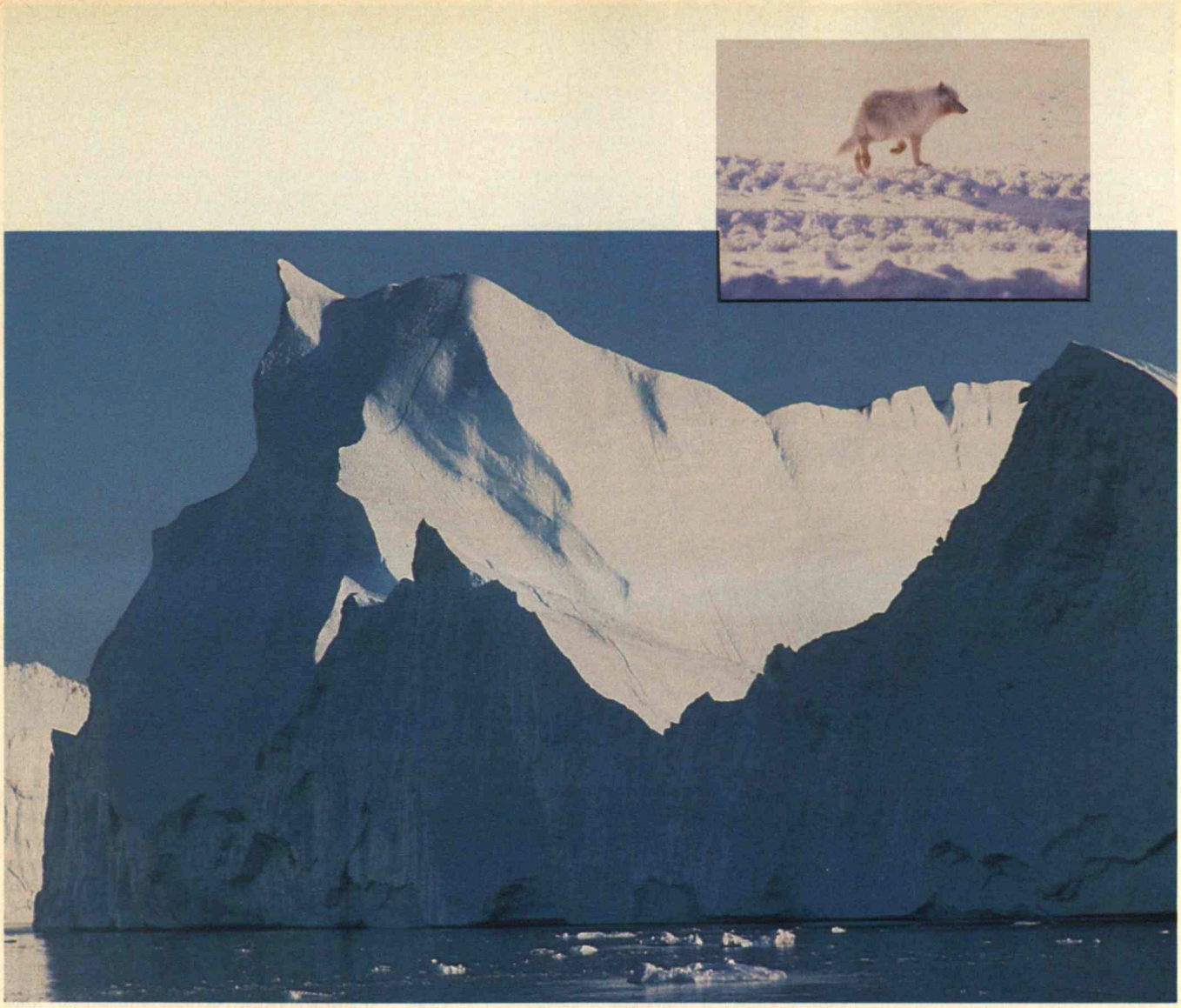
Suddenly the pilot yelled and the copilot crawled back: we could see two black specks on the ice below. Three minutes later we were skidding along the ice toward two padded tents.

The Earth's Changing Magnetism

The mind-boggling concept of huge lines of magnetism rising from the earth off South America and the widespread magnetic forces gathering and disappearing into the earth at magnetic north has long intrigued geophysicists. The magnetic north pole, sometimes called the "dip pole"—the spot where a freely floating magnetized needle on a string will point down at a 90-degree angle—is the focal point of scientific interest.

Geologic studies suggest that the magnetic pole has tended to circle slowly around the true pole. In recent centuries the magnetic pole's annual, or secular, migration has been leading it gradually northward. In addition, every day the magnetic pole moves on a roughly elliptical course. This ellipse varies in size, but it can be as much as 100 kilometers from end to end. The pole also can shift erratically from minute to minute.

Not only is tracking all these movements difficult; the very source of the earth's magnetism remains a mystery. Parts of the earth's crust have become magnetized over time, but scientists now reject the theory that the earth contains a permanent ferromagnetic core. At high temperatures, such as the core's 750° C or more, ferromagnetic substances lose almost all their magnetic properties. Although geologists do not understand the exact mechanism, they hypothesize that the earth's highly conductive fluid core, rotating and forming eddies within the residual magnetism of the crust, simulates a powerful dynamo that generates electricity. Like any dynamo, this one creates a magnetic field.



Today the frozen expanses of the Arctic still inspire awe from those who explore by small plane. Above: An Arctic wolf, hunted by the Inuit. Below: Not a mountain range, but an iceberg.

Geological evidence upholds this theory. The magnetic intensity of clays, igneous rock, and samples of baked earth formed up to 500,000 years ago is less than that of more recently formed samples. If the earth's basic source of magnetism were a "permanent" core, it would have gradually decayed, and recent rock formations would show weaker magnetism than old ones.

Studies also show that during the last 100 million years the magnetic poles have wandered from near the equator to near the geographic poles. Evidence for such migration appears, for example, in rocks in the mid-Atlantic ridge, which show bands of opposing magnetic polarity that were formed during different eras. Scientists' estimates of how long the poles take to reverse themselves range from 10,000 to 230,000 years. In any case, such reversals support the dynamo theory. The changing eddies within the earth's fluid core might well produce long-term magnetic shifts.

The daily elliptical movements of magnetic north are another matter. In 1882 the Scottish physicist Balfour Stewart proposed that they could be caused by electric currents in the upper atmosphere, and geophysicists have since verified this theory. In the ionosphere, which extends 70 or 80 kilometers above sea level, the sun's ultraviolet light knocks electrons free from atmospheric gasses. This allows electric currents to flow. The sun's heat also creates winds in the ionosphere, and their motion in this conductive medium sets up a dynamo. This dynamo remains fixed relative to the sun and distorts the earth's magnetic field in a regular pattern as the planet rotates every 24 hours.

Norwegian physicist Olaf Kristian Birkeland hypothesized in 1903 that charged particles from the sun cause other movements in magnetic north. This is in fact the case, though the mechanisms are somewhat indirect. Solar winds—ionized gasses flowing from the sun at 300 to 500 kilometers per second—encounter the earth's magnetic field and cause cavities or distortions. Sun spots—storms on the sun that release sudden bursts of high-energy protons and electrons traveling even faster than the solar winds—cause more erratic changes in geomagnetism. The earth's magnetic field, in turn, diffuses the solar particles, protecting us from their harmful effects.

Birkeland tried to model these processes by putting a magnetized sphere in a vacuum tube and bombarding it with electrons. He produced miniature auroras—the astonishing curtains of light that occasionally play across the far northern and southern skies at night. Actual auroras are more complicated than those that Birkeland produced, but they are caused by charged particles from the sun.

The author's wife at a camp near the North Pole. Two Americans, perhaps from the U.S. Navy, were boring holes in the ice for a mysterious project.

Expeditions of the Past

Scientists and adventurers have studied the variations in geomagnetism since the nineteenth century. In 1831 Commander James Clark Ross, a Briton who had the financial backing of Booth's Gin, trekked toward the magnetic north pole and was lucky enough to get close to this elusive point. On June 1 of that year, at Cape Adelaide in Canada's Northwest Territories, 70° 5′ N and 96° 46′ W, a freely floating magnetic needle pointed almost vertically—at 89° 59′ from horizontal. On that day, magnetic north was some 500 kilometers south of its current location. Norwegian explorer Roald Amundsen claimed to locate the magnetic pole again in 1904.

Scientists still track the constant changes in the earth's magnetism. The British and U.S. navies update world magnetic charts every five years, an effort they began in 1858 and 1882, respectively. The International Association of Geomagnetism and Astronomy has also adopted this system, publishing current geomagnetic data in its *International Geomagnetic Reference Field* every five years. Soon after publication, scientists again begin to gather and organize new data for the next "epoch."

Researchers complete their geomagnetic surveys using aircraft and satellite. For example, *Project Magnet* of the U.S. Navy's Oceanographic Division employs aircraft specially equipped with a non-magnetic "boom" extending from the tail. From there, a magnetometer—in effect a sophisticated compass—can plot the direction and strength of the earth's magnetism at any given location. In 1979, NASA launched a satellite called *MAGSAT 80* equipped with a magnetometer. This satellite circled the earth much farther from its surface and therefore farther out in the magnetic field than any airplane could, sending back data on geomagnetism for about a year.

U.S. scientists at NASA's Goddard Space Flight Center, as well as Soviets and other scientists, use this information to produce computer models of the earth's current magnetic field. They also attempt to predict its future configuration and the location of the poles. Anyone such as myself who wants to find magnetic north depends on these models.

Compass Heading: Vertical

Occasionally scientists still try to chart the transient magnetic North Pole on the ground. In May 1984 the Canadian government's Earth Physics Branch conducted a detailed survey on and around King Christian Island to find the exact current location of the magnetic north pole. Lawrence R. Newett and E. Ronald Niblett flew in, made observations, and departed within a few days.

Tracking the magnetic pole on land is a tough task. Not only does it move 30 to 100 kilometers on its diurnal course, but it shifts so unexpectedly and rapidly that you can hardly follow it. You have to have luck. And of course, the constantly moving ice, fierce winds, and snowstorms provide a constant threat.

After our group had landed near the two black tents, a bundled figure strode toward us, icicles forming on his red beard. As casually as if this were a fast-food outlet on a highway, he asked us if we would like a cup of coffee.

We asked incredulously what he was doing here.

"That I can't say." He grinned. "But what about that coffee?"

Cliff Mercer and his buddy John Bitters, hunched over a radio inside the tent, may have been working for the U.S. Navy, but they wouldn't confirm that either. We learned that they had parachuted down on the North Pole, and that they were then picked up and dropped again about 100 kilometers from the pole at their present camp. However, the camp, located on a strip of ice, had since drifted about 200 kilometers from the coordinates our pilots had received a week ago, and the Ameri-

cans' radio beacon had frozen out of use. Hence our difficulty finding them.

U.S. Navy equipment and ice screws—large bores for making holes through the ice—lay near their tent. They told us the ice at the camp was 14 feet thick—and then dropped that subject as if they shouldn't have raised it. Perhaps they were making observations to aid submarine navigation under the ice cap. We were curious about the strange pair on the polar ice cap that was prying secrets out of the desolate and dangerous Arctic, but it was clear that they were not going to give us more information.

We were sharing our rapidly freezing bottle of champagne with the two men in the bright evening sunshine, when an old DC-3 lumbered onto the ice. This was the "Tri Turbo" our pilots had mentioned, complete with an extra turbine on its nose as well as one engine on each wing. It too had been hunting for this movable ice strip to bring the men supplies.

We refueled and took off for Tanquary Fiord on Ellesmere Island. After an overnight stop with the hospitable crew of the Eureka weather station, we girded for our approach to the magnetic pole, which lay to the southwest. Ottawa geophysicists had predicted that on April 22, magnetic north would be on King Christian Island, the site of an abandoned oil camp, at 77° 8′ N and 102° 2′ W. The U.S. Geological Survey had computed that magnetic north would be 77° 44′ N and 102° 55′ W, while the U.S. Navy predicted the spot would be 100 kilometers to the north.

Our compasses fluctuated wildly as we flew over King Christian Island, yet I knew that the magnetic north pole might be miles away, depending on local magnetic conditions and sun spot disturbances. If only we could land, get away from the metal of the plane, and check!

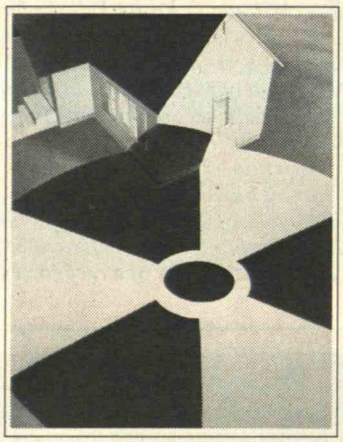
It was not to be. Again the rough and icy terrain would not permit a landing. We could have broken the plane's undercarriage on the remote island—or worse. We touched down and pulled off.

We circled the magnetic pole and hoped for the day when we could return, perhaps with magnetometers and snowmobiles to chase down the rapidly shifting pole. Someday scientists will learn to predict more accurately where it will be. But as Richard L. Coles, a scientist with the Canadian Earth Physics Branch, told us, "If you touched down on King Christian Island this past spring, you were as close to the magnetic north pole as you are ever likely to get."

After receiving a degree from M.I.T. in 1936, LADISLAW REDAY put in a brief stint as an engineer. But a year in a schooner on a scientific expedition to the South Seas persuaded him to opt for a life of adventure. He has written travel articles in more than 50 periodicals.

The Indoor Radon Story

BY ANTHONY V. NERO, JR.



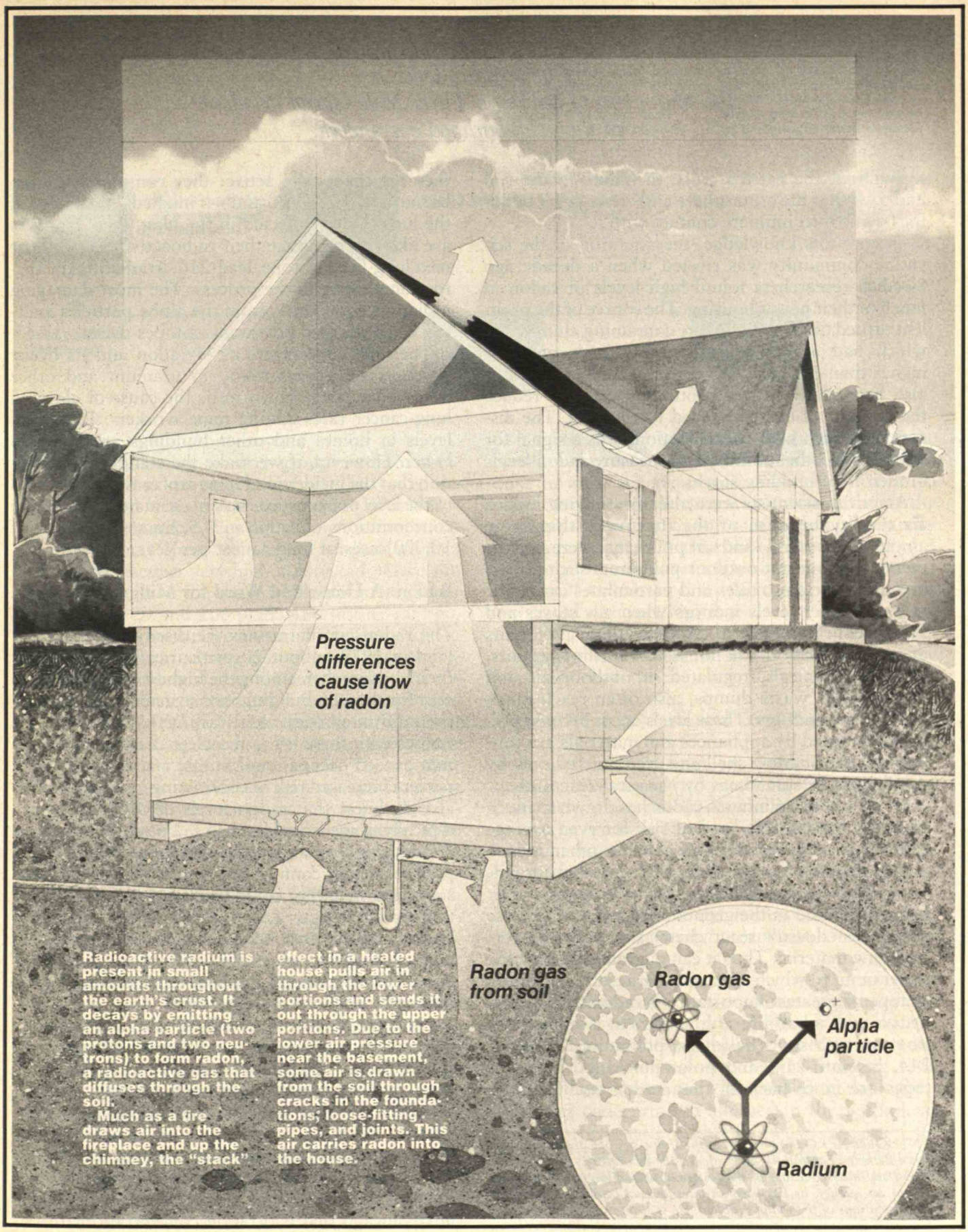
THE public often focuses on nuclear power and weapons as the major sources of environmental radiation. But the scientific community has recently come to realize that the largest dose of radiation that most of us receive comes from the air in our own homes. Significant amounts of radon—a natural radioactive gas—accumulate in our houses simply because we tend to build them on the largest source of radioactivity around: the ground. The risk from indoor radon is typically thousands of times larger than that from other more notorious environmental pollutants. In fact, millions of Americans are exposed to more radiation in their own homes than underground uranium miners experience.

The potential extent of the radon problem first became apparent in the spring of 1979. The accident at the Three Mile Island nuclear power plant had just occurred, and—partly because I had just written a book on nuclear power—I had become accustomed to receiving a steady flow of phone calls on radiation issues. But that didn't prevent me from being startled when a colleague in our group at the University of California's Lawrence Berkeley Laboratory called to tell me about an energy-efficient house in Maryland where our group had found radon concentrations 20 times greater than normal. These levels are the radiation equivalent of having a Three Mile Island accident—which involved the largest release from any nuclear plant—occur in the neighborhood once a week.

How was this possible? Indeed, why were we and several other groups of scientists even bothering to monitor radioactivity in homes? For us, it was the awareness that indoor pollutant levels were already high, combined with the possibility that efforts to reduce energy use in buildings might raise concentrations substantially. In the case of radon, we would eventually find levels beyond our wildest imaginings.

We knew from the beginning that radon was present everywhere. Radon results from the radioactive decay of radium, a member of the decay chain that begins with uranium. And, like uranium, radium is present in small amounts

Natural radon enters our homes from the ground and gives us the most significant radiation dose we receive. But we can find and fix the houses that need help.



Radioactive radium is present in small amounts throughout the earth's crust. It decays by emitting an alpha particle (two protons and two neutrons) to form radon, a radioactive gas that diffuses through the soil.

Much as a fire draws air into the fireplace and up the chimney, the "stack" effect in a heated house pulls air in through the lower portions and sends it out through the upper portions. Due to the lower air pressure near the basement, some air is drawn from the soil through cracks in the foundations, loose-fitting pipes, and joints. This air carries radon into the house.

ILLUSTRATIONS: MICHAEL YOUNG

These radon levels are the equivalent of having a Three Mile Island accident in the neighborhood every week.

throughout the earth's crust, including in the soil and rock that the atmosphere and virtually all buildings come into intimate contact with.

Despite this knowledge, the attention of the scientific community was riveted when a decade ago Swedish researchers found high levels of radon in much of their newer housing. The source of the problem turned out to be concrete containing alum shale, which had a radium content hundreds of times higher than ordinary soil or rock. Newer buildings also had relatively low ventilation rates to reduce the amount of energy needed for heating. The discovery of such high concentrations was a signal for scientists in other countries to measure radon levels in their own building stocks.

American scientists were already studying indoor air quality because of the discovery that large amounts of several kinds of pollutants were present indoors. Important outdoor pollutants such as carbon and nitrogen oxides and particulates can occur at even higher levels indoors when gas stoves and kerosene heaters, which produce these pollutants during combustion, are not vented to the outdoors. Organic chemicals, regulated in outdoor air and around toxic waste dumps, also often reach much higher levels indoors. These levels occur because pollutants emitted by appliances and materials are confined by the building shell and are removed only by ventilation, or sometimes by chemical reactions.

Of all indoor pollutants, radon has drawn so much attention because the level of risk for even average exposures is unusually large. Unlike other indoor pollutants, radon comes primarily from outside, entering homes through their understructures after being generated in the ground. Because it is a noble gas, radon doesn't react chemically with the surrounding material. Thus it can migrate, reaching the water or air to which humans have access. The radon isotope of greatest importance is radon-222, which decays with a half-life of four days to a sequence of isotopes with short half-lives: polonium-218, lead-214, bismuth-214, and polonium-214. These isotopes are more harmful than radon itself because they are chemically active: they can attach to airborne particles, walls, and—if inhaled—the lining of the lung. Once collected in the lung, these isotopes are likely to complete their radioactive decay to the next long-lived isotope, lead-210, irradiating the surrounding tissue in the process. The most damaging radiation dose comes from the alpha particles emitted when the two polonium isotopes decay.

The high concentrations of radon and its decay products sometimes found in uranium and other mines have been shown to be the cause of elevated lung-cancer rates among mine workers. Radiation levels in homes and other buildings are typically lower. However, if we make the standard assumption that the incidence of lung cancer is proportional to the level of exposure, we can estimate that average concentrations of radon in U.S. homes cause about 10,000 cases of lung cancer per year.

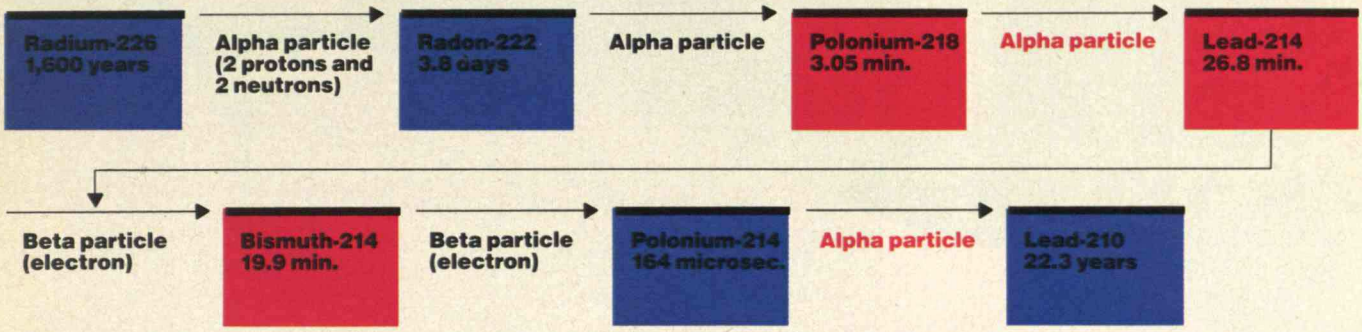
Radon: A Household Word for Millions

The radon concentrations we discovered in Maryland in 1979—about 20 picocuries per liter of air (pCi/l)—were then among the highest ever found (except for those in buildings constructed with radium-contaminated industrial tailings). Occupants of houses with these levels receive radiation exposures that exceed occupational limits, and they have a 5 percent increased risk of contracting lung cancer. We already knew that radon levels in ordinary homes typically range from less than 0.2 pCi/l to more than 4 pCi/l. Finding an energy-efficient home with 20 pCi/l seemed to confirm our fears that unusual measures to save energy could result in levels well above the normal range. The builders of the Maryland house went far beyond the usual weatherstripping and caulking to reduce the infiltration of outdoor air: they incorporated a special unpenetrated plastic barrier throughout the outer wall.

However, further studies have revealed that most high radon levels occur in ordinary homes, not in special energy-efficient structures. At about the same time that we began monitoring energy-efficient homes, a research team at Argonne National Laboratory studying radioactivity in people's lungs found unusually high amounts in one of the group's own employees. The scientists' investigations led them to identify several seemingly ordinary homes near Chicago that had radon concentrations reaching 20 pCi/l and higher.

ANTHONY NERO is a physicist at the University of California's Lawrence Berkeley Laboratory. As leader of the laboratory's indoor radon group and later co-leader of the program on building ventilation and indoor air quality, he has been an international leader in discovering the dimensions of the radon problem. He is author of A Guidebook to Nuclear Reactors *and has written or been editor of several other volumes on environmental monitoring and indoor radon.*

Radon, a noble gas, cannot react chemically, but it decays into a sequence of radioactive isotopes that can. These isotopes may attach to the lining of the lung and irradiate nearby tissue. Red-shaded isotopes and alpha particles pose the greatest threat.



Ironically, as other research groups monitored radiation from nuclear plants, they also discovered the high radiation levels produced by radon in ordinary homes. For example, concern about radiation exposures around Three Mile Island led Pennsylvania officials to discover very high indoor radon levels in the eastern part of the state, with a surprising number between 20 and 100 pCi/l. And just a year ago, because a worker at the Limerick nuclear plant in Pennsylvania kept setting off radiation alarms, investigators discovered that his house had by far the highest radon concentrations yet found in the United States—over 2,000 pCi/l. Monitoring in this area, now famous as the Reading Prong, revealed many homes with very high indoor levels. These higher levels are far more significant than releases from any accident at a U.S. nuclear plant, just as people's average exposure to radon indoors is far larger than radiation doses from normally operating nuclear plants.

Scientists have continued to find high concentrations of indoor radon in many parts of the country. High levels have been found in Maine, partly because of the large amounts of the gas in domestic water supplies. Communities in Montana, North Dakota, Colorado, and Washington have also discovered high levels, usually from radon generated in the ground. We now believe that high concentrations may exist in any part of the country, and that the vast majority of the areas at highest risk have not been identified simply because there has been no effort to do so.

A key question is how frequently high concentrations occur. Reseachers have often monitored homes because some chance finding (such as the worker who set off alarms at the Limerick nuclear plant) indicated that high concentrations were probably present. However, an analysis of about 20 studies done in areas where there was no prior reason to expect high levels, leads to the conclusion that the average concentration of radon in single-family houses is 1.5 pCi/l. Furthermore, between 1 and 3 percent of houses have much higher concentrations of 8 pCi/l or more. Considering the serious risks associated with such high levels, we believe that these roughly 1 million homes will soon be the focus of the largest environmental search that this country has ever undertaken.

Radon Decay Products and Lung Cancer

The expansion of the nuclear enterprise in the three decades following Enrico Fermi's construction of the first nuclear reactor ultimately depended on rapid growth of the uranium supply. But efforts to extract uranium from underground mines in the United States and elsewhere paid a dividend that no one, especially the uranium miners, wanted—lung cancer. Scientists soon linked the miners' unusually high lung-cancer rates directly to exposure to radon's decay products.

This unfortunate experience is the primary basis for estimating people's risk of contracting lung cancer from exposure to radon in homes. It is also the origin of the traditional units for measuring radon decay products. These include the working level (WL), so named because 1 WL used to be the highest radiation concentration allowed in the workplace, and the working-level month (WLM), the term for exposure to 1 WL for a working month, or 173 hours. A typical residential exposure rate, 0.3 WLM per year in a house with 1.5 pCi/l of radon, is much lower than those that resulted in elevated lung-cancer rates

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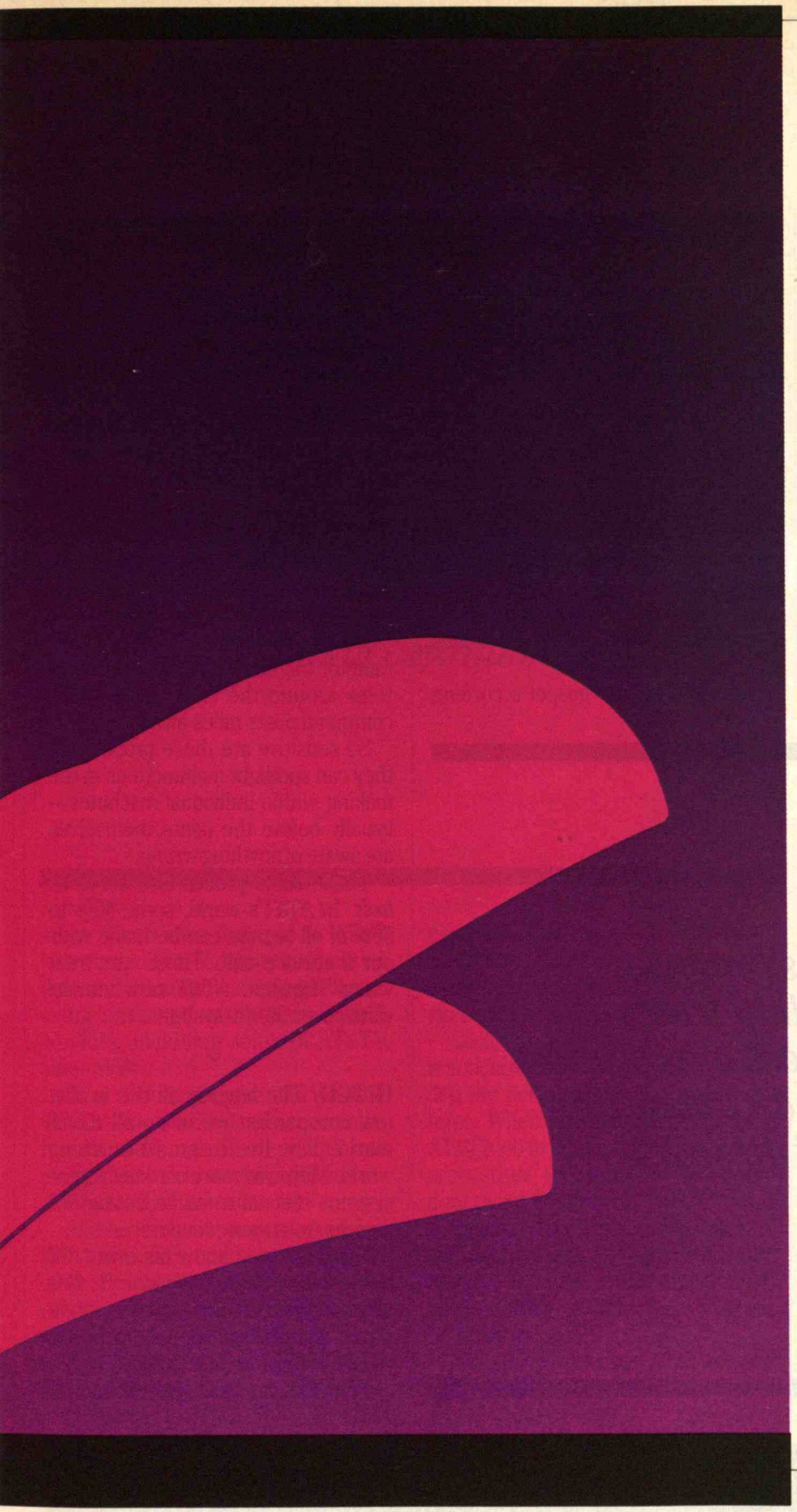
DIAGRAMS: OMNIGRAPHICS



STORMY WEATHER AHEAD FOR THE AUTOMATED OFFICE

In 1945, the U.S. Navy was putting the first digital computer through its paces. Suddenly, for no apparent reason, the room-sized machine broke down. After a long search, technicians discovered the cause. Deep within the machine, crushed between the points of a relay, was a moth.

"Bugs" have bedeviled Computer Man ever since.

Until recently, things were getting better every year. Each new generation of business machines has proved more reliable than the last.

Yet, for all this progress, the business that trusts its affairs to computers may

continued on next page

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be more at risk today than at any time in the last 40 years.

The rise of office-wide and company-wide systems is changing the arithmetic of risk. The number and variety of devices now being installed multiply the chances that, on any given day, *something* will fail.

More disturbing: *business machines no longer fail alone.*

The "why" of this will be familiar if you ever struggled with those old-fashioned Christmas lights: one bad bulb and the whole string went dark. In an office system, each "bulb" is likely to be a $10,000 business machine. And the "string," a maze of cables and fiber optics stretching (literally) all over the map.

What's to be done? Must whole companies now be hostage to the performance of machines? Below, AT&T digs into the issues and finds reason for optimism—as well as alarm.

◇

BLOOD. Any company whose life's blood pumps through a computer is going to want some sort of backup. A count of America's business machines would turn up thousands of devices whose sole job is to sit and wait.

All this duplication does as much to enrich hardware vendors as it does to protect system users.

By contrast, the gospel according to AT&T is *"communication, not duplication!"* In AT&T's world, information is portable. Our stock in trade are networks that can be instantly reconfigured to shift the burden of a downed computer to another device whose day-to-day chores are less immediate.

Like cast members in a Broadway show, the devices in such a system are capable of stepping into each other's roles at a moment's notice.

By no coincidence at all, the same AT&T networks that permit you to work around a problem can *prevent* most problems in the first place.

Remote sensing devices can now monitor the health of entire office systems around the clock from AT&T command posts miles away.

So sensitive are these probes that they can spotlight malfunctions in the making within individual machines—usually before the users themselves are aware of anything wrong.

These same probes also serve as *tools.* In AT&T's world, some 40% to 50% of all repairs can be made without a service call. Those are "real world" figures: AT&T now stands watch over 35,000 systems.

◇

HITCH. The hitch in all this is that few companies live in an all-AT&T world. Few live in an all-*anything* world. More and more of today's office systems rest on a fragile ecology of devices from *many* vendors.

Vendor A may know his own stuff inside out. Ditto for Vendor B. But when your system depends on a whole alphabet of vendors, who do you call? Who's accountable?

That was precisely the question a

"For all this progress, the business that trusts its affairs to computers may be more at risk today than at any time in the last 40 years."

Vendor A may know his own stuff inside out. Ditto for Vendor B. But when your system depends on a whole alphabet of vendors, who do you call? Who's accountable?

major electronics firm put to AT&T last winter. This company had built up data and communications networks using lines and equipment from 7 vendors, including some of AT&T's chief rivals.

What the company wanted was one vendor that would stand accountable for the workings of every line and every switch they owned in 48 states.

Would AT&T take the job?

As a service company, we're moving in that direction, but there are limits to what any company can promise where others' products are involved. We are judged by the promises we *keep.*

AT&T's proposal: a trial marriage. We'd start small, get it right, and expand from there. In this case, "starting small" meant across-the-board responsibility for systems at 50 sites in 16 states.

Today, as far as the electronics firm is concerned, it is AT&T's job to watchdog the performance of all these systems. When trouble knocks, it is now AT&T's job to pinpoint the fault, and to orchestrate the efforts of other vendors to put things right.

One AT&T-er sums up the complex logistics this way: "When a customer has one number to call – no matter when, no matter what – you'd better be ready to jump."

Free Offer: How does AT&T (or any vendor) work in harness with a competitor? A recent AT&T/Hewlett-Packard white paper offers an inside look at the issues, the pitfalls, and the keys to success. For a free copy, please telephone 1 800 247-1212. Or you may write Mr. Dale Hegstrom, AT&T Information Systems, P.O. Box 1405, Morristown, NJ 07960-1405.

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JEANS. AT&T now serves 7 million business customers. Some wear pinstripes, some wear jeans. They are a cross section of American business.

The biggest have more computers and communications gear than many *governments.*

It is these big companies who feel most keenly the lack of integrated service and support. They expect us to lead the charge to fill this void.

They see it as part of our job.

Meanwhile, we have customers who have yet to buy their first PCs. For them, we are a telephone, an Operator's voice, and someone to call "in case." (AT&T service technicians aren't drawn from a hat. Like neighborhood cops, each one patrols a particular business beat.)

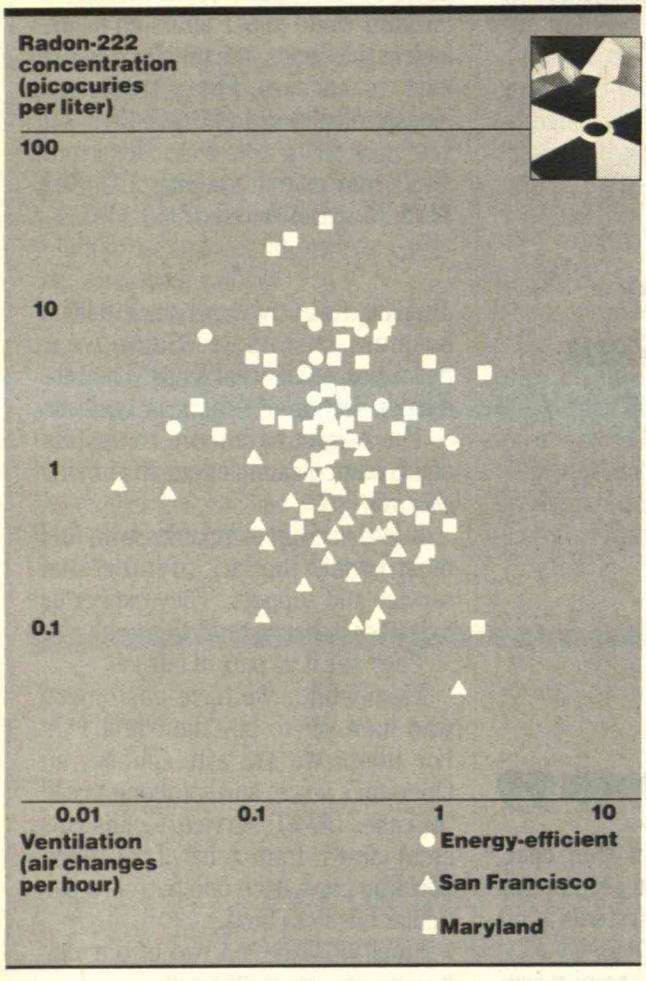
Small or large, no two of our customers are exactly the same.

Our job is to be there. No matter who calls. No matter when. No matter what. We're AT&T.

AT&T

The right choice.

Surveys of houses show that radon concentrations have little correlation with energy efficiency or ventilation rates.



among miners. Before mine operators introduced modern control measures, miners were often exposed to much more than 4 WLM per year, today's occupational limit. However, people living with 20 pCi/l or more of radon—apparently not a rare situation—will equal or exceed this limit. This finding is quite disturbing, considering that occupational limits are normally far higher than limits for members of the general public.

How great are the risks? The studies of uranium miners showed that 1 WLM exposure increased workers' chance of contracting lung cancer by about 300 in 1 million. Thus, a miner who received 10 WLM per year for 30 years, totaling 300 WLM, stood about one chance in ten of getting lung cancer from this exposure (not including risks from cigarette smoking or other causes). This is the same total exposure that one would get from living one's life in a house with 20 pCi/l of radon.

Of course, the data on the miners' risk cannot be applied quite so naively to ordinary exposures of the general public. After all, most of the miners were healthy, smoking males working in an atmosphere laden not only with radon and its decay products but also with particulates and engine fumes. Moreover, the epidemiological studies of miners leave significant uncertainties as to their cancer risks.

Nonetheless, risks to the public from exposures to radon's decay products are reasonably well understood. We estimate that people living in an average 1.5-pCi/l house, with exposures of 0.3 WLM per year or about 20 WLM in a lifetime, have a 0.3 percent chance of contracting lung cancer, give or take a factor of two or three. The average exposure of the population is slightly lower—approximately 0.25 WLM per year—because about one out of four people lives in an apartment, where radon concentrations are somewhat lower because of relatively little contact with the ground. Our estimate of cancer risk from radon derives from data on miners with higher exposures than those of the average homeowner. But in the case of radon, the difference in exposures is no more than a factor of ten, considerably smaller than in most other risk estimates.

This 0.3 percent average cancer risk from radon, while small compared with risks of death from voluntary actions—including driving (1 or 2 percent) or smoking (perhaps 25 percent)—is very high compared with most other environmental risks. Most of the carcinogens that the Environmental Protection Agency regulates, such as benzene, vinyl chloride, and various pesticides, carry lifetime risks of no more than 0.001 percent for the average person, and perhaps 0.01 percent for highly exposed people. For long-term occupants of the million houses exceeding 8 pCi/l, the risk is about 2 percent, with the risks from exposure to 20, 50, or 100 pCi/l proportionately higher. And in these cases the risk estimates require no extrapolation from the levels miners have been exposed to. The implications are serious.

The Source of the Problem

Given such risks, what is to be done? Certainly neither I nor my colleagues would be willing to live very long in a house with a level of 10, 20, or 100 pCi/l of radon. (My own home has a concentration of only 0.5 pCi/l.) Let's look first at the false starts we have already made in finding a solution to the problem,

DIAGRAMS: OMNIGRAPHICS

Increased ventilation is an impractical remedy for most radon problems.

beginning with our initial assumption that building materials were to blame for indoor radon exposures.

As in Sweden, concrete is the U.S. building material with the most importance as a radon source. But after examining about a hundred samples of concrete from around the country, our research group was convinced that concrete could account for only up to 10 percent of the typical 1 pci/l of indoor radon. The only other obvious source of radon was the ground, though we found it hard to see how so much radon could pass through barriers such as concrete basements, slabs-on-grade, and ventilated crawl spaces.

While investigating the properties of concretes, our group had also begun to examine the connection between indoor concentrations of radon and ventilation rates. This was based on our second false premise: that tightening buildings to save energy would have a large influence on whether a house had high radon levels. About a third of the energy used to heat or cool buildings is required solely to condition the air that is exchanged between indoors and outdoors. In homes, this ventilation is caused primarily by outside air infiltrating through the building shell. In most U.S. homes, indoor air exchanges completely with outdoor air once every hour or two, even when windows are closed. Relatively simple measures such as weatherstripping and caulking windows and doors can reduce this exchange, as can special techniques such as the use of double outer walls or an unpenetrated plastic barrier in the building shell. The payoff is a significant drop in energy use, but presumably at the cost of higher levels of indoor pollution.

To test this association, our group measured both the radon concentration and the ventilation rate in the houses we examined. The result was surprising: we found little or no correlation between the two. We were forced to conclude that differences in the radon levels in various homes were primarily due to differences in the strength of the radon source.

We set about calculating this strength, even without being certain what the primary source was. We did this by comparing the radon concentration and ventilation rate in each of the houses to determine the rate at which the gas was entering, or the souce strength. As we had suspected, the source strengths varied widely among these houses—by about a factor of a thousand. After determining that the various building materials used in homes could only account for the smaller entry rates, we concluded that the only remaining source was the ground the houses were standing on. Yet if the radon was moving through the ground and into the house in the usual way that a gas diffuses, we expected it would enter at about one-tenth the rate that we had observed. Clearly there was another mechanism at work: the houses must be actively drawing radon from the ground.

Air infiltrates into a home largely because of small pressure differences between inside and outside. These differences have two primary causes. Winds create a higher pressure on the upwind side of the house, and in fact create a rather complex pattern of high- and low-pressure areas. Differences in indoor and outdoor temperatures also cause pressure differences of roughly the same magnitude as those caused by winds. Much as a fire draws air into the fireplace and up the chimney, in a heated house the "stack" effect draws air in toward the bottom of the structure, where the pressure is lowered, and sends it out toward the top, where the pressure is raised.

We suspected that the lowered pressure near the base of the house could draw radon-bearing air from the soil. Since the air in typical soil contains about

Though existing radon surveys are far from comprehensive, they suggest that an average home has a radon concentration of 1.5 picocuries per liter of air (pCi/l). The occupant of such a home receives a radiation dose about three times as much as from all medical procedures.

The numbers in parentheses give the percentage of houses in each location with radon levels of more than 8 pCi/l. This is a high level that owners should consider trying to reduce.

1,000 pci/l of radon, only one-thousandth of the air normally infiltrating a house has to come from the soil to account for all the radon present in the average house. Higher levels could be caused by higher flow rates from more permeable soil, or by higher concentrations of radon in the soil. This hypothesis, which a number of experiments have confirmed, explains the large size and variability of radon levels inside houses. It also provides a basis for designing effective means of controlling high radon levels.

Finding and Fixing High-Radon Houses

A few years ago, researchers at Lawrence Berkeley Laboratory's program on conserving energy in buildings wrote a pamphlet for the Department of Energy called "Finding and Fixing the Leaks." This brochure described how to reduce the infiltration of air through the shell of a house. Since even ordinary "house doctoring," which includes such measures as weatherstripping or caulking, can exacerbate existing indoor air pollution, we included information on various pollutants and suggestions for identifying and dealing with most problems. However, what we had discovered about radon suggested that it would be more difficult to deal with. One cannot determine radon levels through one's senses, and while relatively inexpensive techniques for measuring the gas are available, monitoring every home in the country would cost billions of dollars. Moreover, the difficulties of trying to curtail the flow of this gas from the soil into a million or so homes seemed daunting.

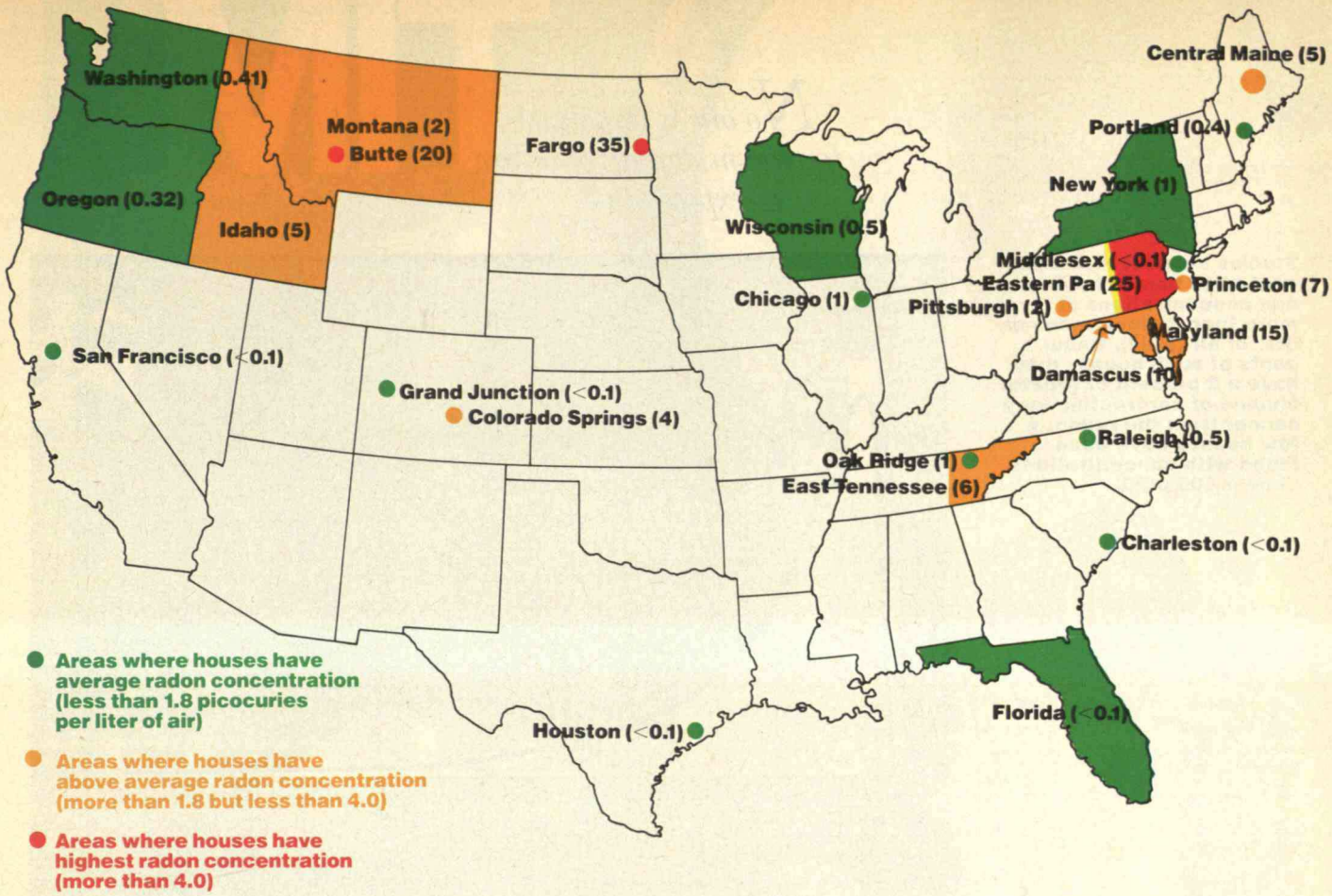
One seemingly obvious approach to controlling radon is to remove airborne particles—and hence the decay products that cling to them—with an air-cleaning device such as a fan coupled to a filter. This does succeed in lowering the *total* concentration of decay products. However, with fewer particles in the air to cling to, a larger fraction of decay products remain unattached. Unfortunately, these unattached products appear to cause a greater radiation dose, so the net effect of air cleaning is unclear. Control of indoor radon is better left to other techniques.

Since our research showed so little correlation between ventilation rates and radon concentration, it is not surprising that increased ventilation proves to be an impractical remedy for most radon problems. The occupants of a house with 20 pci/l of radon and an ordinary infiltration rate of one air change every hour and a half would find it uncomfortable to lower the concentration to, say, 4 pci/l simply by raising the ventilation rate. Five times as much air flowing through the house would not only make the house drafty but would double or triple the heating bills. (The only way to avoid this would be to use a heat exchanger that recovers heat from the outgoing air. This option is reasonable for newer, low-infiltration houses in cold climates but not for broad use.)

The alternative is to reduce the rate at which radon enters the house. One approach might be to carefully seal the understructure of the house. Unfortunately, sealing does not protect adequately against a pressure-driven flow of radon. Even if 90 percent of the entry points are sealed, the house can still draw almost as much radon from the ground. Moreover, minor cracking that occurs as the house settles can add new entry points.

The solution appears to be to reverse the pressure difference that is drawing the gas from the soil in the first place. This can be done by driving one or several pipes through the basement floor, and then using small fans to exhuast air from the underlying soil or gravel to the outdoors. This lowers the air pressure in the soil near the basement, and radon is no longer sucked into the house. Radon entering through a sump system can be removed by a similar approach: cover the sump, connect a pipe to it, and pull air outdoors with a small fan. If radon is entering through a crawlspace, a homeowner can create the same effect by actively ventilating the space.

The more difficult issue now is finding the million or so houses with high radon concentrations. Scientists may be able to locate susceptible areas by examining soil characteristics. Data on the radium content of U.S. surface soils are available from the U.S. Energy Department's National Uranium Resource Evaluation program to assess uranium resources. Airplanes carrying radiation detectors flew over the entire country monitoring gamma rays from—as it happens—bismuth-214, one of radon's decay products. These data do not indicate how much radon might be in houses, but they do indicate how much radium is generating the radon. We also need information on the permeability of soil to the flow of air. Data on soil characteristics, some related to air permeability, have been collected locally for agricultural and building purposes. Analyses of these data, or new investigations related to radon, may provide more comprehensive information on radon entry rates. Finally, local indoor monitoring pro-



grams will clarify the correlation between indoor radon levels and local source characteristics, including radium concentrations and soil permeability.

Indoor Radon Standards?

One of the more intriguing and difficult aspects of dealing with the problem of indoor radon is that, while it is of substantial importance and scope, there is no one to blame. We choose to live indoors for our own convenience, comfort, and—indeed—health. And the typical modern home is certainly better built and weatherized than a cave, tent, or structure of logs and thatch. But in the vast majority of homes with excessive radon levels, no unusual features cause the problem and no one can be blamed. These are ordinary structures, rarely special in any way except to their occupants.

People who are concerned about high radon levels or—worse—have learned that their homes have excessive levels are therefore largely left to their own devices. But various entities—including government agencies, utilities, and standard-setting organizations—have begun to step into the breach. Research groups are studying the problem of radon in particular and indoor pollution in general, both to assist with specific cases and to devise a national approach to the problem.

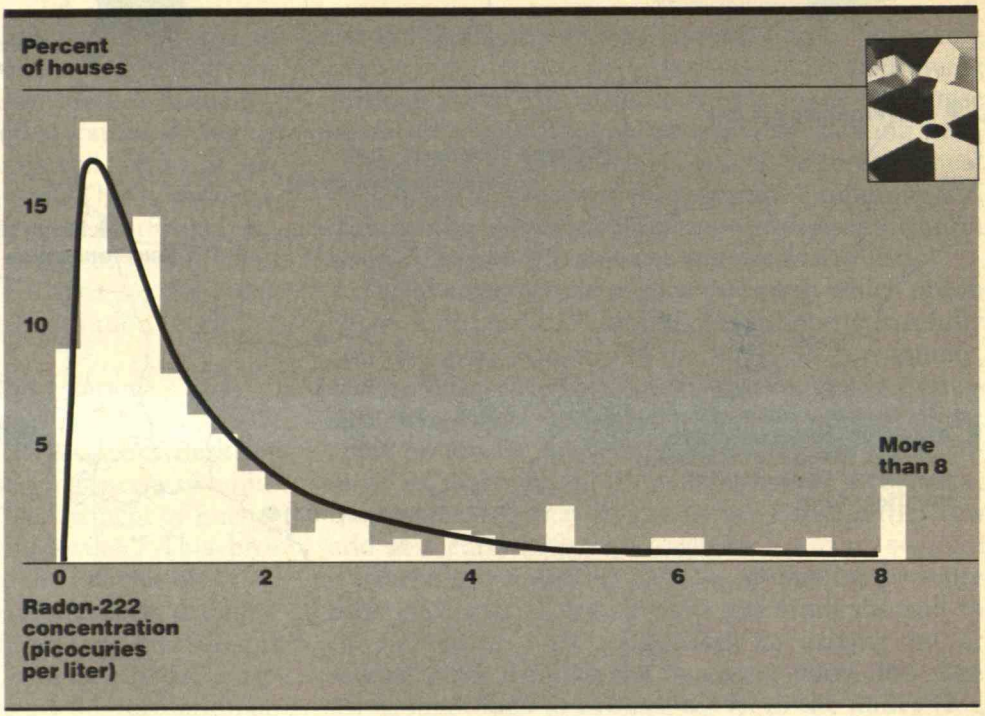
One issue in formulating a national strategy is how or whether to set standards for indoor air quality. Unlike outdoor air, which can be affected by any number of factors and which affects a broad population, indoor air is essentially a private resource—located in 80 million buildings and under the control of at least as many individuals. Hence, a new rationale is required for setting indoor air standards. Should standards be advisory or should they carry regulatory force? What level of risk is acceptable in private environments? Who is responsible for implementing standards, either by monitoring or taking remedial action? Indeed, what form will standards take?

Any scheme for controlling radon will probably rely on local guidelines in the form of codes for new buildings and stipulations regarding remedial action on existing homes. In both cases the risks deemed acceptable to house occupants will be greater than those associated with other environmental standards, but no more than those that individuals incur through many voluntary activities.

Guidelines for radon and other indoor pollutants are likely to take two forms: first, target ventilation rates, coupled with general limits on entry rates; and second, upper limits on concentrations. Radiation standards provide some precedent for such a dual structure. There is a general guideline limiting public

No one is responsible for radon, but all of us are exposed to it.

Studies suggest that 2 percent of all homes have radon concentrations of more than 8 picocuries per liter of air (pCi/l). Occupants of such houses may have a 2 percent or greater chance of contracting lung cancer from the radon. A few houses have been found with concentrations of over 100 pCi/l.



exposure to all forms of artificial radiation, and stricter limits on exposures arising from certain technologies. Thus, the general radiation exposure limit for the public is 500 millirems (mrem) per year, but the limit at the boundary of a nuclear power plant is 5 mrem per year. The radon exposures we are most worried about are much higher than ordinary radiation standards. Even the TMI accident caused a maximum exposure to the public of only about 20 mrem, equivalent to only 2 days in a 20-pci/l house.

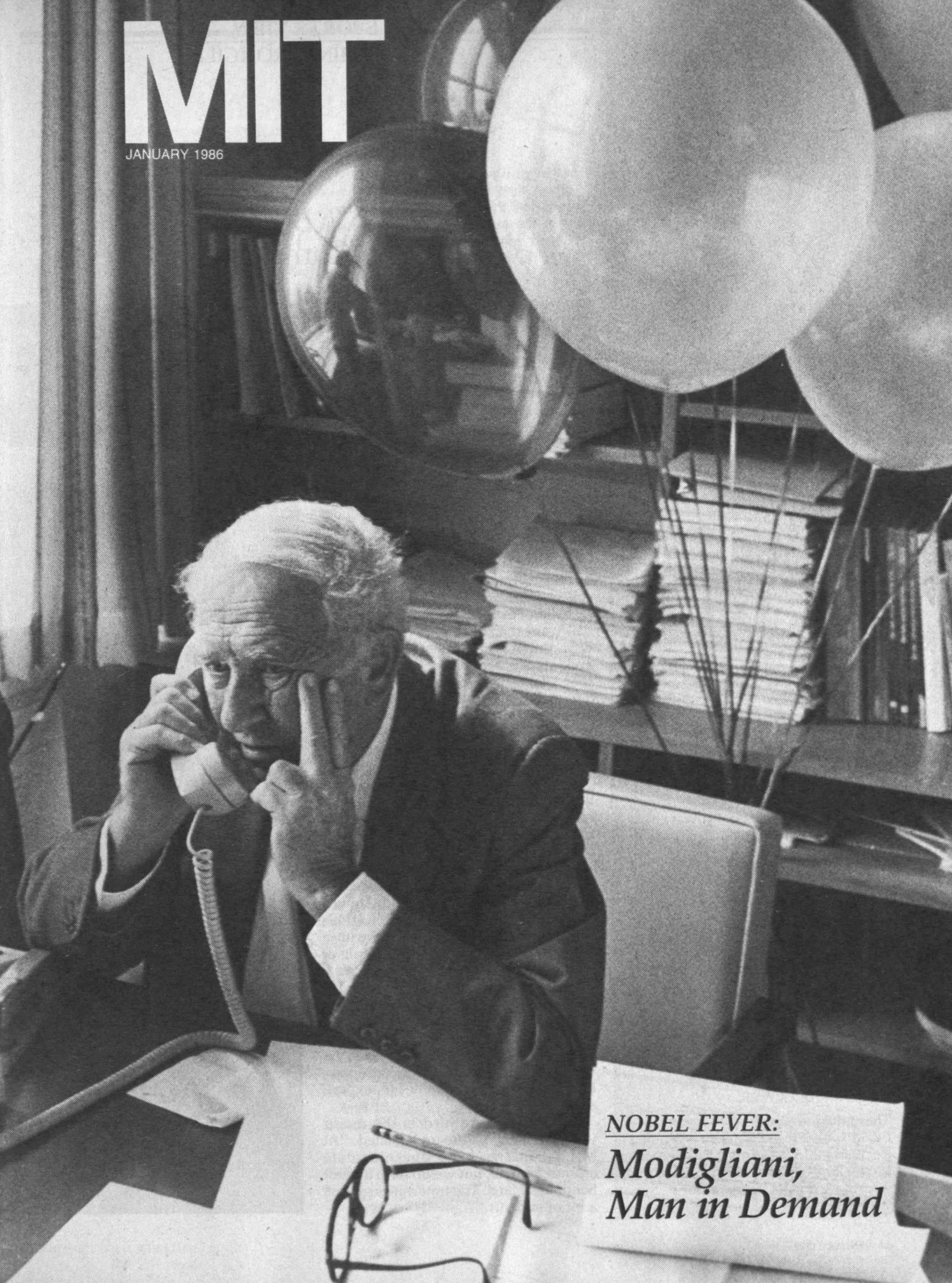
A ventilation standard requiring about half an air change per hour would at least maintain average concentrations of indoor pollutants, including radon, at present levels. The radon concentration of 1.5 pci/l in single-family houses would give a an exposure of 0.3 WLM per year, equivalent to about 300 millirems per year—far higher than the level permitted near nuclear power plants. To deal with exceptional cases, the general ventilation standard should be supplemented by an explicit limit on exposure. Remedial action would be recommended at, say, the 2 WLM per year exposure limit (equivalent to about 8 pci/l of radon) recommended in 1984 by the National Council on Radiation Protection and Measurements. These two types of standards would control average exposures (and hence the overall cancer rate from radon) while protecting individuals from excessive risk.

The way such standards are implemented can be important. We presume that there is no "safe" level of exposure to radon, and our objective is to reduce the risk substantially, not eliminate it. If the limit is 8 pci/l, it would not be satisfactory, for example, to reduce the level in an 8.5 pci/l house merely to 7.9 pci/l. The standard might have as its objective a level of around 4 pci/l—a significant reduction in exposure. Furthermore, because it is accumulated exposure that is significant, the urgency for remedial action will vary with the concentration of radon found. Living for a year in a house with 10 pci/l increases one's lifetime radon exposure by only 10 percent of the average. But living at 100 pci/l would have the same effect in only a month, indicating a need for speedier action.

Radon is an odd pollutant. None of us is responsible for it and all of us are exposed to it: even average levels of exposure carry risks far above those associated with other environmental pollutants. And high levels are enough to cause grave concern. Handling the problem effectively requires a new way of dealing with environmental concerns, coupling the assistance of governmental agencies with the efforts of individuals to make their own homes safer. Those who are affected shouldn't panic: this is a problem we have always lived with. But controlling the most significant radiation dose of our lives will require a sustained national effort to find and fix the houses that need help. □

MIT

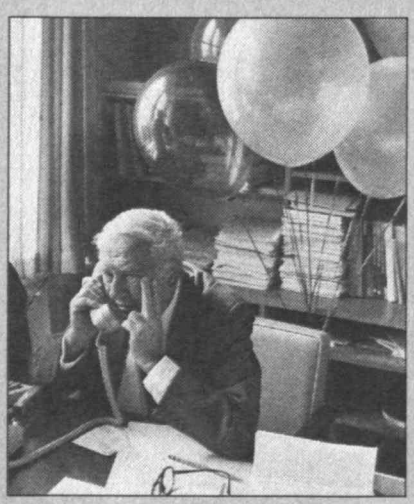
JANUARY 1986



NOBEL FEVER:

Modigliani, Man in Demand

MIT
JANUARY 1986



ABOUT THE COVER

The early morning announcement on Oct. 15 of his Nobel Prize in economics made M.I.T. economist Franco Modigliani an instant celebrity, beseiged by media from around the world. Photo by Calvin Campbell.

SPORTS VIEW

BY CARMINE FRONGILLO

M.I.T.'s Big Man on Campus

M.I.T. doesn't have a big-time football program. The Beavers play at the club level, and Larry Monroe—who has the size and talent to have played college football at the major college level—likes that just fine.

Monroe, a 6-7, 240-pound defensive tackle from Arab, Ala., is at M.I.T. to pursue a doctorate in chemical engineering.

The Beavers' tri-captain only went out for the squad as an afterthought. "I really didn't know all that much about playing football when I came here," Monroe said. "I came to M.I.T. because I was interested in becoming a professor of engineering. I'd like to teach at the college level.

"I didn't even know M.I.T. had a football team. I met a grad student in my department (Harvey Stenger, Sc.D. '84), and he recruited me for the program."

M.I.T., though bogged down by a 3-5 record (losing two games by one point each), boasts one of the top defenses in the New England Club Football Conference with Monroe as its—appropriately enough—nucleus.

Before he began playing for the Cambridge institution four years ago, Monroe's last involvement in organized football had been in the fall of 1969 for the Arab Junior Knights.

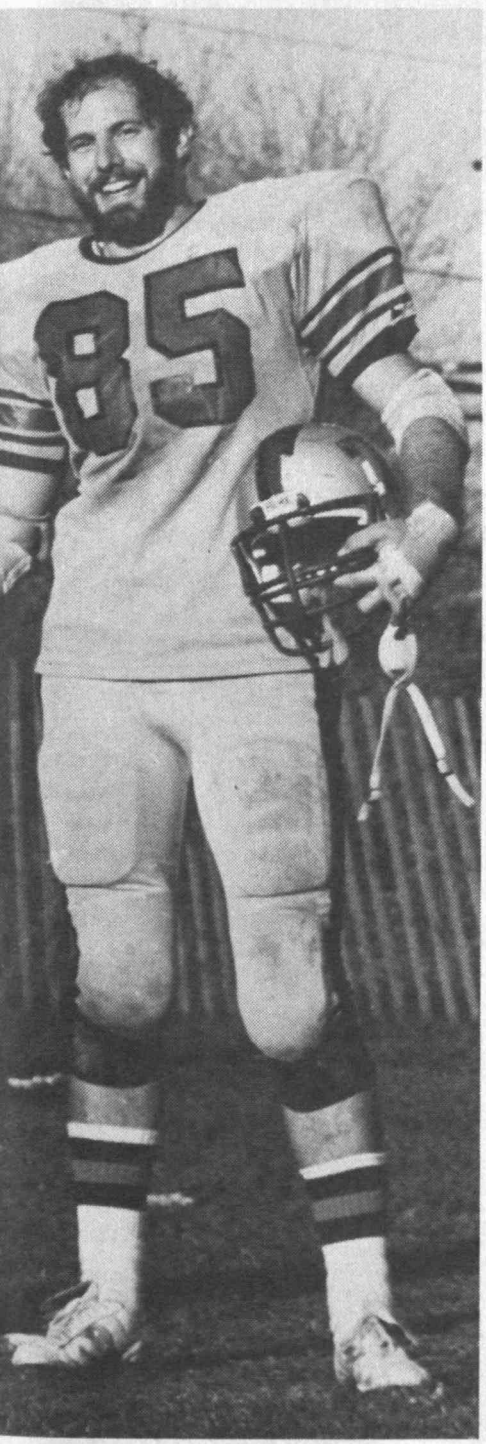
After graduating from Arab High School, where he was the valedictorian of his class, Monroe attended Auburn University in Alabama. He received his degree in chemical engineering with a 2.99 grade point average—on a scale of 3.0.

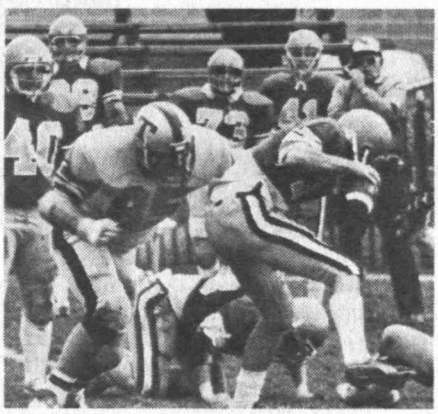
He then spent a year working for Du Pont's Wilmington, N.C. laboratories before beginning his advanced studies at M.I.T.

The 28-year-old Monroe reflected on the change of pace from the high-powered, football-as-a-way-of-life experience at Auburn.

"Football at Auburn is the major weekend activity," he understated. "At M.I.T., the weekend doesn't rotate around football, but we do have a number of loyal fans. The fraternities give us a lot of support."

Coach Dwight Smith is smiling in the photo with his 6-7 defenseman Larry Monroe, G. But Smith can't be happy about the impending graduation of Monroe, shown below sacking the quarterback in the last game of his college career.





When Monroe first went out for the squad in the fall of 1982, his 13-year layoff from football showed.

"I had a lot to learn when I first came out for the team," he admitted. "I could always fend people off because of my size. But I had to work on my foot speed."

"Playing here has been great for him, and great for us," said M.I.T. coach Dwight Smith. "We normally wouldn't get a player his size. . . ."

"He's a great leader," Smith noted. "Despite demands on his time, he's always there." (Monroe's teammates presented him with the game ball from his last game.)

Aside from providing a respite from his studies, playing football at M.I.T. has afforded Monroe an opportunity to find out first-hand just how good a football player he could become.

"I'm glad I played here because I had always wondered how good I could have been if I played in high school," said Monroe. "By playing here, I found out that I'm a decent football player, but I'm not in (the pro players') league.

"When high school players come out for our team they are suprised at the level of play. This is a very good team."

And that's the brains speaking, not just the brawn. □

CARMINE FRONGILLO is a sports writer; his column is reprinted with permission from The Boston Herald.

PHOTOS: STEVEN H. WHEATMAN '86

Capturing Wiesner's Vision

Jerome B. Wiesner's greatest legacy to M.I.T. is his commitment to the social interface of technology—how technology has increased the comfort and richness of human life while adding to the complex interconnectedness of society; how society is changed by technology and how it can influence technological change. A subset of these preoccupations is Wiesner's conviction that technology must be enriched by the arts and the arts by technology—a proposition that is now embodied in concrete and steel in the Jerome and Laya Wiesner Building.

Inside is a collection of activities whose interrelations are clear only in the light of Wiesner's zeal: the Council for the Arts at M.I.T., the Media Laboratory, including the Experimental Music Studio and the Visible Language Workshop, and the Committee on the Visual Arts, responsible for exhibitions and the Institute's permanent art collections.

The logic of this assembly was made obvious early in October, during an elaborate, three-day dedication program in honor of Jerry and Laya and the $40 million facility that bears their name.

The Wiesner Building itself is an understated white, cube-shaped structure with an extending concrete archway that ties it to the central core of M.I.T.—the line that begins in the "infinite corridor" of the main buildings and ends in the atrium of the Whitaker Building.

Given its mission, that's just where the building should be—on the main line of M.I.T., where so much of today's computer science and technology originated and where there has traditionally been a lively concern to optimize the usefulness of new knowledge. Such is the program of the Media Laboratory, which occupies a lion's share of the Wiesner Building—to make computers better servants of humans by improving the links between the two (*see page 78*). (The Media Laboratory, under the direction of Professor Nicholas Negroponte, '66, had its origins in what was known as the Architecture Machine Group, or Arch Mac.)

"The combination of computing and communication, as we know it now and can expect it to evolve in the decades ahead, will vastly expand human creative capacity," Dr. Wiesner said at the dedication. Paul E. Gray, '54, called the building "a window into the future."

Wiesner himself gave credit to the late Norbert Wiener, professor of mathematics at M.I.T., for first understanding that communications take place in networks—a concept essential for understanding societies and computers alike, said Wiesner. The fact that technology unconsciously mimics living systems, also attributed to Wiener, is a central theme in Dr. Wiesner's argument for the computer's power to increase human understanding and creativity. Computers deal with information much as humans do, Wiesner says, and studying computers may thus teach us much about the process of human cognition.

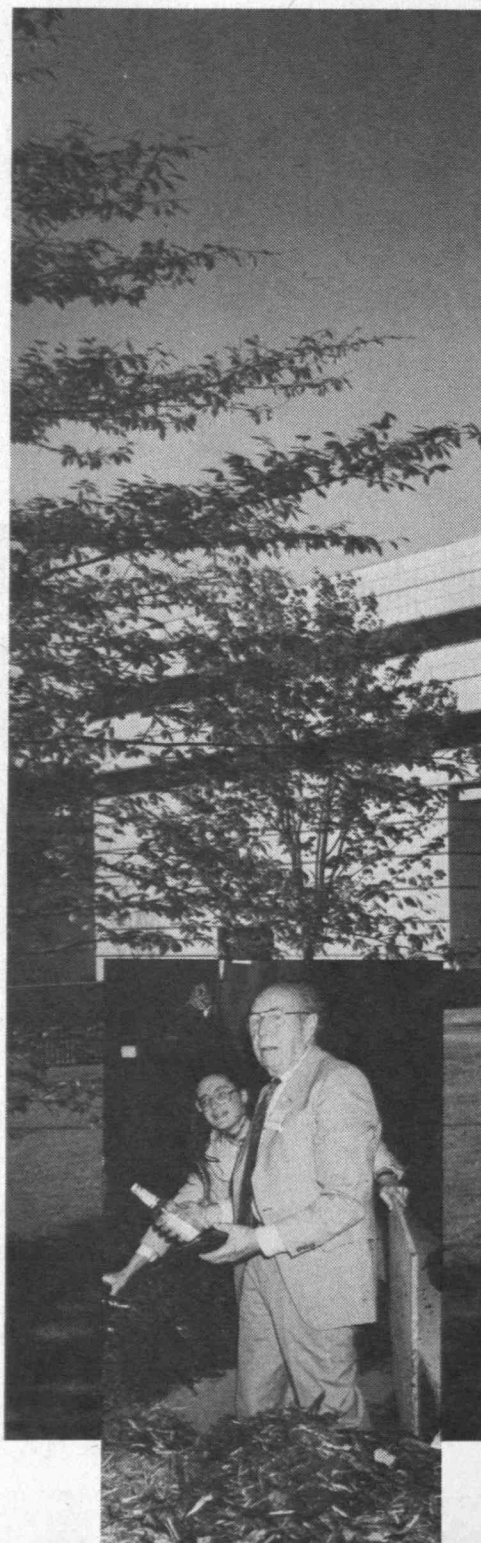
Because there is no model for a building linking art and technology, the Wiesner Building was designed almost while it was being built. Architect I. M. Pei, '40, describes it as the "most challenging and most interesting" building on which he has worked at M.I.T. (*see page A8*).

The design process was made even more unusual by the collaboration of the architect and three artists chosen by Kathy Halbreich, director of exhibitions for the Committee on the Visual Arts. The artists were commissioned to provide works that would be an integral part of the building—not so-called "plop art" added as after-thoughts. That collaboration yielded three programs:

☐ Scott Burton designed the benches and powerfully influenced other details of the ground and first floors of the Wiesner Building atrium.

☐ Kenneth Noland designed a pattern of colored panels that begins on the exterior of the building and migrates inside the atrium—a "brilliant" success, say critic Robert Campbell and Jeffrey Cruikshank in an essay on the art/architect collaboration.

☐ Richard Fleischner designed the exterior courtyard space east of the Wiesner Building. His solution for this



Below: Harold E. "Doc" Edgerton, '27, advocate for archeologists of the future, buried clearly dated bottles under the new Wiesner Building. He's also the 1985 recipient of the McDermott Award for "contributions to the arts as means of human fulfillment." At left: key figures in the dedication (left to right) Jerome Wiesner, President Gray, and Laya Wiesner.

"complex outdoor public space" is a broad walkway with sophisticated patterns of paving materials, a number of unique teakwood benches, and precisely planned plantings.

"When you deal with the collaboration, that goes beyond just being sticklers for details," commented Stephen Pelletier, project manager for Daniel O'Connell's Sons, Inc., the building contractor. "You are talking about something that's extremely gorgeous out there."

Coaxing Wiesner to M.I.T.

It was with special delight that James R. Killian, Jr., '26, president-emeritus, recalled during the dedication ceremonies the letter in which he urged Wiesner to come to M.I.T. as an assistant professor in 1945. "We believe that opportunities here over the coming years in your field of interest," wrote Killian, "will be of ample scope to your work."

Wiesner had worked on speech, music, and problems of electronic noise in signal detection before World War II and on radar systems at the M.I.T. Radiation Laboratory. The common denominator in all these was a fascination with communications that had already found expression in Wiesner's boyhood—he was the proprietor of an unofficial neighborhood telephone system in Dearborn, Mich. It was obvious that he would be captivated by Wiener's theories of communications and cybernetics. But the holistic concern for human communications that is celebrated in the Wiesner Building became evident later in his career, growing through his service as President John F. Kennedy's science adviser and as M.I.T.'s president.

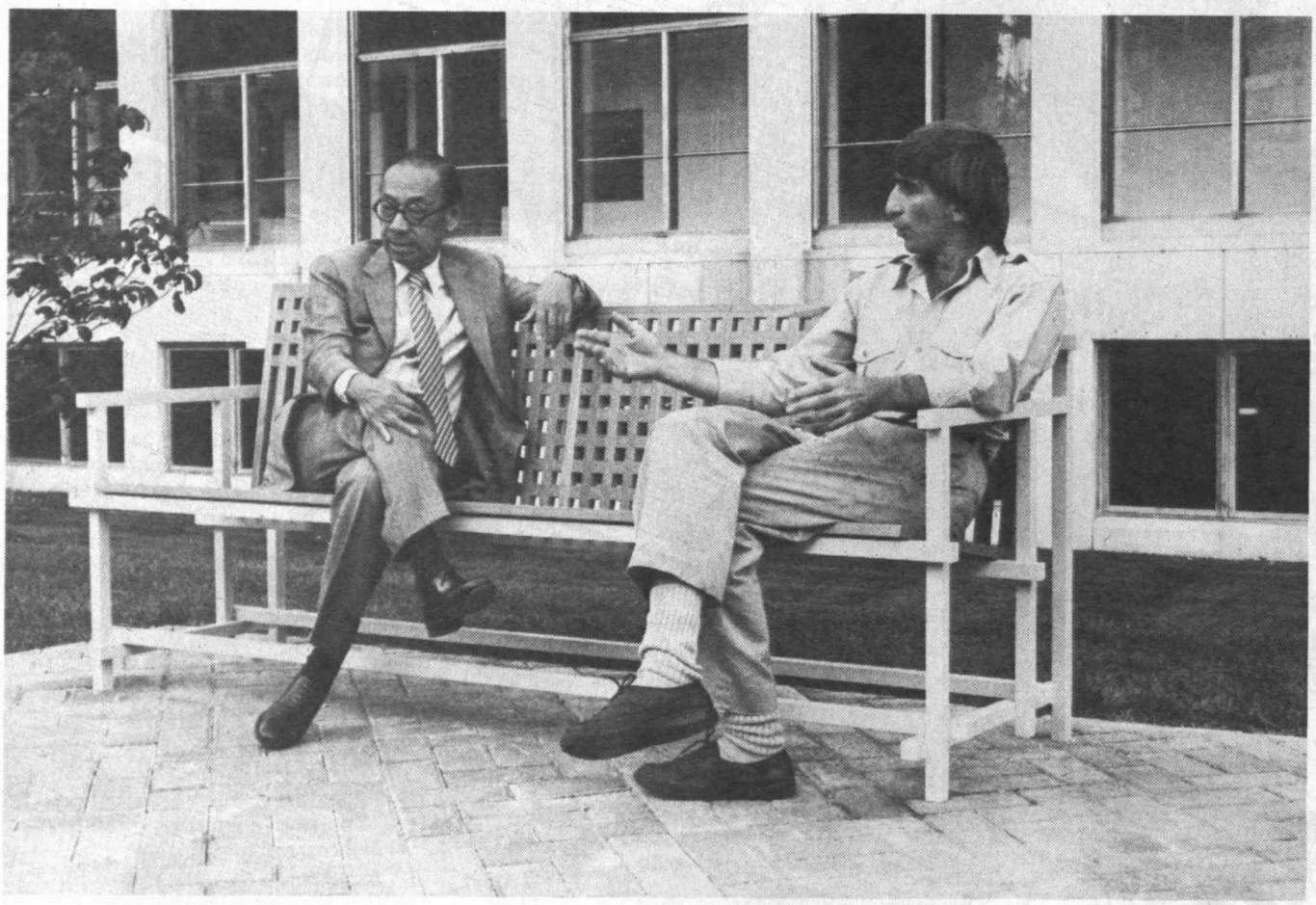
From the Wiesner Building, promised John de Monchaux, dean of the School of Architecture and Planning, will come important new ideas "about how we experience our world and how we pass those ideas on to others." And President Gray predicted it would be "a birthing ground for major intellectual achievements." He called it "a golden thread—a commitment to better human communications."—*John Mattill* □

As Professor Stephen Benton, '63, (shown upper left in a broadcast on Station WCVB Boston) discovered, working in the pioneering Wiesner Building can be a ticket into the media spotlight. His hologram research was but one of the aspects of the arts, architecture, and media technology at M.I.T. that has drawn the attention of every publication shown and more. Photo at right: The building's chief fund raisers, Jerry Wiesner (left) and Director of the Media Lab Nicholas Negroponte, '66.

PHOTOS: FRANK REVI, '86

Shared Creation of "Civilized Spaces"

BY STEPHEN E. HUNTLEY, '85, AND
MICHAEL F. BOS, G



It is the smallest but most challenging and most interesting building I worked on at M.I.T.," said its architect, I.M. Pei, '40, of the Wiesner Building at its dedication on October 2. Yet, he said of the experience, "I wouldn't want to repeat it too many times."

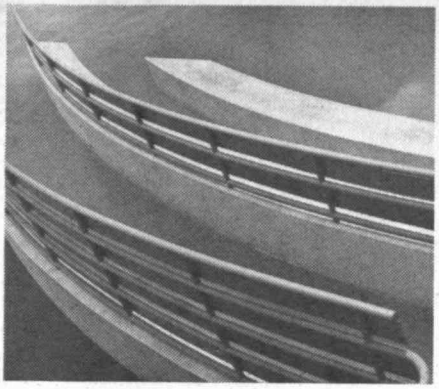
Pei obviously spoke with authority, for his building record at M.I.T. is unrivaled among living architects. With the Landau Chemical Engineering Building, the Dreyfus Chemistry Building, and the Green Center for Earth Sciences to his credit, he has now created a fourth major contribution to the M.I.T. campus.

This last work differs markedly from the others, as anyone who has even glimpsed the building can attest. Pei explained this as follows: Whereas there was a clear architectural tradition to follow in developing of the McDermott Court area (where Pei's other buildings stand), such guidance was lacking in the present case. The structures nearby were very different one from another. Instead of searching for an ephemeral common thread, he chose the more radical solution of adding something entirely new—in the hope that "by being different, maybe this building might pull the other ones together."

The Wiesner Building is also unique in the process of its creation: it is a collaborative effort of an architect and three artists. Kenneth Noland planned the panels and colored bars on the outside and in the atrium, Scott Burton designed the public seating, the stairwell, and the balustrades, and Richard Fleischner created the patterns of grass, trees, and geometrically paved courtyards between the building and its neighbors.

Pei describes the constraints of this approach: An architect is accustomed to collaborating with contractors, builders and government officials, but not to changing his plans in the middle of the building process. An artist, on the other hand, is used to keeping his work open to change to the last minute, but not to having to collaborate with others.

In summary, Pei said that he did not consider the Wiesner Building a major



Even the outside of this building matters: "For every person who enters the building, 100 will be walking in the outdoor spaces," noted Wiesner Building architect I. M. Pei. He is shown at left with Richard Fleischner, designer of the bench and the courtyard, also shown below.

Right and top: details of the architectural seating by Scott Burton, which in turn inspired the curves of the atrium's stair opening, rail, and balconies. What we can't show are the brilliant bands of color Kenneth Nolan gave the atrium wall.

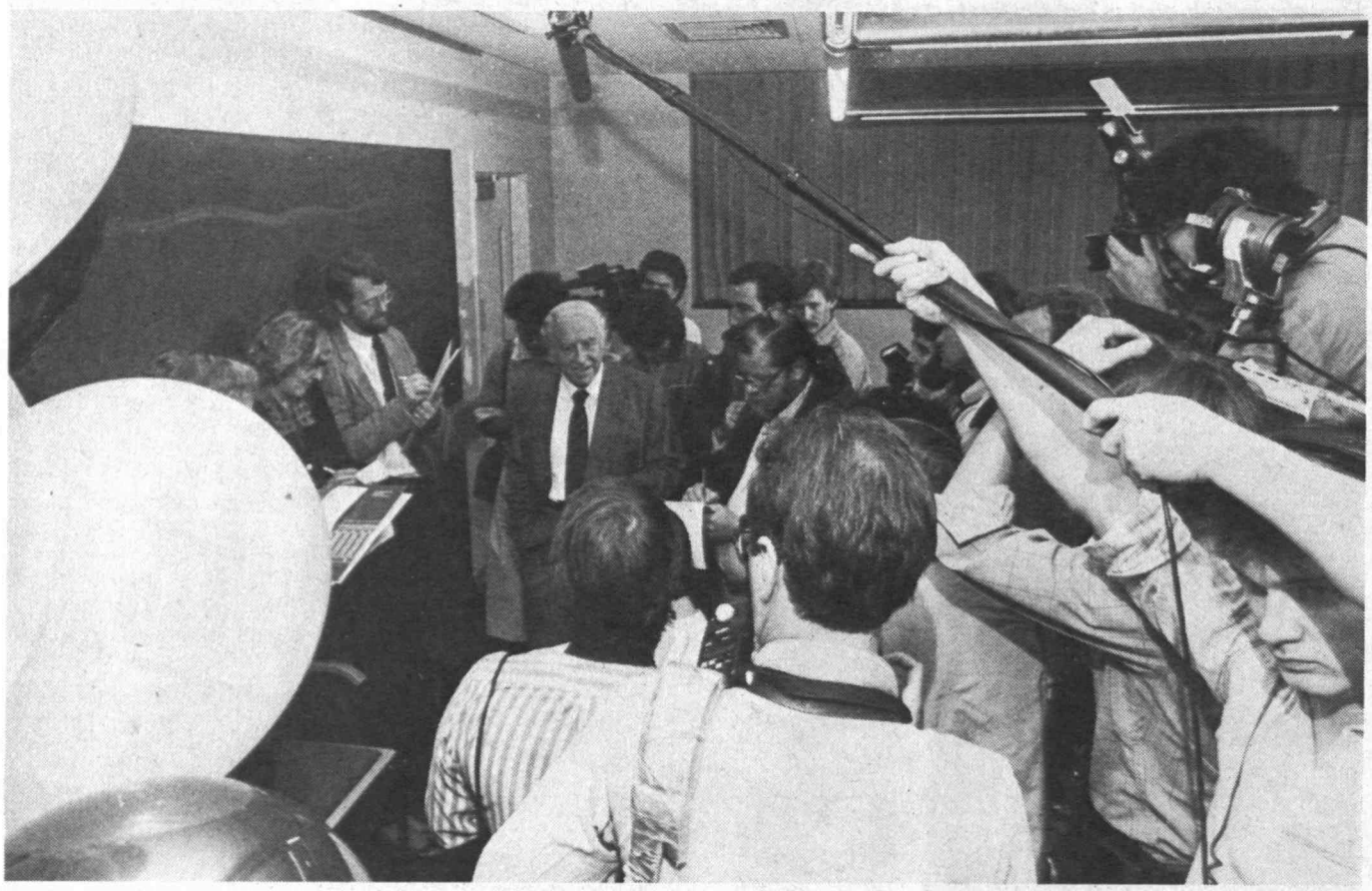
architectural statement. Rather, he said, "it is a space-making object": it creates spaces in which exciting activities can take place. He said that making bold statements is not always appropriate. Referring to the make-up of Paris, he argued that extraordinary architecture should be saved for truly special occasions. "There is a (specific) time and place for creating exciting buildings, but there is always a time and place for creating civilized spaces to improve the quality of life." □

Stephen Huntley is an undergraduate and Michael Bos a graduate student in the Department of Physics.

PHOTOS: STEVE ROSENTHAL, CALVIN CAMPBELL

BY CHARLES H. BALL

A Nobel Prize for Franco Modigliani



Franco Modigliani's day of days began at 7 in the morning October 15 with a telephone call to his Belmont home from the Royal Swedish Academy of Sciences informing him that he had won the 1985 Alfred Nobel Memorial Prize in Economics.

It was the beginning of a joyous and exhausting 12 hours that ended in a Cambridge television studio with Professor Modigliani telling a national TV audience pretty much what he had been saying to interviewers from near and far all day at M.I.T.—that the Reagan administration's failure to cope with the nation's growing deficit could have ruinous consequences.

The television appearance, in a quiet, nearly deserted studio at WGBH-TV, also offered a stark contrast to an otherwise hectic day that included a high-spirited—one newspaper called it festive—press conference at the Sloan School of Management.

His work helped lay foundations of corporate finance.

It was there at mid-morning that the 67-year-old Institute Professor was greeted by applause from students, faculty members and adminstrators, several of whom then toasted him with champagne. Dr. Modigliani holds dual appointments in the Economics Department and the Sloan School.

Standing beside Dr. Modigliani, as she continued to do throughout the day, was his wife of 46 years, Serena.

There were brief remarks by President Paul E. Gray, '54, Sloan School Dean Abraham J. Siegel and another Nobel laureate in economics from M.I.T., Professor Paul A. Samuelson, who greeted his close friend with the words, "Hail Caesar."

Professor Samuelson, in 1970, was the first American to receive the Nobel economics prize. The announcement of Dr. Modigliani's award marked the 13th time in the 17 years the prize has been

PHOTO: CALVIN CAMPBELL

Journalists from two continents mobbed the press conference following announcement of Modigliani's Nobel Prize in Economics.

given that an American has won or shared it.

The Nobel citation drew particular attention to the practical applications of Dr. Modigliani's work. His analysis of savings, the five-member selection committee said, had been "extremely important" in determining the effects of different types of national pension programs. And his work in the area of financial markets, they said, had helped lay the foundation for the entire field of corporate finance.

The committee also noted that his theory of corporate finance, now so routinely accepted, had flown in the face of traditional wisdom. "That is the true test of a brilliant theory," said a committee member. "What first is thought to be wrong is later shown to be obvious."

Dr. Modigliani's basic research in savings, called the "life-cycle" theory, was published in 1954. (His collaborator was a student, Richard Brumberg, who died of a congenital condition when he was 25.) The theory explains household saving by linking it to individual behavior, economic growth and demography. It holds that people save for their retirement—but only for their own old age and not their descendants.

In his work with financial markets, Dr. Modigliani analyzed the effect of any company's financial structure on the stock market's view of its value. He and an associate, Merton Miller, concluded that the market value of a company had no genuine relationship to the size and structure of its debt. Instead, they found, stock market values are determined mainly by what enterprises are expected to earn in the future.

Before the cameras and bright lights in the Sloan Schools's Schell Room, Professor Modigliani praised "the great institution of M.I.T.—a marvelous place where everything is done to make your work a success."

Soon after Modigliani began speaking, he laced into President Reagan. "I think one of the biggest surprises of our life . . . is how a man like the president could have . . . been elected on the grounds that the deficit was the greatest curse that ever occurred and caused all kinds of harm . . . Then this man has suddenly turned around and . . . somehow his administration explains that the deficit does not reduce savings," Dr. Modigliani said.

Looking at the assembled students, he charged that the administration's fiscal policies were undermining their future. He added, "We are ruining the rest of the world, and all because the president says that the last thing we're going to do is raise taxes. Well, hell!"

When the press conference ended, Professor Modigliani returned to his office on the fourth floor of the Sloan Building to begin a non-stop series of in-person and telephone interviews that left him little time to savor his latest honor. His lunch was a takeout cup of coffee and a turkey sandwich.

Newspaper and magazine photographers took pictures of him at his desk against a backdrop of a dozen brightly-colored balloons. One photographer convinced him to go downstairs for a shot with the Boston skyline at his back. When another took picture after picture after picture, Dr. Modigliani wryly wondered why it was necessary to work so hard to get an attractive picture. "I think I should be insulted," he joked.

As messages piled on his desk and interviewers crowded in on him, the besieged professor showed remarkable calm and patience, talking to reporters in English, Italian and French, as the situation demanded. No, he said, he is not related to the painter of the same name. Yes, he has two sons, Andre, 45, a professor of sociology at the University of Michigan, and Sergio, 39, of Brookline, an architect. How is his name pronounced? "Mo-deel-YAH-nee." Yes, he likes to ski and play tennis, and he intends to use some of his $225,000 prize money to upgrade his laser-class sailboat. No, he won't splurge but will fol-

Press Comment on Modigliani

The choice of Franco Modigliani as winner of the Nobel Memorial Prize in Economics is a popular one among economists, a tribe often given to highly refined and sometimes vocal dispute. . . . "Economists all over the world are students, admirers and friends of Franco Modigliani," said Paul A. Samuelson of M.I.T.

—*Eric Berg,* ***The New York Times***

While Modigliani's career exhibited both remarkable versatility and unusual duration—four decades since his first important paper—his most striking gift was an ability to remain in nearly constant connection with views of those around him. Whether creating new ways of seeing or combating them, Modigliani has led a rich, dense life in economics. . . .

. . . an unreconstructed Keynesian of liberal views, [he] has nevertheless managed to keep up with the changing times in an era of surging technical sophistication . . .

. . . it was Modigliani who took five years to build the large-scale model of the U.S. economy that the Federal Reserve System still uses to gauge the expected effects of policy.

—*David Warsh,* ***The Boston Globe***

"There's something central about his work," said Robert Heilbroner, an economist at the New School for Social Research, where Mr. Modigliani received his doctorate in economics in 1944. "He has a sense of what really matters."

—*Bob Davis,* ***Wall Street Journal***

If Professor Modigliani soothed this listener, it was not because of what he said about national deficit-spending: "a disastrous policy which will be costly—not to me, because I am old, but to you who are very young." It was, rather, his description of economic life. He made the people, if not the government, sound as if we are behaving quite rationally.

—*Ellen Goodman,* ***The Boston Globe***

"We are ruining the rest of the world because the president says the last thing we'll do is raise taxes."

low his own theories and spread out his spending.

In his native Italy, Professor Modigliani is even better known than he is in the United States. Italian television, newspaper, magazine and radio reporters vied for his time—and he seemed to recharge himself when talking to them.

One caller, a friend at a university in Bologna, said that the people there were celebrating his achievement and that some were even crying with joy. The congratulatory telegrams included one from the president of Italy.

Dr. Modigliani, who is Jewish, fled Italy in 1938 to escape the fascist regime, but he has kept in close touch with the Italian political and economic scene. He came to the United States from France, where he and Serena were married, in 1939. He has degrees from the University of Rome and the New School for Social Research in New York City. He taught and did research at several universities before joining the faculty at the Carnegie Institute of Technology in 1952. He came to M.I.T. 10 years later as a professor of economics and finance and was named an Institute Professor in 1970.

His last responsibility this day (he had to be up early the following morning for an appearance on the "Good Morning America" television show) was an interview on the MacNeil/Lehrer Newshour on public television, to be done via remote broadcast from the Channel 2 studios in Allston.

As he sank into the back seat of a cab, he commented on what an incredible year it had been. He was selected to receive the 1985-86 James R. Killian, Jr., Faculty Achievement Award last May (he will deliver the traditional Killian lectures April 2 and 9). Last September, about 50 former students and colleagues honored him by conducting a conference on his work in Martha's Vineyard, where he has his vacation home. And now he had become the sixth Nobel laureate on the M.I.T. faculty.

On the news program, he again insisted that the administration should begin attacking the deficit immediately by making cuts in military and civilian expenditures and raising taxes. On this subject he was stern, even angry.

On a different note, he said he intended to continue his work at M.I.T., particularly because he enjoys his students so much.

After the broadcast, he stopped to chat with another guest, a Filipino exile who spoke in Spanish, not a language Dr. Modigliani speaks but one he understands. And in the darkened lobby, waiting for a cab, he talked with a woman holding a child, mentioning his own four grandchildren. She said she had seen him on television and that it was a great honor to meet him in person.

Then he got into his cab and went home. □

CHARLES BALL is assistant director of the M.I.T. News Office. His report of the day spent helping Modigliani cope with an avalanche of media attention first appeared in Tech Talk.

"Sorry, wrong number."

October 15 was also memorable for Tushar M. Goradia, 22, a medical student in the Harvard-M.I.T. Division of Health Sciences and Technology. He was awakened at 7 A.M. by a phone call, and a "very dignified" voice asked him if he was affiliated with M.I.T. Goradia said yes. "I'm calling to inform you that your name was announced today as the Nobel Prize winner in economics," said the voice.

Impossible, said Goradia, explaining that he is just a student. "Aren't you Franco Modigliani?" asked the distressed caller, who then apologized profusely for the disturbance.

At a friend's urging, Goradia told his story to the *Boston Globe*, which printed it. And there the mystery lay until illuminated in a note to *Tech Talk* by Anders Bjorner, assistant professor of applied mathematics at M.I.T.

Bjorner recalled that on October 14, the last day of a visit to his native Stockholm, he was contacted by fellow mathematician Tord Ganelius. Ganelius is the secretary general of the Royal Swedish Academy of Sciences, which supervises the Nobel Prizes in economics. He told Bjorner that the academy was about to name a member of the M.I.T. faculty as recipient of a Nobel, but they were having trouble finding a phone number for the honoree.

The Academy tried without success to get the appropriate home phone number by calling the Institute early in the day. Bjorner explained that M.I.T. was closed for the Columbus Day holiday, but unfortunately he did not have an M.I.T. directory with him, so he could give no further help in time for the early-morning announcement of the prize.

"I have no idea how they finally found Professor Modigliani's phone number," Bjorner wrote in his note to *Tech Talk*, "but Mr. Goradia's story seems to indicate that it was not easy."

A check of Goradia's telephone number shows that it is the same, except for the last digit, as the home telephone number for Modigliani's son Sergio, who himself received a number of calls early that morning from reporters trying to locate his father. He is listed in the Boston telephone directory, but his father is not.

Bjorner thinks it might not be a bad idea to send an M.I.T. directory to the Swedish Academy "on the assumption that they will have occasion to use it in the future." *Adapted from* Tech Talk □

I CIVIL ENGINEERING

Eric F. Peyrard, S.M.'82, is working in the International Office of the French Department of Housing—in charge of the Export Credit Insurance Program. . . . **Sara N. Harvey,** '71, a senior manager at Digital Equipment Corp., has been installed as director for Region F of the Society of Women Engineers (SWE) last June 30 during the 1985 SWE National Convention. Harvey represents SWE members and students throughout New England—promoting the advancement of women in the engineering profession.

Frank S. Besson, S.M.'35, a retired army general who was the first commander of the Army Material Command, passed away July 15, 1985. Besson, a leading authority on military transportation, worked on the development of portable steel mesh runways for airfields, portable pipelines, the famous Bailey bridges, and other specialized equipment during World War II. Among his other major assignments: (1955) chief of staff for logistics and transportation for NATO; (1958) chief of transportation for the army; (1969) chairman of the Joint Logistics Review Board; and (1970) founding director of the National Rail Passenger Corp. The 75th army officer to attain the rank of full general, Besson held three Distinguished Service Medals and two Legions of Merit.

II MECHANICAL ENGINEERING

ASME has honored two alumni by election to the grade of fellow: **Franklin O. Carta,** '52, senior research engineer and supervisor of the aerodynamics group at the United Technologies Research Center, East Hartford, Conn.; and **Robert W. Mann,** '50, Whitaker Professor of Biomedical Engineering at M.I.T. Carta is honored for his "major contributions in understanding and control of unsteady aerodynamic and aeromechanical aspects of turbomachinery performance," Mann for 25 years of work on human rehabilitation during which he has "helped define the field" and made significant contributions to it.

Professor **David E. Hardt,** Ph.D.'78, is now director of the Laboratory for Manufacturing and Productivity, succeeding Professor **Nam P. Suh,** '59, who is on leave from M.I.T. to be assistant director of the National Science Foundation. Hardt, whose research and teaching are on the modelling and control of manufacturing processes, has been a member of the faculty since completing his doctorate.

Professor **Thomas Sheridan,** Sc.D.'59, in the department at M.I.T. is completing his duties as the 1985 chairman of the United Way campaign at the Institute. . . . **James V. Beck,** S.M.'57, professor of mechanical engineering at Michigan State University, Lansing, has written two books published by John Wiley and Sons: *Parameter Estimation in Engineering and Science* and *Inverse Heat Conduction: Ill-Posed Problems.* The latter was published last August. . . . Professor **John B. Heywood,** Ph.D.'62, director of the Sloan Automotive Laboratory at M.I.T., has been named Freeman Scholar by the American Society of Mechanical Engineers. Heywood was cited for work on which he reported at ASME's winter annual meeting last November: "Fluid Motion Within the Cylinder of Internal Combustion Engines." . . . **Anna O. Yau,** S.M.'80, passed away in Goleta, Calif., in 1985; no further details are available.

III MATERIALS SCIENCE AND ENGINEERING

Carl V. Thompson, '76, assistant professor of electronic materials at M.I.T., has been honored with a two-year appointment as the Institute's Mitsui Career Development Professor of Contemporary Technology. Thompson is an expert on solid state kinetic processes in thin-film electronic materials—an area of interest equally in the U.S. and to the Mitsui Group of Japan, sponsors of the professorship.

The Crystal Physics and Optical Electronics Laboratory—the outgrowth of the Laboratory for Insulation Research founded by Professor Emeritus **Arthur R. Von Hippel** just after World War II—has a new director: **Harry L. Tuller,** associate professor of ceramics and electronic materials. Tuller, who came to M.I.T. in 1975, is a specialist in electrically and optically active ceramics and glasses and their applications.

A $1 million grant has come to the department at M.I.T. from TDK Corp., Japan, the world's largest manufacturer of magnetic recording tapes and a major producer of ceramic components; the fund has established the TDK Professorship, to which Professor **Bernardt J. Wuensch,** '55, has been appointed. The gift marks TDK's 50th anniversary, and it's an expression of thanks: **Yogoro Kato,** who studied at M.I.T. from 1903 to 1905, returned to Japan to help discover the magnetic applications of ferrites to exploit which TDK Corp. was founded.

Fedia R. Charvat, Sc.D.'56, (since 1977) general manager of new products at Union Carbide, Norwalk, Conn., has been promoted to vice-president of the Electronics Division, responsible for technology coordination within the division. . . . **Alexander D. Wilson,** S.M.'69, supervisor of product research at Lukens Steel Division, Lukens, Inc., Coatesville, Penn., has been named a fellow of the American Society for Metals. Wilson was selected for his research in non-metallic inclusion structures and fracture mechanics technology.

Milton Stern, Sc.D.'52, vice-chairman of Stauffer Chemical Co., Westport, Conn., has been elected to the board of directors of Chesebrough-Ponds, Inc., as a result of Stauffer's acquisition by the latter. . . . **Yves Berube,** Sc.D.'67, reports of his 22 years of "silence" after leaving M.I.T. to join the faculty at Lavel University, Quebec: "My interest shifted from colloid chemistry to process control in mineral engineering. After supervising some 25 graduate theses and having spent 10 years doing so, I became restless and switched to politics with the nationalistic Parti Québécois.

"I was elected member of the Parliament in 1976 and in 1981 I enjoyed the dubious pleasure, as president of the Treasury Board of having to chop 12 percent from our $20 billion budget. . . . In 1983, I enjoyed some time and comfort as minister of education and later as head of the new Ministry for Higher Education, Science, and Technology. . . . Francine (Course IV, '65) and I are still married and raised two lovely daughters, now leaving colleges to enter universities. We are still living in gorgeous Quebec—a great place for politics, fine music, theatre, food, and skiing—unspoiled by civilization." . . . **Brahm Prakash Sekhri,** Sc.D.'49, of Bombay, India, passed away in 1984; no further details are available.

Professor Thomas Sheridan, Sc.D.'59, led a kick-off day rally as M.I.T.'s 1985 United Way chairman. At press time the campaign was over the 75-percent mark on the way to a $250,000 goal. (Photo: Calvin Campbell)

IV ARCHITECTURE

Composers and the Computer (Los Altos, Calif.: William Kaufmann, Inc., 1985) is the title of a new book by **Curtis Roads,** research associate in the M.I.T. Media Laboratory where he is also editor of the *Computer Music Journal.* Roads' book is described as "the first to examine the aesthetics, philosophy, and computer-music compositions of well-known composers."

Alex Loy Seid, M.Arch.'74, reports that he is an architect/planner, with the Massachusetts Port Authority, operators of Logan Airport, Hanscom Field, and the Tobin Bridge facilities. Indeed, he is "the first architect to be hired by Massport in its 25-year history." Future projects include a third tunnel under Boston Harbor, for which Seid is studying the planning, urban design of Massport properties and facilities that will be im-

pacted. Seid received a private pilot's license last May. . . . **Stephen A. Kliment,** (B.Arch.'53), former executive director of Whitney Library of Design, has been named vice-president and editorial director of the new book division of Practice Management Associates, Ltd., to be known as PMA Publishing, Brookline, Mass. The division's publishing activities will include management areas such as financial, personnel, marketing, productivity, and legal issues.

Christopher L. Hassig, a graduate student and instructor in the department at M.I.T., died in a fall while mountain climbing in Peru on August 26, 1985. Hassig had developed a subject in wood frame construction. . . . Two deaths have been reported to the Alumni Association, with no further detail available: **Michael B. Johnson,** M.Arch.'77, of Seattle, Wash., on June 21, 1985; and **Raymond J. Schneider,** M.Arch.'46, a rear admiral in the U.S. Navy in Baltimore, Md., on July 5, 1985.

V CHEMISTRY

Professor **Klaus Biemann** of M.I.T. will receive the American Chemical Society's Frank H. Field and Joe L. Franklin Award for outstanding achievement in mass spectrometry in New York next April. He's honored for his role in "developing computer-assisted mass spectrometric methods for determining the chemical structure of molecules of biological significance." The $3,000 award is sponsored by Extranuclear Laboratories. At the same meeting, **John I. Brauman,** S.B.'59, J.G. Jackson-C.J. Wood Professor of Chemistry at Stanford University, will receive the ACS James Flack Norris Award in Physical Organic Chemistry, in recognition of his work with charged molecules in the gas phase.

Mankil Jung, S.M.'78, is research assistant professor at the Research Institute of Pharmaceutical Sciences and assistant professor of medicinal chemistry in the School of Pharmacy at the University of Mississippi. . . . **F. William Southam,** Ph.D.'50, writes, "I retired last July after 36 years with Alcan International, the research and development arm of Alcan Aluminum, Ltd., where I served as senior technical consultant for the last 15 years." . . . **Robert E. Miller,** Ph.D.'49, director of research and development at Grain Processing Corp., Muscatine, Iowa, has taken on the additional responsibilites of senior vice-president.

David L. Morse, Ph.D.'76, has been named senior research associate—chemistry, Research and Development Division at Corning Glass Works, Corning, N.Y. Morse joined Corning in 1976. . . . **Charles E. Kolb,** '67, has been elected president and chief executive officer of Aerodyne Research, Inc., Billerica, Mass. Prior to this appointment, Kolb served as Aerodyne's executive vice-president and director of research.

Anthony P. Malinauskas, Ph.D.'62, director of the U.S. Nuclear Regulatory Commission programs at the Oak Ridge National Laboratory, was one of six scientists to receive the Department of Energy's 1985 Ernest Orlando Lawrence Memorial Award for outstanding contributions in the field of atomic energy. Malinauskas was cited for his analyses of movement of fission products in nuclear reactors. . . . **Martin Gall,** Ph.D.'71, reports that he is on sabbatical for one year at Columbia University's Chemistry Department. Gall will return to UpJohn, Kalamazoo, Mich., in July 1986.

George W. Coleman, S.M.'37, of Southborough, Mass., passed away on July 9, 1985. Before retiring, Coleman was director of research at the Parker Manufacturing Co., Worcester, where he had been chief metallurgist and chemist. Coleman also served as vice-president and general manager of Snell Manufacturing Co., Fiskdale, Mass. Coleman was an 18-year member of the Southboro School Committee (16 years as chairman); and a 50-year member of the American Chemical Society. . . . **John H. Pomeroy,** Ph.D.'49, of Bethesda, Md., manager of the international research program on moon rocks gathered by the Apollo astronauts, passed away on March 14, 1985.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Joseph F. Keithley, '37, and his wife Nancy are the donors of a career development professorship in electrical engineering, and Assistant Professor **Martin F. Schlecht,** '77, is the first incumbent of the new chair. Keithley is the founder of Keithley Instruments, Inc., Cleveland, leading maker of accurate and sensitive instruments for measuring voltage and current. Schlecht's work is in the field of electric power—the use of semiconductor devices in power circuits; he joined the faculty upon completing the last of his five M.I.T. degrees in 1983.

Two endowment funds to provide scholarship aid for undergraduates in the department have been established in honor of Professors Emeritus **Charles Kingsley, Jr.,** '27, and **Truman S. Gray,** Sc.D.'30. The goal is $50,000 in each fund. Why now? Not only because scholarship funds are short as tuition rises. The real answer is because both Kingsley and Gray are celebrating their 80th birthdays—Kingsley on October 14, 1985, and Gray on May 3, 1986.

Two honors for **Mildred Dresselhaus,** Abby Rockefeller Mauze Professor in the department at M.I.T.: she is a principal editor of the new *Journal of Materials Research,* a project of the Materials Research Society; and she was one of six panelists discussing "Natural Products Research: the Impact of Scientific Advances" at the prestigious Philip Morris Science Symposium late last year. . . . Professor **Harry C. Gatos** of the Department of Materials Science and Engineering at M.I.T. is a member of the advisory board to the new journal.

Raymond E. Peet, S.M.'48, retired vice-admiral of the U.S. Navy, has been elected a director of Energy Factors, San Diego, Calif. . . . **Gary J. Handler,** S.M.'66, former operations analyst at Bell Labs, Inc., is currently vice-president of network planning at Bell Communications Research, a division of the Nynex Corp., White Plains, N.Y. . . . **Michael S. Adler,** Ph.D.'71, manager of the Power Electronics Laboratory at the General Electric Research and Development Center, Schenectady, N.Y., was recently elected an IEEE fellow.

VI-A Internship Program

At the end of the summer **Kevin J. O'Toole,** '57, new VI-A associate director, attended project presentations by VI-A students at GenRad, Honeywell Electro-Optics and Lincoln Laboratory, while Director Tucker was on his annual West Coast/Dallas trip. Many students as well as company personnel have stopped in to make O'Toole's aquaintance. The next major phase of Kevin's indoctrination will be the VI-A orientation and selection process including the VI-A annual meeting and two interview days in March when all our company representatives gather on campus.

That the quality of students joining the VI-A Program remains high is attested by the continuing high number and percentage of seniors being granted admission to the graduate phase of VI-A. As of October 1985, 67.9 percent of all VI-A seniors had applied for admission and 73.6 percent of these (or 53) had been granted S.M.-only admission. These percentages will rise in January when all applications will finally be in and the Graduate Office has made its final decisions. A number of the S.M.-only's will be given "regular" admission, thus allowing them to pursue the doctorate after the master's.

The VI-A Office continues to receive a wonderful share of alumni/ae visitors. It is heartening to talk with them and be told how much the VI-A experience meant to them in retrospect. It was great getting acquainted with **James B. Angell,** '44, associate department chairman, Electrical Engineering Department, Stanford University. Angell was visiting M.I.T. in connection with committee work on the revision of the undergraduate electrical engineering curriculum at Stanford.

Another visitor was **Kevin D. Stoddart,** '71, who entered the Program about the time Mr. Tucker became director. Kevin is with Watkins-Johnson Co., San Jose, Calif. He confirmed that **James L. Fenton,** '78 and **Joel E. Schindall,** '63, are still with Watkins-Johnson.

Stopping by during a recruiting visit for Sentry/Schlumberger, San Jose, was VI-A Co-ordinator **Burnell G. West,** '60, accompanied by **James A. Lutz,** '84, senior product marketing engineer in their Advanced Technology Division. We had an interesting discussion about Silicon Valley and the changes at Fairchild/Schlumberger. . . . Visiting from the oldest VI-A class since our last writing was **William L. Sammons,** '43, president for North American operations, Carrier Corp., Syracuse, N.Y.

Other visitors: **Richard W. Chin,** '81, recruiting for Hewlett-Packard Co., Cupertino, Calif.; **Robert M. Gray,** '79, Information Systems Lab., Electrical Engineering Department, Stanford University; **Joshua L. Koslov,** '79, with RCA Labs in New Jersey; **C. Timothy Kuo,** '82, a senior engineering with M/A Com Linkabit, Lexington, Mass; and **Andrew L. Robinson,** '79. Andy planned to leave G.E., Schenectady, in mid-December to join the Electrical Engineering and Computer Science Department as assistant professor at the University of Michigan, Ann Arbor.—John A. Tucker, Director, VI-A Program, M.I.T., Room 38-473, Cambridge, MA 02139

X CHEMICAL ENGINEERING

Two alumni in the department have been named fellows of AIChE: **Curtis C. Williams III,** Sc.D.'50, manager of processing engineering/separations for Shell Oil Co., Houston; and **William B. Katz,** S.M.'40, president of the Illinois Chemical Corp., Highland Park. . . . **Elisabeth M. Drake,** Sc.D.'58, chairman of the Chemical Engineering Department at Northeastern University, Boston, is serving as acting dean of the college for the 1985-86 academic year.

Thomas H. Goodgame, Sc.D.'53, writes that he was elected president of Environmental and Chemical Consulting Engineers, Inc., Brentwood, Tenn., at a recent meeting of the Board of Directors. In addition to his duties as president and board chairman, he is principal of the Alamogordo, N. Mex., office. Before joining ECCE, Goodgame was director of environmental control for Whirlpool Corp., where he was responsible for all counterpollution activities in the U.S. and Canada. . . . **Charles M. Donohue,** S.M.'61, president of the Hilton-Davis Chemical Co., Cincinnati, has joined the Board of Trustees at the College of Mount St. Joseph, Ohio. . . . **Joseph W. Dickey,** S.M.'67, manager of Power Resource Services, Florida Power and Light Co., has been named a fellow of the Florida Engineering Society. . . . **George M. Cunningham, Sr.,** S.M.'27, of Laguna Beach, Calif., passed away on August 19, 1985; no further details are available.

XIII OCEAN ENGINEERING

The seventh ocean engineering alumni reunion was held last November 14 at the Warwick Hotel, New York City. Professor **Chryssostomos Chryssostomidis,** Ph.D.'70, briefly described the department's activities in the general area of design—both teaching and research. Over the last several years, the department has been devoting a major effort in this area.

On May 4, 1985, 11 members of Course XIII-A's NB-60 class held a mini 25-year reunion in the Washington, D.C., area. Those present: **Thomas Albee, Eugene Avallone, Norman Berge, Robert Bosnak, Michael Davis, James Grabb, Philip Lyons, Graeme Mann, William Markle, Myron Ricketts, Keith Schumacher,** and **John Shappel.** Bob Bosnak reported: "Reminiscing, discussion of the second and even third careers, and plans for

retirement were the order of the day, and letters from members who could not attend were read."

Peter A. Quigley, '85, was the 1985-86 recipient of the Robert Bruce Wallace Academic Prize. Peter's research activities have included the use of an auxilliary sailing vessel's propeller as a turbine under the supervision of Professor **A. Douglas Carmichael**. The award is a gift of Mr. and Mrs. A. H. Chatfield in honor of Mrs. Chatfield's father, **Robert Bruce Wallace,** '98. The prize recognizes outstanding leadership and ability as well as superior academic performance, and includes a plaque and a cash award that covers the cost of one academic year at M.I.T. (Peter took the 1983-84 academic year off to train with the U.S. Olympic sailing team.)

George A. Kreizis, S.M.'86, has been awarded the Ocean Engineering Undergraduate Research and Academic Acccomplishment Award. The award (established this year) recognizes extraordinary research accomplishments by an undergraduate student in the department. Kreizis has written several papers on the dynamics of marine risers under the supervision of Professor Chryssostomidis. The award includes a plaque, a full tuition scholarship, and living allowance at the maximum level for a graduate-research assistant at M.I.T. In the spring of 1985, Kreizis received a $750 grant from the M.I.T. Sea Grant Program to support his research on the linear dynamics of compliant risers.

John E. Agapakis, Ph.D.'84, received a merit award from the James F. Lincoln Arc Welding Foundation in recognition of his research on visual sensing techniques for automatic robotic welding fabrication. . . . **James J. Burgess,** Ph.D.'85, was the recipient of the AOO scholarship award for his paper on applied research on cable dynamics, submitted through the M.I.T. Sea Grant Program. . . . **John Dawley,** '86, and **Chirdpun Vitoorporn,** S.M.'86, each received $100 awards for the best ship designs for the final ship design project in subject 13.40—Introduction to Computer-Aided Ocean Engineering Design. The awards were made possible through the Goulandris Fund, which was established through a donation of the family of Nicholas P. Goulandris.

Lieutenant **Gregory Kolodziejczak,** Oc.E.'85, was the recipient of the 1985 Brand Award, which is given to the military officer (USN or USCG) completing the Naval Construction and Engineering curriculum with the highest cumulative grade point average. . . . Lieutenant Commander **William Needham,** who will receive his degree in June, was the recipient of the M.I.T. Award for Excellence in Corrosion Engineering for 1985. The national award is presented annually in recognition of superior achievement in the field of corrosion. (Lieutenant Commander **William Luebke,** who is also a student in the ocean engineer program, was the 1984 recipient.)

Professor **Ira Dyer,** '49, has been selected president of the Acoustical Society of America. . . . Professor **A. Douglas Carmichael** is the 1985-86 chairman of the New England Section of the Society of Naval Architects and Marine Engineers. . . . Professor **Jerome H. Milgram,** Ph.D.'65, has directed an Institute-wide project to develop a user-friendly interface between student laboratories and Project Athena, the Institute's program to introduce computers into all M.I.T. curricula.

Nicholas M. Patrikalakis, Ph.D.'85, and **Amiram Moshaiov** have been appointed assistant professors in the department at M.I.T. Patrikalakis' research is in the use of computers in engineering and design of marine systems. Moshaiov has recently been awarded a Ph.D. from the University of Michigan and will teach and pursue research in structural design and marine structures, with an emphasis on ship structures. **Michael S. Drooker,** Oc.E.'73, has been appointed research engineer and lecturer in the area of computer applications in marine design, while Associate Professor **Peter N. Mikhalevsky,** Ph.D.'79, resigned last summer, taking a position with Science Applications, Inc., Washington, D.C.

Two members of the faculty at M.I.T. have been awarded patents: Professor **Koichi Masubuchi,** for underwater arc stud welding systems; and Professor **Jerome H. Milgram,** for two devices to control subsea well blowouts: a separating collector and an oil collector for installation on a seabed.

Lieutenant **Charles Goddard,** Oc.E.'85, was the 1985 winner of the Naval Sea Systems Command Award in Naval Construction and Engineering, in recognition for his contribution to the Naval Construction and Engineering Program and for his outstanding academic performance.

Albert F. Suchy, S.M.'80, recently left his post as engineer officer of the U.S. Coast Guard cutter *Bear*—the first of the new famous class of cutters. He is now assigned as section chief of the major cutter section of the Naval Engineering Branch of the Fifth Coast Guard District in Portsmouth, Va. Suchy resides in Portsmouth with his wife and three children. . . . **William K. Blake,** Ph.D.'69, a research scientist at the David Taylor Naval Ship Research and Development Center, Bethesda, Md., has been awarded the 1985 David Taylor Award for "outstanding pioneering research on propulsor hydroacoustics."

Captain **Carl R. Hirschberger,** S.M.'43, USN (Ret.), passed away on July 9, 1985, in Fitzwilliam, N.H.. Hirschberger was chief engineer of the light cruiser *Boise* during World War I, later serving in shipyards in Philadelphia and Charleston and at the Naval Engineering Experiment Station in Annapolis. From 1952 to 1956 he was chief constructor of the aircraft carrier *Saratoga* and staff engineer of Military Sea Transportation Services—Atlantic. Following retirement in 1961, Hirschberger developed and patented a self-feathering propeller for sailing vessels and was author of several articles for naval and technical journals. . . . Two deaths have been reported to the Alumni Association, with no further details available: Rear Admiral **William Alden Brockett,** S.M.'43 (USN Ret.), of San Diego, Calif., in 1984; and **Antonio J. Galvache,** S.M.'31, of Madrid Spain, in 1984.—Patricia A. LeBlanc-Gedney, Department of Ocean Engineering, M.I.T., Room 5-228, Cambridge, MA 02139

XIV ECONOMICS

Margaret Garritsen de Vries, Ph.D.'46, historian of the International Monetary Fund, is the author of three new volumes of *The International Monetary Fund, 1972-1978: Cooperation on Trial,* published last fall by the fund. Volumes I and II are titled *Narrative and Analysis* and Volume III *Documents.* De Vries previously authored two volumes of the history of this international organization covering 1966 to 1971 and was co-author of one of the three volumes covering 1945 to 1965.

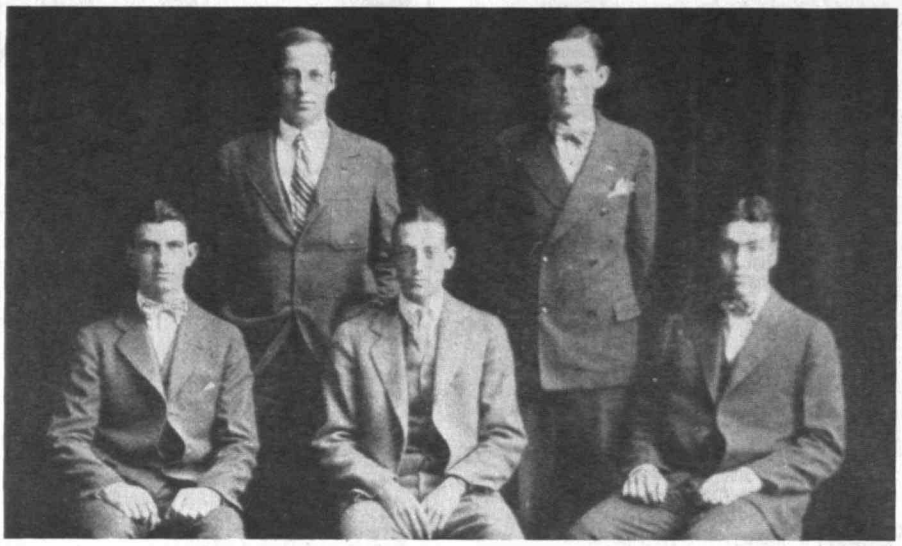
Carlos F. Diaz-Alejandro, Ph.D.'61, professor at Columbia University specializing in Latin American economics, passed away on July 17, 1985, at the age of 48. Prior to his appointment to Columbia in 1984, Diaz-Alejandro had been professor of economics at Yale (since 1969). He served in 1984 on the National Bipartisan Commission on Central America (the Kissinger Commission). . . . Two deaths have been reported to the Alumni Association; with no further details available: **Egon Sohmen,** Ph.D.'58, in 1985; and **Rafael Lusky, in 1985.**

XV MANAGEMENT

Formerly strategic planner for the Product Development Department at Exxon, **Kevin E. Lonnie,** S.M.'81, is now an industrial liaison officer at M.I.T. Since receiving his Sloan School degree, Lonnie has also worked for M.I.T.'s Office of Personnel and Labor Relations and for the Chase Manhattan Bank as a credit analyst and assistant treasurer.

Professor **Edgar H. Schein** is the author of *Organizational Culture and Leadership: A Dynamic View*

The Launching of Aeronautical Engineering at M.I.T.



Franklin T. Kurt, '27 claims a major role in convincing M.I.T. to establish Course XVI in 1927. But he had lots of help. As early as 1909 there was an Aero Club at the Institute, and in 1927 Technique carries this photograph of the Aeronautical Engineering Society. Left to right: Everard M. Lester, Franklin T. Kurt, Brewster A. Gillies, James C. Reddig, and Benjamin S. Kelsey.

As Franklin T. Kurt, '27, remembers it, he was single-handedly responsible for the creation of M.I.T.'s pioneering Course XVI—Aeronautical Engineering.

It was in his senior year that Kurt was called into the stately, formal office of President Samuel Stratton, after submitting the fourth in a series of formal petitions to the faculty. The first three had been rejected, but now Stratton told him, "We have had so many of these long petitions and resolutions to have to read at the faculty meetings, to avoid more, we decided to form the Aeronautical Engineering Course." Kurt wrote his thesis—"The Advantages of Amphibious Aircraft in the Advancement of Flying"—under the course, becoming the first and only graduate in 1927.

Kurt diligently pursued his career at Grumman Aircraft on Long Island, designing, building, and testing amphibious aircraft. The "Widgeon" was his favorite.

Among Kurt's retirement projects in Maine has been writing *Water Flying*, now in its second printing as the "bible" for amphibious flyers. Joseph C. Burley, '27, secretary of the Class of 1927, who's responsible for this report, concludes that "all graduates of Course XVI should be grateful for the persistence and foresight of Franklin Kurt." □

(San Francisco: Jossey-Bass, Inc., 1985, $21.95), described by the publisher as providing a "more comprehensive explanation of organizational culture than has previously been available." Schein has also contributed a key chapter on "How Culture Forms, Develops, and Changes" to *Gaining Control of the Corporate Culture*, an anthology under the same imprint edited by Ralph H. Kilmann, Mary J. Saxton, and Roy Serpa.

Mary P. Rowe, who's been special assistant to the president at M.I.T. in the role of ombudsperson for 13 years, is now adjunct professor in the Sloan School. Rowe is teaching courses in conflict resolution and minority issues.

Charles C. Holcomb, S.M.'75, is vice-president for business affairs at Baptist College at Charleston, S.C. . . . **Ilene S. Gordon,** S.M.'75, formerly director of corporate development at Packaging Corporation of America, Evanston, Ill., has been promoted to vice-president—corporate development and diversified business. Gordon will head a new operating division—Diversified Businesses—developed to explore acquisitions and manage some newly acquired businesses. . . . **Ann E. Bublitz,** S.M.'83, writes, "I am now at CIBA-GEIGY's Greensboro, N.C., facility were I am a manager in the New Technology Department, traveling around North America looking for new technologies relevant to agriculture."

Winford G. Ellis, S.M.'74, reports that last May he became deputy senior member of the Nuclear Propulsion Examining Board Staff, Commander in Chief, U.S. Atlantic Fleet, Norfolk, Va.

Management of Technology Program

Pilkington Brothers has been making some changes for its program graduates in England: **Geoff Andrews,** S.M.'82, has become manager for new business opportunities for the Electro-Optics Division, and **Charles Berry,** S.M.'83, is now marketing director for Barr and Stroud.

Elliot Blackman, S.M.'82, is alive and well and enjoying his work at Digital, Hudson, Mass. His title seems to change regularly—as he is now senior strategic planning specialist. Jane Morse and Ed Roberts saw Elliot in October at an informal presentation they gave at DEC's Littleton, Mass., facility, where Elliot came to provide insight for the group on "a day in the life of an MOT."

Peter Drummond, S.M.'85, telephoned in September to report he was starting work with Lucas, a motor components business in Birmingham, England, as sales and marketing manager. He spoke recently with **Dave Rimmer,** S.M.'85, who was back at Pilkington in North Wales. Dave told him that Susan misses Boston. Peter's new job has put him only an hour and a half from the Rimmers'.

Ted Finch, S.M.'84, called in September to let us know he and Jeanne had just moved into a new two-family house in Cambridge on Lexington Ave. They'll live in the rental part until they have the main part fixed to their liking. . . . **Anita Kirkpatrick,** S.M.'85, has moved back to San Diego after a summer in Boston. As of this writing, she was searching for a suitable position but planned to do some part-time teaching in the meantime.

Some of our graduates like to move around a lot! **Ken Miller,** S.M.'82, has left AT&T Federal Systems in North Carolina to join his brother's business in Ohio—Frey Scientific Co.—as vice-president and managing partner. It was a deal too good to pass up, as Joan, too, has been snapped up as their marketing director. . . . **Rick Orr,** S.M.'85, wrote this fall to announce he and Sallee are expecting "Baby Orr" in March.

Drew Peck, S.M.'85, and Liz stopped by in September to say hello and to have their last doctor's appointment for Drew's broken arm. They reported five MOT'85 graduates made it to Alan and Ruth Drane's party in August. He is enjoying his position with Gartner Group in Stamford. Liz is now selling for a gourmet food company and hopes to get into catering. I'm sure all the '85 MOT's would agree she couldn't have found a more perfect niche!—Jane Morse, Program Manager, M.I.T., Room E52-125, Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

Professor **Theodore H. H. Pian,** Sc.D.'48, in the department at M.I.T. was named an honorary member of the American Society of Mechanical Engineers during the Society's winter annual meeting last November. Pian was honored for "outstanding contributions in the areas of structural mechanics and finite element analysis'. . . and his exemplary record as a mechanical engineering educator." . . . Major **Robert P. Bongiovi,** S.M.'71, executive officer to the assistant secretary of the Air Force for Research, Development, and Logistics, Washington, D.C., has been named "Action Officer of the Year" by the deputy chief of staff for research, development and acquisition, Headquarters, U.S. Air Force. Bongiovi is the first to receive the new headquarters award in recognition of service "as the linch pin, the cornerstone, of Air Force research and development staffwork in the Pentagon."

Rear Admiral **Raymond John Schneider,** S.M.'46, USN (Ret.), former commander of the Naval Electronics Systems Command, passed away on July 5, 1985 in Elkridge, Md. Schneider served on the light cruiser *Detroit* during World War II and later held a variety of positions in engineering, research and aeronautics; he retired in 1975 with two Legion of Merit awards. . . . Rear Admiral **Emerson Evans Fawkes,** S.M.'41, (retired) of Arlington, Va., passed away on May 5, 1985; no further details are available.

15

Our 70th reunion year has been continuing with so much correspondence from many of you. Keep it up. I have heard from **Bob Warren, Loring Hall,** and Amy Ford Stearns in recent weeks, and the interest seems to be at a high peak. Loring sent a note from Edward Stone, **Pop Wood**'s nephew, who mentioned how much he has been enjoying Loring's notes and inquiring if any of the '15ers knew how Pop came to be called "Pop" instead of Carl. Would love to hear from some of you classmates if you have an answer.

We complete **Loring Hall**'s notes on your junior year at M.I.T.:

April 4, 1914: Signed up **Arthur Parker,** during Business Law class, to work for me next summer selling aluminum wire. Collected a $5 deposit. Had a hard test in Geodesy. After supper took the street car to President McLaurin's house. About 50 of us spent a pleasant evening there, getting acquainted and listening to music. Taylor, '14, played very well on the violin. **Harvey Daniels, Tom Jewett** and **Carlton Lovell** were there. Met F.R. Jones, a fraternity brother of Tom's. He owns an auto, but didn't offer to drive us home.

April 9, 1914: Took the 1:39 train for Newtonville, where the geology class had another field trip. Saw examples of eskers, kames, kettles, sand-plains, drum-ins, delta-beds, top-set beds and fore-set beds, all of which will have to be accounted for in an exam some day. Learned a lot. Returned on the 4:02 train to Huntington Hall where **Wally Pike, Millard Pinkham, George Rooney, Frank Scully** and others made ourselves hoarse practicing Tech songs and cheers. It was an enthusiastic crowd. Cooked griddle cakes for supper.

April 10, 1914: Collected dues from the Civil Engineering Society members. Tried to see Professor Spofford but he was tied up. Started to read Poincare's *Science and Hypothesis.* Took the train to Wellesley, where Isamacy and Edith put on a fine salmon dinner—then took me on a tour of the college grounds. College Hall burned to the ground a month ago. Nothing but bare walls left.

April 11, 1914: Had a conference with Professor Spofford to select a thesis for senior year. **Highley** and I have tentatively decided to go in together on "The Strengh of Rivets in Tension," but have to get approval first. Played a game of Intrafraternity baseball—PSK beat DKP 8-1. **Bud Curtis** pitched for us and showed class. I caught one fly ball. Made no runs, no hits, had no errors. It was a lot of fun.

April 13, 1914: Walked part way and met Kay, to ride in town together on the street car. As usual, I enjoyed her bright conversation. Worked hard all day, especially after lunch when **John Gallagher** and I spent three strenuous hours on an electric lab experiment "Full Load Efficiency and Inherent Regulation of an Alternator." It was a pippin, involving 20 instruments and four lab assistants.

April 15, 1914: Had our usual geodesy class. After lunch watched the annual "Technique Rush" in which a wild scramble goes on for a limited number of the year books which are passed out through a small window. I had planned to participate, but the three guys who were going to team up with me backed out, so I just watched. Had an illustrated lecture on "Asphalt Paving." Professors Breek and Allen took part in the program. Sat with **Pinkham.**

April 14, 1914: First performance Tech Show 1915. Took Kay to lunch at Phi Sigma Kappa, then went to the Opera House. **Ober, Whitcomb, Milliken, Murphy, Roswell** and **Faunce** went also, each with his girlfriend. It was a good show. **Hastings Smyth** as the leading "lady" was attractive and could act, too. The whole performance was by Tech men, who also wrote the music and lyrics, built the scenery, and filled all the management positions. How they find time for it, I can't figure out.

April 17 - April 20, 1914: Part of Junior Week. **Seward Highly** and I were guests of **Dick Hefler** and his parents at Dennis, Cape Cod. Spent four days exploring the Cape and enjoying the hospitality of the Heflers. Dick's sister, Gene, was there too, and was very entertaining.

April 21, 1914: Back to work, somewhat tired from the "vacation." Completed an EE Lab report. The Mexican War started today, with U.S. ships bombarding Vera Cruz, while the Marines went ashore and captured the city. A young Cambridge man named Haggerty was the first to be killed.

April 22, 1914: **Dick Hefler** and **Bill Holway**

M.I.T. Summer Camp in Eastport, Me., attended by civil engineering students, had its first session in 1912. "I think it's going to be the highlight of the whole four years," says Loring Hall, '15, in his 1912 diary.

ILLUSTRATION: TECHNIQUE 1914

and I went to the ball game. The Red Sox played the Philadelphia Athletics. In the eighth inning Tris Speaker drove in three runs that tied the score at 9 to 9. The game was called at that time so the two teams could catch their trains.

April 23, 1914: The geology class took the 1:45 ferry to Nahant. We spent a delightful and instructive afternoon on the rocky beaches. Visited Senator Lodge's estate. Saw three battleships streaming out of the Charlestown Navy Yard bound for Mexico.

April 24, 1914: Professor Shimer took the members of his class to the Agassiz Museum at Harvard. He traced the development of man through invertebrates, fishes, reptiles, birds, and so forth.

April 28, 1914: At a meeting of the C.E. Society in 11B. Mr. Roger W. Babson, '98, gave a talk about forecasting business conditions. He gave us charts and graphs.

April 30, 1914: Had a tough test in stratigraphic geology this morning. After lunch went on our fifth geology field trip. This time it was to Brighton, where we studied some sedimentary rocks with igneous intrusions. Walked part way home with **Ted Freibus, Ralph Malcolm** and **Henry Niesmann**.

May 2, 1914: My Civil Service Exam report came today. My average was 78.96% and I am 14th on the list. **Highly** is 7th, **Tisdale** 6th, and **Ted Friebus** 10th.

May 7, 1914: Field trip to Squantum, Mass. with Dr. Lahee. Back in town to the C.E. Society banquet at the Copley Square Hotel. Speeches by Professors Spofford, Desmond Fitzgerald, and Harrison P. Eddy.

May 8, 1914: Spent the whole day in the drafting room. Received an offer of a job from U.S. Geologic Survey at $45 per month.

May 11, 1914: Had a "special project" in E.E. Lab that tied me up in knots. Signed up two more salesmen for the "Wear-Ever" program, H.G. Morse and Brock, '17.

May 16, 1914: Talked with Major Cole about my application for a scholarship. He seemed to think my chances were good. In the evening attended our fraternity banquet at the Hotel Thorndike. Had a good meal and a good time.

May 23, 1914: After business law in the morning, spent a happy Saturday afternoon canoeing at Riverside on the Charles River with Kay. She was adorable in a linen suit she had made and proved to be a plucky paddler against the current. We had a rare chance to talk about a lot of things that were on our minds. It was a red letter day.

August 3, 1914: Met Professor Hosmer and Dean Rustom at the North Station and took the 10 p.m. sleeper for Maine, where I am going to be an assistant at the M.I.T. Summer Surveying Camp.

August 4, 1914: Rode from the E. Machias station to Chase's Mills in Professor Russell's auto, then came across the lake in the M.I.T. launch, the *Tech*. Was assigned to Tent #C23, with **Jack Steere** as a tent-mate. He is very congenial. **Arthur Bond** is here also, as part of the staff.

August 5 - August 23, 1914: Put in seven weeks as a civil engineer instructor. Most of the work was pretty strenuous, but I enjoyed the outdoor life and the company of a fine group of men. There was time for some good games of baseball, a Tech minstrel show, and long exploratory walks. The most rugged was with **Jack Steere** to Lubec and Eastport, Maine, over a weekend. The round trip was about 50 miles. Professor Cullimore offered me a job as an instructor at Toledo University after graduation. Salary $1,400 a year. Didn't make any commitment, but I don't think I want to be a teacher.

September 26, 1914: Registered for the new term, which starts September 28.

The 70th Reunion booklet that we compiled, giving information to all of you on each classmate (obtained through letter writing and telephoning) has been a big hit.

By this time you have received Loring's notes for the senior year, which we feel will conclude our achievement. Certainly it has been a big year for you '15ers, and we recommend to any other class that personally telephoning the classmates, to find out how and what each is doing to be a very successful adventure. Try it classes—you'll like the results! The enthusiasm has been absolutely unbelievable. And by the way, '15ers Mary Kyger from the Alumni Office informed me she has placed a copy I sent to her in the museum!

Frank Hull wrote to M.I.T. and said he feels M.I.T. is the greatest college in the USA and the world. Writing that at age 97 is terrific!

We all agree! M.I.T. is the BEST! Keep writing!—**Joyce E. Brado**, 491 Davison Rd., Apt. 9, Lockport, NY 14094

16 70th Reunion

Thank you, **John Fairfield** for your nice letter from which we quote in part: "It's so good to get the *Technology Review* and read of classmates. **Shatswell Ober,** who died in September is the last of those classmates that I knew intimately—a fine chap and a good friend. We corresponded for many years. As you may know he lost his wife some years ago and then broke his hip but managed to drive his car and keep house until this spring. Did **Frances Duff** write you about their family reunion? They were planning on 73 relatives to celebrate their wedding anniversary last fall. Paul and Frances were always good correspondents and pleasant company." . . . **Dina Coleman** writes: "No news, live alone with company of a dog. Tend the house (paint and repairs) and garden, with help on the ladder and strenuous parts. Attended wedding of my younger grandson in August. Thanks to M.D., son, daughter (West Virginia and New York City), friends nearby, and companionship of my dog, I enjoy life—reading, gardening, and puttering."

Shatswell Ober died September 2, 1985 at age 91 in North Attleboro, Mass. (See obituary, *Technology Review*, November/December, p. A20.) He leaves his daughter, Marjorie Roberts of Wrentham, and two grandchildren.

Talked with **Paul Duff** in early October and he and Frances were well. He said, "I don't pay any attention to my age, and when someone asks me how I feel I say so far so good." In fact Paul was feeling so good that he sang a few words from "When A Young Man's Fancy Softly Turns to Love" followed by "It's Always Fair Weather When Good Fellows Get Together." "If you don't like my singing, I'll hum," he said. . . . Also talked with Anne (Mrs. **Izzy) Richmond**. She and Izzy are doing well. She has a bad case of arthritis in one of her hands, but having a built-up grip on the golf clubs, she is able to play regularly. They haven't decided yet whether they will return to Spain again this winter. Izzy is walking about four miles (spread over several walks) daily. He carries a stick with him to "drive off the women."

In talking with Paul and Anne both are enthusiastically pressed for information on the 70th reunion plans and for more commitments to attend. We'll finalize plans shortly and get the reunion announcement to you. We might try two luncheons, one on Technology Day in late spring and the other in late summer. This would give everyone two opportunities to attend one or the other, some being able to attend both. Let's have your thoughts on this. Keep well and continue to contribute to the happiness of others.—**Bob O'Brien,** Acting Secretary, H.E. Fletcher Co., Groton Rd., W. Chelmsford, MA 01863, (617) 251-4031 or 935-3750, ext. 204

17

Irving Peskoe, '39, writes that **Ken Lane** died July 18, 1985 in Miami, Fla. Mr. Peskoe says that Ken was active in the Miami Club during the past few years ("a great guy—modest, soft-spoken with real presence and dignity").

Mr. Lane is described by the *Miami Herald* as a pioneering aeronautical engineer who built planes for Orville Wright and designed the engine that powered Charles Lindbergh's *Spirit of St. Louis* across the Atlantic. Before Lindbergh took off for his historic 33 1/2-hour solo flight from New York to Paris in 1927, the young pilot asked Mr. Lane to make a last-minute check of the plane, said Mr. Lane's wife, Betty. Shortly after his safe crossing, Lindbergh—called Slim by Mr. Lane—sent the engineer a telegram.

In 1923, Mr. Lane became chief engineer for Wright Aeronautics Corp. While working for Wright Aeronautics, he was responsible for the design of the Wright Apache, an aircraft that established world altitude records. Along with Lindbergh, Mr. Lane worked with other aviation trail-blazers, including Richard Byrd and Eddie Stinson.

In the 1930s, Mr. Lane frequently worked in South America, instructing airline personnel there in the operation and service of their aircraft. During World War II, he did work for the federal government, including projects for the FBI.

Mr. Lane was active in the Coast Guard Auxiliary in Miami, often patrolling for Flotilla 6-5 in his 36-foot craft, said Alfred Ponzol, a friend. "He was one of the nicest guys that I ever met in my life."

Mr. Lane is survived by his wife, sons Robert and John, three grandchildren and three great-grandchildren.

William Sullivan, retired rear admiral, died September 6, 1985 in La Jolla, Calif. at age 91. He received an architectural engineering degree from M.I.T. and may be remembered for his track and field activities. In 1917 he won the New England intercollegiate high jump championship with a jump over 6 feet.

Decorated for his worldwide service in two world wars, Admiral Sullivan was a deep sea diver and had various assignments involving ship construction and repairs, including one on Olongapo, in the Philippines.

He was supervising ship constructor for the navy's Asiatic fleet in Shanghai from 1934 until 1937, a period when he supervised the salvage of the *USS Chaumount*, the army transport that grounded in North China waters. Also Admiral Sullivan directed operations during the submarine campaign until 1942. He was called on to direct salvage of the *Normandie*. He inaugrated a school for divers that furnished experienced divers for the navy during the war years. At the outset of the war, when he held the rank of commodore, he organized harbor-clearing forces for operations in Port Lyautey, North Africa, near Bizerte. As the West European ports became liberated, Admiral Sullivan's salvage operations were transferred to each port in turn as the enemy was driven out.

He commanded task forces at the Sicillian landings at Salerno, and at Naples, at Cherbourg in France, and other ports. Still later, he moved his harbor-clearing operations to the Pacific and Manila. His task forces operated at Omaha and Utah Beaches in the invasion of Normandy, and his units were awarded citations for their efforts at Omaha Beach and at the capture of Manila. His American decorations include the American Distinguished Service Medal, two Legions of Merit, the American Defense Service Medal, the Victory Medal, the China Service and American Area campaign and the European, Asiatic and Middle East Campaign medals.

From Britain, Admiral Sullivan earned the title of Honorary Commander of the Order of the British Empire, and he also earned the French Legion of Honor and the Croix de Guerre, as well as the Italian Order of the Crown of Italy. He retired in 1948, and operated a construction company in Tokyo for six years, returning to Beachwood, N.J., and later moving here. He leaves his wife, Elizabeth (Vytacil) of La Jolla, two brothers, three sisters, and nieces and nephews.—*ed.* (**Walter J. Beadle,** Secretary, Kendal at Longwood, 217 Kennett Square, PA 19348)

18

At this time of the year there is a real shortage of news from all of you.

On September 15 I was the only member of our class at the Cardinal and Gray Society at Endicott House in Dedham. The special program was a video demonstration of the man-propelled plane designed by M.I.T. undergraduates. They won the prize for the fastest plane in an international contest. About 75 alumni and spouses enjoyed an afternoon together in this most beautiful M.I.T. setting.

Len Levine writes that he keeps busy with men's retired clubs and bridge. . . . Thru the Alumni Office we learn of the death of Ruth Wells, wife of **Franklin Wells** on June 9, 1983.—**Max Seltzer,** Secretary, 865 Central Ave., North Hill, Apt. B403, Needham, MA 02192; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

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When I reviewed the story of our 65th Reunion, I noted with dismay that the listing of classmates present contained some glaring ommissions. My abject apologies to Mary and **Henry Massey** and Kay and **Frank Maconi,** who were most certainly there and who added much to the success of the occasion. [Your secretary orginally included these classmates but they were later omitted due to a printing error. The editor apologizes.] . . . We received a letter and phone call from **Eric Etherington,** who had hoped to come up for a visit from the Cape, but was unable to do so. Better luck next time, Eric.

At the very least this provides an opportunity to appear in the roster of classes since I have no other news except to comment that no obituaries have occurred since the last issue—all to the good, I take it.—**Harold Bugbee,** Secretary, 702 Country Club Heights, 3 Rehabilitation Way, Woburn, MA 01801

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A phone call late yesterday afternoon from **Herbert Kaufmann** in Sarasota, Fla. brought the sad news that assistant secretary **Josiah Crosby** had died the day before (September 28). Josh was a loyal alumnus and a warm friend to many in our class. Over the past 20 years, Betty and I had many dates with Josh and his wife Claudia, in our winter sojourns to Sarasota. Josh had a cardiac arrest a few years ago and subsequently some minor strokes. Recently he went into a nursing home and died peacefully there. We shall miss him. Our deepest sympathy goes to Claudia Crosby.

A few more deaths are being reported this month. **S. Paul Johnston** of Easton, Md., died on August 9, 1985. Paul had a distinguished career including development of lightweight alloys for aeronautical use at Alcoa; advisor to Presidents Roosevelt, Truman, and Eisenhower on air power; editor of *Aviation Magazine*; active duty in 1944 in Hawaii for the Naval Air Transport Service; director of operations of the U.S. Strategic Bombing Survey; and director of the Smithsonian Space Museum. . . . Also reported are deaths of **Eugene H. Kennedy** of Norfolk, Va. (date unknown), Dr. **Charles W. Scranton** of Pinehurst, N.C., on July 25, 1985, and Mrs. **A. Warren Norton** during 1984.

Donald Morse mailed me a notice of a meeting of the Cardinal and Gray Society at M.I.T.'s Endicott House on September 15, 1985. Attending from our class were **Don, Ben Fisher, Leo Pelkus, Frank Whelan** and **Ed MacDonald**. Slides and video tapes were presented of the *Monarch*, the fastest man-powered airplane. M.I.T. engineering students won the coveted prize for the 1,500-meter flight. Don wrote that it was a fine meeting on a beautiful fall day.

A clipping from the June 9, 1985 edition of the *Los Angeles Times* tells us of the 64-year architectural career of assistant secretary **Samuel Lunden**. He is the architect of many buildings in Los Angeles as has been recounted in previous class notes. He has received many awards. Over the decades Sam has made dozens of four-day train trips to Washington to the AIA headquarters. The clipping states that "when Samuel E. Lunden strides into the San Francisco convention of the American Institute of Architects today, it will be for the 47th time in his career." "I have had three careers," he says. "First on his list is M.I.T., then Town Hall (a civic group), and finally his work." Sam received the Marshall B. Dalton Award in 1980 from the Corporation Development Committee. In 1981, he received an award for 35 years of active service to Town Hall and is now an honorary life governor. In 1982, Sam was the speaker when the University of Southern California celebrated the 50th anniversary of the dedication of the Edward L. Doheny Memorial Library designed by him. More honors followed in 1983 and 1984. Sam, we salute you!

Your secretary is just back from a 16-day trip to five European countries, labeled a "Flower and Gardens Tour of Europe." We visited Holland, West Germany, Switzerland, France, and England. The trip was hosted by horticulturists associated with Cornell University. Highlights were the flower auction near Amsterdam, where six million cut flowers are auctioned off daily under one 38-acre roof and shipped fresh to the U.S. and other European countries; a trip to Claude Monet's flower garden, where he painted many of his impressionistic paintings; a trip up the Rhine River; a trip to Lucerne; Paris; and London. The travel was mostly by deluxe bus—48 passengers including my daughter and son-in-law. It was a fine trip.—**Sumner Hayward,** Secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

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The news this month is limited to obituaries. Our class treasurer, **Earl H. (Buck) Eacker**, died September 5, 1985, at age 85, after a long siege with cancer. He came to Tech in 1920 after two years at Annapolis, graduating with his S.B. in 1922 and S.M. in 1923. He started work with Charlestown Gas and Electric Co., which after several mergers became Boston Gas Co. Buck became president in 1948 and chairman of the board in 1963, retiring in 1964. He was active in many fields: president of the New England Gas Association and the Guild of Gas Managers, director of American Standards Association, Algonquin Gas Transmission Co., Associated Industries of Massachusetts, the Waterfront Redevelopment Corp., the Greater Boston Chamber of Commerce, and the Hundred Club of Massachusetts. He was a trustee of the Eliot Savings Bank, a corporator of the Boston Five Cents Savings Bank, a trustee of the World Trade Center and Commercial Club of Boston. In addition, he was a member of the Somerset Club, Algonquin Club, Annisquam Yacht Club and the Singing Beach Club of Manchester. At Tech, he was a member of Alpha Tau Omega and, in later years, a treasurer and trustee of the Technology Building Corp. Buck is survived by his wife Alexandra (whom we all know as Peter), two sons, a daughter, seven grandchildren, and a nephew.

Paul C. Merrill died July 2, 1985, at his home in Long Beach, Calif. He is survived by his wife, three children, eight grandchildren, and three great-grandchildren. I have no information as to his work or activities.

The sympathy of the class is extended to the families of these classmates.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

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Rodney Goetchius died May 18, 1985. He graduated with our class in electrical engineering and was president of the class from 1978 to 1983. After graduation, he joined the American Telephone and Telegraph Co. and was assigned to the headquarters staff in New York City. In 1944 he began a series of managerial assignments: division plant engineer in Philadelphia, traffic circuit engineer in New York, division traffic superintendent in Cleveland, and area traffic manager in Cincinnati. From 1952 to 1956, he was area plant manager for Long Lines, Western Area (headquartered in Kansas City), and then he transferred to New York as plant operations engineer for the entire Long Lines Department. He joined the Western Electric Co. in 1958 as assistant manager, engineering, to help the Air Force implement the SAGE project for the early detection of attacking aircraft. In 1959, he was assigned to work on the world-wide tracking and ground communication network for Project Mecury, the first U.S. manned space flight program. He later was manager of the Northeastern Region of Western Electric, and when he retired in 1966 was manager of the New York Region. He was a member of numerous country and golf clubs and a member of the Board of Education of Chatham, N.J. (president from 1941 to 1946). His hobbies were golf, fishing, bridge and photography.

George King died January 8, 1985. He graduated with our class in business and engineering administration. He retired in 1967 as vice-president of Chemical Bank and Trust Co., New York City. In 1949 he was a member of the Committee on Finances and Development of the M.I.T. Region II. We have no further information about his career.

Joseph Maxwell died in 1985. He studied chemistry with our class after taking his S.B. degree elsewhere. He was president of the Conrad Co., Philadelphia, Pa., vanilla importers. We have no other information on his career.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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Honorary class member, Professor **Irwin W. Sizer**, and his wife Helen, recently celebrated their 50th wedding anniversary in a party held in McCormick Hall. Dr. Sizer is president of the Whitaker Health Sciences Fund. . . . **Ray Lehrer**, our treasurer, writes from his Maine residence that Hurricane Gloria was kind to him there, but that they had to cart away six cartloads of trash from his Weston, Mass. home. He will return to Weston after recuperating from surgery on his knee.

Phil Blanchard reports that, on his return from Florida last May, he stopped at the Camp Belvoir museum, the site of the old Camp A.A. Humphries, where he spent six weeks of the summers of 1921 and 1922, along with **"Scoop" Reinhardt, Joe Holden, Cy Hosmer, John Fitch**, and **Perry Matnard**. Phil donated a well-preserved copy of the *Sketching Board* account of the camp to the museum. . . . Your co-secretary, **Dick Shea**, now recovered from his Greek Odyssey, is off for sunny Florida after a fine summer on the Cape. Any classmates wanting the latest scoop on temples, ruins, Greek gods, and especially goddesses, contact him.—Co-secretaries: **Dick Shea**, 709 Cypress Pl., Sun City Center, FL 33570; **Russ Ambach**, 216 St. Paul St., No. 503, Brookline, MA

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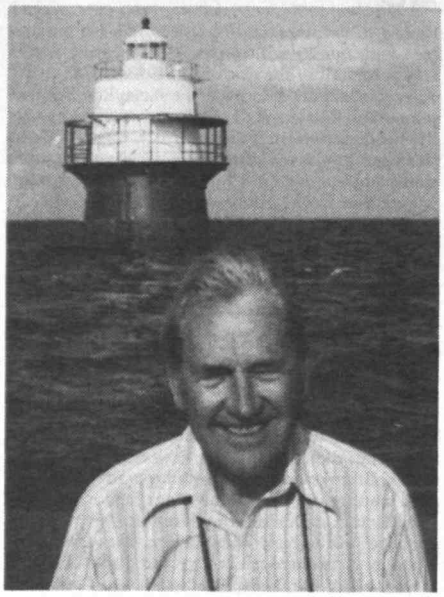
They say that no news is good news, and we almost made it for this issue. However, it is with sorrow that the passing of **Albert K. Newman** must be reported. Tony Savina, '30, thoughtfully supplied a copy of the obituary which appeared



Earl McMahon, '26, chairman of Project Bug Light, Inc., radiates his satisfaction with the restored Duxbury Pier "Bug Light" (background).

A New Shine for an Old Lighthouse

"It's in A-1 shape and good for another 100 years," says Earl McMahon, '26, chairman of Project Bug Light, Inc. His group shared in restoring the 114-year-old beacon, known locally as Bug Light, which guides mariners in Plymouth, Kingston, and Duxbury harbors.

Because of the ravages of a century at sea, Bug Light was about to be dismantled and replaced two years ago by a sleek fiberglass spire. The U.S. Coast Guard estimated that restoring the lighthouse would cost $390,000—too expensive.

But a group of residents, headed by McMahon, valued Bug Light as a historic landmark and convinced the Coast Guard to wait. The preservationists raised $12,000 by selling T-shirts and cup plates, holding a fashion show, playing baseball games, and raffling a painting.

Then the citizens' group and the Coast Guard worked out an agreement—federal funds for work on the lower portion of the lighthouse and private funds for the top portion. The Coast Guard sandblasted, primed, and painted the thicker, bottom plates, and the citizens performed the upper restoration.

And now McMahon says, "It really sparkles. It's been a very satisfying project." — *Sandra Knight* □

in the Stamford, Conn. paper. Albert died on August 15, 1985 at the Bridgeport Hospital of heart failure. He lived in Stratford. He worked for many years for the Homelite, Corp. as an electrical engineer and was a vice-president of the corporation when he retired. He was a member of the Congregation B'Nai Israel of Bridgeport. Albert is survived by a son, Joseph L. Newman of Plymouth, Minn., a daughter, Joan Frankenthal of Israel, six grandchildren, and two great-grandchildren.—**F. Leroy (Doc) Foster,** Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26 60th Reunion

An article in the *New York Times* is headed "Looking Inward, M.I.T. Seems Ready to Strengthen Arts and Humanities." Since this was the major goal of the administration of **Jim Killian**, we were curious to read why it was again coming to life as if it were a new issue. Dr. Gray explains, "Enrollment has shifted from almost everything else into engineering," particularly into electrical engineering and computer science. To a great extent this shift has reflected job markets and the developing balance of modern technology. But it has made M.I.T. lopsided, Dr. Gray says. It would be unfortunate, indeed, if all the progress in developing a balanced education since the fifties were to be lost. Further to amplify this point, I will quote from a letter to Jim Killian from **George J. Taylor**: "I just don't want to stop writing about your wonderful background of experiences as so capably expressed in your book. But I'll cease with one significant item relating to education, where you mention the importance of the School of Humanistic and Social Studies, established in 1950. What a magnificent dissertation in education that was at a time when you were President. Then in the years moving on to 1960, M.I.T. moved on very rapidly into the real business of a modern university in the development of Centers." George's letter contains so much of interest about his own career that I would like to quote it all, but space limitations prohibit that, so we will touch on only the highlights. He first met Jim Killian at M.I.T., where he had come as a graduate S.B. from Armour Institute to study for his master's degree. He also developed a close relationship with Vannevar Bush. His early career as an electrical engineer was with the Cooper-Hewitt Electric Co. in Hoboken, N.J., then later with G.E. in Nela Park, Cleveland, and in 1942 at G.E. headquarters in New York. In the 1950s he was president of the Illuminating Engineering Society.

We have mentioned in these notes the closely-woven relationships among the members of the **Crockett A. (Dave) Harrison** family. They recently had a reunion on the occasion of his 55th wedding anniversary, described by the *Portsmouth* (N.H.) *Herald*: "Fannie C. Harrison (Mrs. Crockett A.) is a ninth-generation descendant of Thomas Seavey, who came to the Isles of Shoals a few years after his uncle William Seavey arrived in 1632. Although she and her husband live in Grove City, Pa., they are coming to this area for their anniversary. With them for the three days will be 17 of their immediate family of 27, who will become acquainted with the area where their emigrant ancestors lived upon their arrival in this country at very early dates. There will be five daughters, two sons-in-laws, six grandchildren, the husband of one granddaughter, and a great-grandson. They will be coming from Ohio, Pennsylvania, Michigan, New Jersey and Osaka, Japan. The reunion party will visit the Isles of Shoals, one of which bears the Seavy name and a number of their early ancestors' homes."

Howard Humphrey writes of his retirement 15 years ago after 30 years with DuPont: until four years ago, he lived in a house in the country, which kept him very active, but now he lives in a condominium in the city of Wilmington. In 1983, he and Virginia celebrated their 50th wedding anniversary. They expect to join us at the 60th reunion. . . . Howard advises us of the death on August 23 of **Ward L. Hamilton**. Ward had been an employee of the Ritter Co. (now part of Sybron Corp.) for 40 years. He had active service in the Army: four years in the Pacific Theater and later director of transportation in Korea, retiring as full colonel. Ward was a life member of the National Model Railroad Association, the Railway and Locomotive Historical Society, the Retired Officers Association, and the American Society for Metals; and he was a member of the Rochester Consistory, moderator at the Baptist Temple, and member of the University Club. He was commodore of the Brockport Yacht Club for two years. Besides his wife, Eleanor, he is survived by a daughter, a son, two brothers, and four grandchildren. . . . A clip from the *Manchester* (N.H.) *Union Leader* advises of the death July 16 of **E. Sterling Pratt**, after a long illness. He had been part-owner of the Amassa Pratt Lumber Co. of Lowell prior to moving to Nashua, N.H., where he founded the Hanna Motel, Inc. He was very active in Masonic affairs in New Hampshire and in Ft. Lauderdale, Fla. Surviving family members included his wife, Charlotte, a son, two grandchildren, two great-grandchildren, and several nieces, nephews and cousins. . . . The *Times-Herald* of Newport News reported on July 26 the death that day of **Sumner Bradford Besse, Sr.**. He is survived by his wife, a daughter, Barbara, a son, a sister, six grandchildren, and one great-grandchild.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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After a lengthy solicitation by assistant **Larry Grew**, we have a letter from **Alan Beattie** in Westbrook Conn. A couple of rather reserved, shy boys at Phillips Exeter from 1921 to 1923, "Admiral" Beattie and I have been friends for a long time. Alan retired in 1966, moving from Fairlawn, N.J. where he was industrial engineer for American Home Products, to Connecticut. He and Louise have kept busy with a fascinating hobby of collecting brass antiques and exhibiting in shows.

Continuing my search for history of the pioneers of aviation in our Class, I have a letter from **Allison "Bud" Gillies** in Rancho Santa Fe, Calif., giving his account of his early flying at M.I.T.: "The 1927 *Technique* is correct in saying that I got my degree in Course II. (**Franklin "Hank" Kurt** was the first to receive a degree in aeronautical engineering.) In December 1923, my brother Jack '25, enlisted in a Navy program to train pilots for the Naval Reserve; when I learned of this, I decided to join the program too. We started a ground school course two nights a week with Professor E.P. Warner and Commander Noel Davis as instructors. Davis was the commanding officer of the Naval Reserve Base in Squantum. We finished the group school in May and started flight training in Squantum. After six weeks flying primary seaplane trainers, we were transferred to Naval Air Station at Hampton Roads, Va., for advanced training in single and twin engine flying boats. After completing the flight training, we received our commissions as ensigns, with designations as naval aviators, on December 1, 1924. I had a scholarship to get my master's degree in aeronautical engineering starting after my release from active duty in 1928, but the offer of a job as a test pilot was too attractive so I relinquished the scholarship and went to work for the Loening Aeronautical Engineering Corp." Thus started a most active career in aviation for Bud. Born with the instincts of a bird (he and his wife, Betty, have their own plane), Bud can be proud of his accomplishhments in aviation.—**Joseph C. Burley**, Secretary, RFD #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

PHOTO: ED HEAP

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On some previous occasions we have presented reports of intraclass friendships that had begun well before the birth of '28 in 1924. Now we have one more as told in a most interesting letter from **Nap LaCroix**. It is a long letter, so we can give only the highlights now and perhaps get back to some of the other details at a later date. At Mohonk Mountain House, near New Paltz, N.Y., July 17-20, 1985, a group of old '28 friends gathered for a long-awaited mini-reunion. They were Nap and his wife, Gertrude, Anne and **Walter (Dick) Hildick**, **Wilson (Bill) Hammond** along with Nina McTague, Gertrude's long-ago bridesmaid. After dinner that first evening, they got to reminiscing on the origin of their various friendships, and this provided the gist of Nap's four page letter. Nap and Dick started together in the fourth grade at Leominster (Mass.) Grammar School and continued on through high school and M.I.T. Nap and **Frank Sweeney** (now deceased) were friends since the age of four as they lived together in the same neighborhood. They, too, continued as friends through grade school, high school and M.I.T. Frank was very popular in high school and was elected class president. All three, Nap, Dick and Frank, roomed together in Boston's Back Bay when they were Tech freshmen and were joined by **Jack Rouleau** in their sophomore year. Frank got married during junior year and became the first '28 father. Following graduation, Nap went to work for Congoleum-Nairn in Newark, N.J. It was there while rooming at the Y.M.C.A. that he became acquainted with Bill Hammond who was then working for the Pennsylvania Railroad. Within a few years thereafter all of these stalwarts became pretty well scattered due to job requirements, the war years, and the business of raising families. However, they did get together for memorable 25- and 30-year '28 class reunions. Frank died in March of 1985 and Bill is now widowed. Obviously the meeting at Mohonk Mountain House provided great pleasure and was a huge success.

On September 15, 1985 a meeting of the Cardinal and Gray Society was held at the M.I.T. Endicott House in Dedham, Mass. Those of our class associates in attendance were Marjorie (Mrs. **John A.) Carvalho**, Frannie and **Jim Donovan**, **Bill Hall**, Mary (Mrs. **Arthur A.) Nichols**, Janet (Mrs. **John Chamberlain**) Sawyer, Florence and **Walter Smith** and **Frank Taylor**. The speaker, Prof. Walter Hollister, '53, of the M.I.T. Department of Aeronautics and Astronautics, gave a most fascinating account of the development work that resulted in the award-winning manpowered aircraft, The Monarch, and showed a movie tape of the craft in flight.

The class was also well represented at the National Alumni Conference in Cambridge September 20-21, 1985. Listed, in addition to the Donovans and the Smiths were Anne and **George Palo**, **Newt Foster**, Ruth and **Abe Woolf**. Present, too, was our honorary classmate, **Shirly Picardi**, who now holds the office of bursar at the Institute. While at the conference we met (by happenstance) Chuck Buntschuh, '53, the son of our own **Henry Buntschuh**. Chuck reported that his dad is in good health. Henry's other son, Robert, graduated in the class of '55. At the awards luncheon of the conference we were delighted to learn that our classmate, **Arthur C. Josephs**, had been given the George B. Morgan Award in recognition of his outstanding work on the Educational Council. To you, Art, our heartiest congratulations on this well deserved honor.

With deep regret we must report the deaths of three classmates. **George E. Bass** died July 29, 1985. Following M.I.T. (Course II, mechanical engineering), George went to work for a railroad supply company. This job provided him with a six-year stay in Paris. Later he bought the Ferracute Machine Co. in Bridgeton, N.J. and made it his career for the ensuing 31 years. He and wife Medora moved to Santa Barbara, Calif. three years ago for retirement. They have three sons, a daughter, and four grandchildren. . . . **Roland F. Beers** died July 9, 1985. Roland received his S.M. and Ph.D. in electrical engineering and geology, respectively, as a graduate student with our class. His career was highly varied covering the fields of engineering, science, business, and education. He was president of Ethan Allen Community College, Manchester, N.H. Our record shows that he had a son and a daughter. . . . **Theodore B. Pierce** died August 30, 1985 following a brief illness. The information was sent to us in a note from his wife, Claire. She said that Ted had thoroughly enjoyed class reunions and had had high hopes of attending the 60th. Ted graduated in Course VI, electrical engineering, and had his professional career of 42 years with Consolidated Edison Co., New York City. . . . We extend our heartfelt sympathy to the families of these classmates.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Edward B. Papenfus of Vancouver, B.C.: writes, "I continue to enjoy good health, and I am fairly active in looking after and managing my liquid assets, trying to increase their value. My wife Gwen, does not enjoy very good health and has poor vision and hearing problems. Her condition occupies a good deal of my time." . . . **Anthony Standen** of S. Kent, Conn., is still teaching math and making mathematical models. Some years ago he wrote a book, *Forget Your Sun Sign*, an outline of antiastrology. If any classmate wishes to get a copy, please write to him at Ore Hill Rd., Box 91, S. Kent, CT 06785. . . . **Frederic Celler** and his wife Margery live winters (November to May) in Maitland, Fla., and the rest of the time in France, just across the Seine from Paris. They are well, with minor health problems. "We gaze at the past without nostalgia, enjoy the present, and anticipate the future with enthusiasm. Regards to all."

Bill Baumrucker of Marblehead, Mass., writes, "When there were no '29 class notes in the October issue of the *Review*, I began to worry that you might be ill or otherwise indisposed. This was the first time (as far as I can remember) that the class of '29 did not have any notes in the 16 years that you have been secretary. I still play tennis twice a week, but the old legs don't seem to stand up as well as in the past. Best regards to all." Bill had no way of knowing that our '29 notes for that month were to be incorporated with the November/December issue of the *Review* because of lack of space in the October issue.

I have a bit of good news that I would like to share with you. The M.I.T. Alumni Association gave me the Harold D. Lobdell Award in recognition of my services as secretary of the class of 1929, discharging my duties conscientiously for the past 16 years, during the NAC award luncheon on Saturday, September 21, 1985. Those who attended the luncheon and the award ceremonies were: my wife Helen, **Joseph L. Speyer,** our class treasurer, and his wife Ruth, **Bill Bowie,** educational counselor, and his wife Sally, and **David H. Wilson**. I would like to express my appreciation to so many of you who have been faithfully contributing class news which has helped me to carry on with my duties.

I regret to announce the deaths of the following members of our class: **Joseph D. Riley** of Lighthouse Point, Fla., on March 5, 1985; **Henry S. Muller,** of Belmont, Ohio, on March 26, 1985; **Charles B. Bacon,** of Middletown, Conn., on April 30, 1985; Dr. **Daniel Silverman,** of Tulsa, Okla., on June 2, 1985; and **William J. Degnen,** of Westfield, N.J. on August 21, 1985. **Joseph Riley** was a member of the Telephone Pioneers of America and a member of St. Paul the Apostle Catholic Church of Lighthouse Point. He is survived by his wife Mary, two sons, and a daughter. . . . **Charles Bacon** was the president of Bacon Brothers, Inc., and its owner since 1930. He was born in Middletown, Conn. and graduated from Middletown High School prior to entering M.I.T. He was a member of the Rotary Club (and its president in 1945) and a member of the Middletown Water and Sewer Commission (and its chairman for over 20 years). The Mt. Higby Water Treatment Plant was named in his honor in recognition of his many years of service. He was an active member of the Middlesex County Chamber of Commerce and was named "Outstanding Citizen of the Year" in 1981. He was a member of the board of directors of Indian Hill Cemetary Association, a member of the Republican Town Committee, the Inland Wetland Commission, was a corporator and director emeritus of the Middlesex Memorial Hospital. He is survived by his wife Betty, three sons, and three daughters.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

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This month's notes are being written in East Africa where Louise and I are enjoying a photographic "safari" in the Kenyan and Tanzanian Game Reserves. Within the game parks we ride in four-passenger Land Rovers with open tops to facilitate viewing and photography, admirably designed for the rough terrain we traverse. Our first step out of Nairobi was at the newly opened and spectacularly appointed Intrepids Club of the Masai Mara Game Reserve. As widely reported in the U.S. press, The Intrepids accommodations comprise large tents, each provided with twin, four-poster tester beds encased in mosquito netting and connected to a canvas-walled full bathroom facility. On our first day at Masai Mara we had a small adventure with unhappy potentialities that fortunately failed to materialize. In the late afternoon our rather inexperienced driver lost sight of our companion vehicles and by nightfall it became clear that he was hopelessly lost. For the next two hours we cruised over trackless grasslands in total darkness before making contact with the search party that was sent out to find us.

We have been most fortunate with respect to the numbers and the diversity of the fauna we have encountered. The high point of our trip so far occurred shortly after sunrise one morning when we parked about 100 yards from the base of a tree in which our driver had espied a gorgeous leopard stretched out on a branch and munching contentedly on the haunch of a little Thompson gazelle that he had brought down. After we had watched silently for perhaps ten minutes, he came down the tree with the residue of the gazelle in his mouth and stalked purposefully through the grass less than 100 feet in front of our vehicle.

Upon leaving for Africa, I dumped my slender file of material for the January notes in the flight bag and now find that it includes brief reports from **Arthur Wildes, George "Jeff" Wyman, Morris Young,** and **Otto Ziegler**. Arthur has now retired from a career of teaching, counselling, and administration in the public schools of Utica, N.Y. He and his wife Gladys now live in Clinton, N.Y., where he is involved in hospital and United Fund work. He has a woodworking shop in his home and does extensive gardening. . . . The Wymans live in Bloomsburg, Pa. George retired in 1973 as general plant manager of the Sherman Williams chemical plants in Ashtabula, Oh. After retirement he undertook an assignment in Venezuela for the I.E.S. Corps. More recently he has spent much of his time helping out semi-incapacitated contemporaries and has become involved in some design work associated with a townhouse development in which the Wymans are the proud owners of the first unit.

Morris Young is still devoting his full time to the active medical and surgical practice of ophthalmology in Manhattan and may be unique in this respect. (If there are any other classmates still devoting their full time to their principal career

activity, please drop me a line.) Morris's son Charles obtained an M.D. at Louisiana State University and now practices opthalmology with his father. Morris is a retired colonel of the A.U.S. Medical Corps with 39 years of service and is on the Executive Council of the New York Chapter of the Association of Military Surgeons. As previously reported, he is a consultant in ophthalmology to a number of New York hospitals and medical centers and a longtime devotee of magic and the occult. . . . **Otto Ziegler** is still living in Timberville, Va. He expressed his regret that he was unable to attend the reunion last June, one of the few he has missed. It seems that he has been having considerable difficulty with his right foot which has greatly limited his mobility. However, he recently obtained some custom made arch supports from the University of Virginia Medical Center and these supports have apparently greatly improved his situation.—**Gordon K. Lister**, Secretary, 950 N. Abrego Dr., Green Valley, AZ 85614

31 55th Reunion

Adeline (Mrs. **Donato) Grieco** reports the death of her husband on July 12, 1985. Our sincere condolences to Mrs. Grieco.

Ben Steverman, our reunion committee chairman sent details of our reunion plans. If you did not receive the letter, contact Ben at his address listed below. Ben writes, "With fall in the air here in New England, it behooves me to stir my stumps and get going on the 55th reunion plans and other M.I.T. affairs. A recent letter from an old friend, Harry Summer, '33, gives us some news about **Albert Kaye** , who was an old schoolmate of mine at grammar school and high school in Brookline, Mass. before going to M.I.T. Harry writes that the M.I.T. Club of Chicago arranged a trip to a nuclear plant construction site just outside of Chicago and there he met up with Albert. Albert spent a great deal of his career as professor of metallurgy at Purdue University. His actual title now is professor emeritus, metallurgical technology. In his retirement he is still consulting and lives at 6618 Forest Ave., Hammond, IN 46324. I'm enclosing a lengthy obituary from the *Boston Globe* about **Don Sinclair**. I remember Don very well as a very active member of our class at the 50th reunion on Martha's Vineyard. He played the piano for the group that we organized to sing **Claude Machen**'s song extolling the virtues of the class of '31 to the tune of "Sons of M.I.T." I again saw Don and his wife Willona at the Cardinal and Gray luncheon at the Endicott House in Dedham. At that time he appeared to be in good health, and it was quite a shock to read of his death."

Your assistant secretary, **John W. Swanton**, forwards a note from Don's son, William: "So many of our M.I.T. friends missed this sad news the week before the Labor Day weekend, I wondered if you might put a short notice in the *Review*. I am still in a state of shock—it was just five weeks after the cancer was diagnosed. In my more rational moments, I am thankful he didn't suffer any pain. I see the Edgertons and **Germeshausens** and keep in touch with Jean and **Gordon Brown**."

Sadly, I also report the death of our classmate, **Daniel S. Sonnelly** on July 15, 1985.—**Edwin S. Worden**, Secretary, P.O. Box 1242, Mt. Dora, FL 32757; **John Swanton**, Assistant Secretary, Box 2310, R.R. 2, Wiscasset, ME 04578; **Ben Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

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These notes are being written while Hurricane Gloria with winds of 75-90 miles per hour (but not much rain) is outside our home. Electrical power and telephone service are out and branches (even some trees) are falling. Otherwise, all is calm and picturesque.

Edmund McLaughlin writes: "Polly and I escaped the sculptured lawns of Westchester, N.Y. to the icebound banks of the Damariscotta River, Maine (we moved). We then fled Maine's mud season to Petra, Jordan, mostly by sea, thereby missing class of '32's Florida fling. In July we shall intellectualize during a seminar at Cambridge University."

Don Brookfield reports that about 20 classmates contributed about $1,200 to the **G. Edward Nealand** scholarship fund. The class of 1932 treasury contributed $300, thus bringing it to $1,500. In September I attended the M.I.T. National Alumni Conference. There I met Maxine and **Wendall Bearce**, who was celebrating his 74th birthday. (Is he the youngest in our class?) He had just purchased a personal computer and an unusual program of Biblical information. Among his hobbies, he occasionally lectures on the Bible. Incidently, they have just returned from another extended trip through Europe and Israel.

I must relate the sad news that **Maurice D. Trioueleyre** died on April 20, 1985. He was a cost accountant for Colt for many years. He was active professionally, civically, and with his church. He leaves his wife Gertrude, a son, a daughter, and two grandchildren. . . . On July 18, **Benjamin Shreve** died in Bedford, Mass., after a long illness. He worked at the Museum of Comparative Zoology at Harvard for more than 50 years as a herpetologist. He leaves his wife Minerva and two brothers.

We have also received information from the M.I.T. Alumni Association: **Joseph Welch, Jr.**, died on April 13, 1985; **Harry Carlson**, died on August 31, 1984; and **Ira Bach** died on March 6, 1985. When we receive obituary information we will pass it on.

The officers of the class of 1932 wish all members a Happy New Year. I have about run out of material for our class notes. I ask all to send me a short or long note. Do it now! Thanks.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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When the Institute opened last fall, incoming students were advised, "Phone home and look both ways before crossing Mass. Avenue." Times don't change!

Neil Hopkins, who lives in York, Pa., gave an elaborate vocal recital last summer, singing a long program of songs of many kinds. . . . Charlee and **Dick Fossett** went hiking in the Swiss Alps again last summer, after celebrating their 50th wedding anniversary at home in California. . . . Margaret and **Don Neil** spent the summer at their country place, developing a woodland management plan that will run till 1990. The Neils' two daughters were with them part of the time.

Bill Harper, living in Hattiesburg, Miss., reports that they have been working on a registered tree farm and have made plans for the next 15 years. His wife is now selling art, so he no longer has her as a deduction. . . . **Ellery Clark** reports that he won the lawn darts competition once, but he didn't win in 1985. However, he did place first in the bike rodeo. . . . **John Longley** lives near Schenectady, or is it near Albany; where is Slingerland, anyway? He says they are coming to the 55th.

. . . The **Fred Murphys** and **George Stolls** made a trip to Alaska and returned by cruise ship down the inland passage. They suggest all of us make such a trip—it's wonderful! Fred and Anne came to North Carolina for a meeting of old plastic makers last fall, but couldn't get together with me.

Elizabeth and **Joel Stevens** of East Tennessee planned a trip to Austria. . . . **Richard C. Molloy**, one of our aeronauticals, wrote for the first time in 52 years. He and Jane have nine grandchildren. Last year they toured France, with a stop in London. They live at Cushing, Maine, just across the river from the **Herb Somerses**. In the winter they live down Sarasota way. . . . Marg and **Bob Crane** were at the Cape during the summer. By now they are back near Sarasota, where he is working on some low-rise condominiums for his architect friends. They report that Chatham Bar looked good in 1985.—**Beaumert Whitton**, Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

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Pioneers in M.I.T.'s sailing activities probably knew **Gerald Reed**, who passed away last year. He graduated with us in architecture. He had attended Roxbury Latin. He became sailing master at the Institute and held that position until 1976. He coached intercollegiate sailing teams and was director of the sailing and dinghy fleet. He lived in Quincy for 64 years and was member of the Wollaston Masonic Lodge. He wife and son survive him. . . . **Fred Vaughan** passed away on August 24. He is remembered as a star swimmer. He was captain of the swimming team and for a time held an intercollegiate record. In World War II he became a lieutenant-colonel and an expert on Japanese weaponry, writing an army handbook on the subject. Before the war he worked for Westchester Lighting and Grinnel Lithographic. In 1955 he founded the very successful Suffolk Packaging Co. In 1978, on learning he had an incurable form of cancer, he closed the business and took up a new career teaching packaging courses at the Fashion Institute and business courses for the adult-education program of Suffolk County, N.Y. He is survived by his wife, Elizabeth, and two sons. . . . **Larry Stein** informed the Alumni Office of **John Westfall**'s death on August 5. Larry was able to furnish most of the following information, although I knew John in our first years at Tech. After graduation, John worked in the New York area and lived in a Mrs. Ryan's boarding house, where Larry and **Bob Emery** were also living. He moved to Buffalo and worked there before joining the army for World War II. He was stationed in Greenland for a long time and apparently liked it—after the war he took his wife, Frances, there to his former stations. John settled in Barrington, R.I., where he established a successful plastics business, starting first with plastic skis and diversifying into such things as parts for swimming pool filtration units. Frances died in 1978; John's second wife, Ruth, survives him.

In June, Mary Elizabeth and I cruised on the *Mississippi Queen*, enjoying antebellum house-visiting in the lower Mississippi River country. During the summer, we drove to the west, to the Tetons, Zion, Bryce and Monument Valley. It makes us grateful to the Almighty for giving us the additional time to see more of the wonders of our North American continent. . . . **Bob Franklin**'s trip to Europe forced him to leave before he could report on the Mini-Reunion which 32 of our classmates attended. Therefore, we must wait for Bob's return for information about the doings at Williamsburg.—**George G. Bull**, Assistant Secretary, The Elizabeth, 4601 Park Ave., Apt. 711, Chevy Chase, MD 20185; **Robert M. Franklin**, Secretary, Box 1147, Brewster, MA 02631

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Sid Grazi writes from Carlsbad, Calif: "Although I had my back surgery about six weeks ago, I am still having a few problems and have not been cleared for golf. I was hoping to at least give it a try with the very remote possibility that I could retire the cup, which I've held twice. But I'm afraid that's out, unless we have another class tournament next year. It's tough to get old, but it's still the better alternative."

I am sorry to report to you the death of **James D. Parker** on September 29 at his home in Riverside, Conn. Many of you will recall seeing him at our 50th reunion which he attended in spite of

the cancer he had been battling for some time. Mary, his wife, accompanied him and was thrilled to be there with her husband and her brother, **James W. Libby, Jr.**, who were both in the same class celebrating their 50th. **Henry B. Kimball** is the third member of this group who lived in Swampscott and went to Lynn Classical High School and then to M.I.T. All three were at our 50th with their wives. Jim Parker graduated in Course VI-A, went to work for CBS, and was there until he retired except for active duty as air force colonel in World War II and the Korean conflict. He was active in the air force reserves as well. Jim represented CBS at world meetings where wavelengths were the subject of discussions and planning. He was a ham radio fan from school days and had the same call number for over 55 years. I am extending the class's sympathy to Jim's widow from all of us.—**Allan Q. Mowatt,** Secretary, P.O. Box 524, Waltham, MA 02254

36 50th Reunion

It is inevitable that our class ranks decrease with time, but it is sad, nevertheless, to have to report the losses. Belatedly, news comes of the death of **Richard Halloran** in March 1985 in San Francisco. Dick graduated in Course 17, and after a period in the construction business on the east coast migrated westward. At the time of his death he was consulting in the field. He is survived by a brother Edward, 27 White Rd., Wayland, MA 01778. . . . More recent is the news of the death of **C. Douglas Cairns** of Burlington, Vt. and Naples, Fla. on July 6. Doug went into the oil business following his service in the navy from 1941 to 1945, moving to Burlington in 1946 and eventually becoming president of the Champlain Oil Co. In addition to the many local organizations with which a businessman would be expected to be associated, Doug served as chairman of the board of trustees of the University of Vermont in 1974. He was mayor of Burlington from 1957 to 1959, having served two terms as an alderman. He was active in Republican politics, chairing the Nixon campaign in 1968, and the Goldwater campaign in 1960. He was a founder and trustee of the Fanny Allen Hospital Associates. His was a most productive life. He is survived by his wife, Frances, two sons, five grandchildren, and three great-granchildren. I have written to Frances at Apple Tree Point, Burlington, MA 05401.

Reunion plans are coming along well. As of October 1, over 90 class members had indicated that they hoped to attend, and over 80 percent expected to be accompanied by a spouse or companion. By now you should have received a list of those classmates along with a directory of the class. If you have not received these, please let me known at once. About the time you read this, the registration mailing will be in the works, and I hope that you will respond promptly. It will help your committee in its planning. Our plans include an opening dinner on Wednesday, June 4; various activities the morning of June 5; and a fun luncheon, a reception at the President's house, buffet supper, and the Pop concert all on Thursday. Friday brings Technology Day with a morning symposium and the Alumni Luncheon at which the class gifts are announced. Following this, those who plan to go to the Chatham Bars Inn will take off. Those who wish may stay at McCormick Hall until Sunday, and if some of you would like some joint activities, such can be arranged. Here, in capsule form, is the outline of events. Your presence will help to make the affair an unforgettable occasion. Do plan to join us.—**Alice H. Kimball,** Secretary and Reunion Chair, P.O. Box 31, West Hartland, CT 06091

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Syd Karofsky is chairman of Northeastern Wallpaper Corp. and Affiliated Industries. In 1975, he received the wallpaper industry's highest award. He is a past president of the Hebrew Rehabilitation Center for the Aged and of the National Association of Paper Wholesalers. He was the co-chairman of building committees for Themis House at Brandeis University, the Hillel House at Boston University (which he also designed), and the Hebrew Rehabilitation Center for the Aged. He is a life member of the Copley Art Society. His hobbies are watercolor painting, fishing, golf, and photography. He belongs to Ocean Reef Club, Key Largo, Fla., and the Pine Brook Country Club, Weston, Mass. His wife Sylvia's main interests are transcribing books into Braille, knitting (especially for the five grandchildren), and being his "great co-pilot and travel companion." Syd writes, "Looking forward to contacting our classmates from Course IV for our 50th Reunion."

Thomas L. Hallenbeck, retired in 1980 as director of engineering, Baker Brothers, Inc. His hobby is industrial history—glass machines and machine tools. Wife Margaret's (Peggy) main interest is music and church. Tom writes, "Without her help I wouldn't get far. Slowing down a great deal in my ability to get around." . . . **Sidney Mank**, Rt. 1, Box 895, Washington, VA 23661, writes, "Dot and I, after ten years of retirement and rural life, still love living on our mountain side and farming. I am also thinking of returning, in a limited way, to the mainstream in some sort of activity related to real estate and construction. Hope to make it to our 50th reunion." . . . **Robert Russell Wylie**, 49 Purchase St., Danvers, MA 01923, retired July 31, 1985 from GTE Products Corp.-GTE Sylvania as manager of illumination engineering. He is now semi-retired working as a consultant on lighting with his own company. He is a fellow of the Illuminating Engineering Society of North America and his hobbies are Boy Scouts and learning Apple II/c. Travels have included Columbia, Peru, Trinidad, Puerto Rico, Mexico, Alaska and Hawaii. Wife Margaret's main interests are neeedlepoint, cooking (gourmet) and reading. Robert writes, "I spent the last 41 years at Sylvania primarily as design-application engineer. Was head of commercial engineering department for a few years but tired of paper work and meetings not germane to engineering effort and went back to action in field of design application. Participated in Mercury-Gemini projects in lightening. I did a couple of world's fairs and am currently consulting on lighting of a few national historical monuments."

Both **Norm Birch** whom we reported on in our July '85 class notes and **Philip H. Dreissigacker** (814 Hollyhock Lane, Orange, CT 06477) wrote to **Bob Thorson** to report **Wayne Pierce's** death. Phil wrote, "I hate to be a purveyor of bad news but, at our age, I guess it's expected once in a while. Wayne had been fighting cancer for quite some time and presumably was getting along very well until a heart attack hit him suddenly, according to reports I have had. He was extremely active in the Milford Yacht Club and his passing will be mourned. As for me, I have been retired for five years as of May 1 and it hardly seems like a year. I am fully active in town committee assignments and currently chairman of a committee to spend three million dollars of a Bond issue on town and school improvement projects. The committee was formed for one year and we are now in the third year of activity due to the constant expansion of our assignment." Phil sent an obituary notice from which the following is taken. **Wayne M. Pierce, Jr.** (393 West River Rd., Orange, CT 06477) died May 7, 1985. In addition to his wife Grace Harte Pierce, he leaves a son, Wayne M. Pierce III of Milford, three daughters, Tallon Pierce-Brown of Hampton, Va., Robin Pierce-Sutton of Milford and Elizabeth Pierce of Dallas. He was the president of the Pierce-Correll Corp., Milford. He invented a snowmaking machine and metal ski bindings. He developed metal skis, and developed and manufactured an aerial lift for skiing. He was past president of the International 210 Committee, and was the former commodore of the Windjammers at the Milford yacht club. Earlier, while chief engineer at Chance-Vought in Stratford, he was in charge of the development of the Corsair Fighter Plane. In 1946, he owned and operated the TEY Manufacturing Co., and in 1950, he was vice-president of Norden Systems Divisions, Norwalk. In 1958, Mr. Pierce was president of the Hunt-Pierce Corp. (Serva-Lifts), and in 1976, he became co-owner of the Pierce-Correll Corp., Milford (Picoplant-Placers). Memorials may be made to the Connecticut Hospice Inc., 61 Burban Dr., Branford, CT 06405, or to the American Cancer Society, 8 Lunar Dr., Woodbridge, CT 06525.

Bertrand E. Bennison is president of the Medicenter Five, Inc., a non-profit institution on Cape Cod which was established to provide primary care internal medicine, minor emergencies, walk-in care, lab-X-ray, EKG and physical therapy for residents of Cape Cod. . . . **H. Arthur Zimmerman** writes from Cleveland, "**Ed Hobson** and I collaborated on a special Harvard Business School reunion last June. this was a first-ever reunion for the H.B.S. executive education programs. As we had both been class secretaries and knew that attendance would be sparse after all those years, we decided to combine reunions for a couple of Advanced Management Programs, and we did have a very pleasant gathering in the Charles Hotel in Cambridge."—**Lester M. Klashman**, Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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For all who will be in the Boston area this June (1986), our class will have its annual mini-reunion at M.I.T.'s fabulous chateau, Endicott House, in Dedham, Mass. It will be the evening of Friday, June 6. A limited number of sleeping rooms are available for out-of-town guests. To be sure you are on the mailing list, send a note to **Don Severance** at M.I.T., Room 10-283.

Last June **Norm Leventhal** was elected a life member of the M.I.T. Corporation. Norm, as you may know, is in charge of special gifts solicitation for our 50th-year class gift—"38 in 88." What you may not know is that Norm's Beacon Hospitality Group opened an Embassy Suites Hotel on Soldiers Field Rd. in Boston last August.—**A. L. Bruneau, Jr.,** Secretary, 663 Riverview Dr., Chatham, MA 02633

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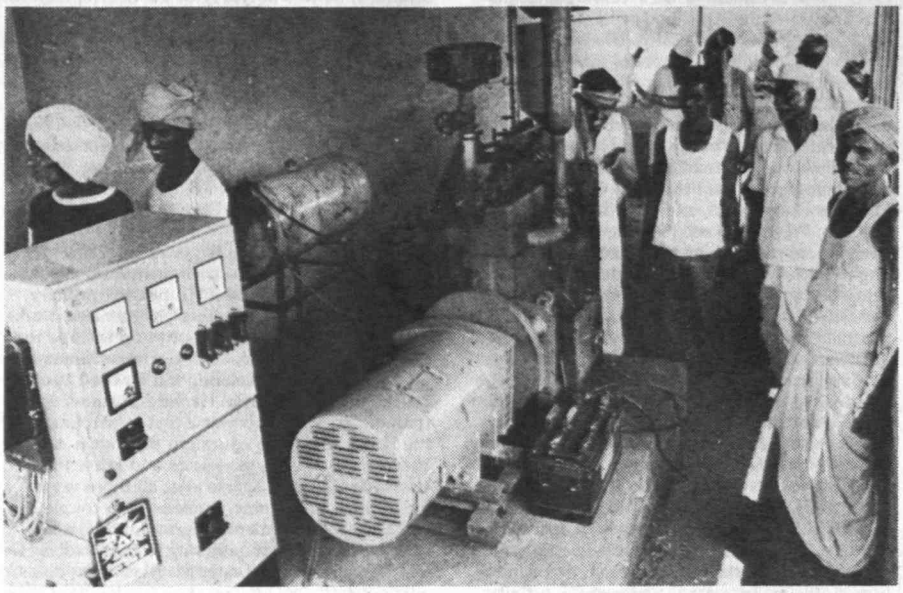
A letter from **Bruce Duffett** indicates how much he enjoyed the 45th, especially the session in the morning at Woodstock on current careers of retirees. He says that **Bill Morrison,** of Winston-Salem, N.C., intended to be at the reunion, but meetings with the Japanese precluded his attendance. Bruce enclosed an article from the *Winston-Salem Journal* covering Bill's activities. Last month Bill purchased Microban Products, Inc., from Tultex Corp. of Martinsville, Va., a company he had headed for four years. Microban is also the process by which he puts an additive into plastics (in the molten state) before they are shaped into anything from fibers for clothing to objects such as combs. This additive will kill bacteria, fungi, and accompanying odors for up to 15 or 20 years. Bill is aiming his marketing at hospitals and other health-care businesses. He is also selling brushes, covers for telephone receivers, and other similar products. However, his primary effort is to sell the know-how to companies that make the products.

Russ Haden sent an interesting letter on his present activities as vice-president of CFA-Corporate Finance Associates in Atlanta, Ga. CFA is a unique organization founded in 1956, of professionals in mergers and acquisitions. At present, it has 61 officers from coast to coast and four overseas, and is still expanding. It provides confidential services to the "middle ground" of companies



This biogas-powered generator provides 25 kilowatts of electricity to bring the Indian village of Khandia into the modern era. For the first time these people have power for lights, water pumps, and a flour mill. It's the proof-of-concept project for rural energy centers conceived by Nanubhai B. Amin, '42, and Bhang C. Jain, Sc.D. '76, chairman and general manager for energy, respectively, of Jyoti, Ltd., Vadodara, India.

A Model for Energizing India

Khandia is an isolated village of 806 people about 150 miles north of Bombay, India. Its residents farm some 450 acres of land and keep over 450 cattle and 130 sheep and goats. India considers more than half the population to be below the poverty level, and the village's only access road is impassable during the rainy season.

But for four hours a day Khandia has the miracle of electricity to pump water, light homes, and run television and radio in the community center. Gas is beginning to replace wood for cooking, and there are several refrigerators—heretofore unattainable luxuries in such an Indian community.

Khandia is the proving ground for an "integrated energy system" conceived by Nanubhai B. Amin, '42, and Bhang C. Jain, Sc.D.'76, chairman and general manager for energy, respectively, of Jyoti, Ltd., Vadodara, India.

Energy for the refrigeration and television/radio comes from a 450-watt photovoltaic system. Gas for cooking comes from a manure-powered biogas plant and from small biogas generators supplied to individual households. Pumps for drinking water (and some for irrigation) are powered by four 3.5-kilowatt gasifiers using agricultural and human waste.

And soon there will be more energy. Fifteen acres of land have been planted into fast-growing trees that will supply an additional resource of organic biomass to generate electricity for lights, pumps, and even a flour mill. Indeed, irrigation will make possible double-cropping on Khandia's arable land, giving the community for the first time in history a surplus of food—a cash crop that will life Khandia out of its poverty.

Already, say Amin and Jain, "the village is truly energized."

And as Khandia has been lifted out of abject rural poverty, so its people have a new spirit of community. Individual farmers have planted trees on their own land. Those with pumps share their water with neighbors who have no wells. A wealthy family donated a house for the community center. A cooperative society has been formed, and it will manage the energy system when Jyoti, Ltd., completes training the village leaders in two years.

But Amin and Jain say they have already proved their point: energy centers based on renewable resources have an important role to play in meeting the needs of remote rural communities in India.—*John Mattill* □

larger than the small ones handled by the big ones who have their own staffs to screen and evaluate. If you know of anyone or any company needing such services let Russ know at 6600 Peachtree-Dunwoody Rd., 300 Embassy Row, Suite 670, Atlanta, GA 30345.

In June 1985 **J. Halcombe Laning,** a senior Draper fellow with the Charles Stark Draper Laboratory, Inc., was placed in charge of a newly formed automation technology department.

Our class treasurer, **Ed Bernard,** writes that he is still trying to clean up reunion accounts with M.I.T. At present the indications are that we expended approximately $1,200 more than we collected. This will be made up from class funds. That's all for now.—**Donald R. Erb,** Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

41 45th Reunion

From the University of Maryland we have this news release: **Albert H. Bowker** has been named executive vice-president. He assists the president in coordinating all phases of work in the University's Central Administration offices in service to the five campuses and other components of the system. Before this he was dean of the University's School of Public Affairs. Prior to coming to Maryland, Dr. Bowker was chancellor of the University of California at Berkeley and of the City University of New York, and dean of the graduate school at Stanford University. . . . **Malcom D. Bray** writes that he is still working, he has one grandchild, and he hopes to attend our reunion. Asked if he would institute any changes in his life, had he to do it over again, he replies that he would do it the same way.

George W. Brown writes that he is still working as senior development engineer with Northwestern University. . . . **Bertram M. Brown** has retired, but is keeping very busy with many activities. He has five grandchildren. He has had a full life so far and says: No regrets!—**Joseph E. Dietgen,** P.O. Box 790, Cotuit, MA 02635

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The Class of 1943 was moderately represented at the N.A.C. in September. Registrants included **Ward Haas, John Jenkins, Kemp Maples, Jim McDonough, Ken Warden,** and me. John is to be congratulated for receiving the Lobdell Award for distinguished service to the Alumni Association. At the N.A.C., class president Warden gave me a copy of "GenRad's Shared Values," a seven-page pep talk by GenRad's boss, **Bill Thurston.** It is quite an inspirational statement of a corporate philosophy, and sets a good example for others. . . . **Chris Matthew** was honored in June by election to a term on the M.I.T. Corporation. Chris is executive vice-president of St. Mary's Foundation, in San Francisco.

I am sorry to report the death, in June, 1985, of Dr. **Andrew C. Peacock,** Rockville, Md. Andy, a native of Boston, received all three of his biochemistry degrees from M.I.T. After service with the Army Air Force in the Pacific during World War II, he began working for the National Cancer Institute in 1949. During his career with N.C.I., Andy received a number of awards for distinguished research in biochemistry and molecular biology. Ironically, he succumbed to the disease which it was his profession to study. Survivors include his wife (and 1943 classmate) **Gloria,** two daughters, a sister, and two grandchildren. We extend our condolences to them.—**Bob Rorschach,** Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Several letters send regrets regarding the Mini-Reunion in Williamsburg in November. Missed were Annie and **Berny Rabinowitz**—when you are

PHOTO: JYOTI LTD.

president of a company, schedules do, unfortunately, get changed. . . . Helen and **Ed Eaton** could not make it either; another president with pressing business matters. . . . **Joe Shrier** was off to London (son finishing his master's at L.S.E.) and then to the Bahamas for a few weeks. . . . **Bob Meny** wrote that he would be visiting England. . . . Marjory and **Dick Whiffen** had to cancel reservations, as well. . . . **John Lednicky** missed the trip due to overseas business. . . . Slow down, fellas!

Last year, world travelers Bobbie and **Burt Bromfield** met **Arnold MacIntosh** in Egypt. This year, making a brief stop in San Francisco en route to China, they met **Arturo Morales** in their hotel lobby and had breakfast with him. This news came from a letter from Burt dated September 17, just prior to the earthquake in Mexico City. Since Arturo was on a business trip to San Francisco, we do not know if he returned home. . . . In early October, co-secretary **Andy Corry** took off on an M.I.T. Quarter Century Club cruise of the Greek Isles. We hope for a detailed report next issue, and more about the Mini-Reunion, too.—Co-Secretaries: **Andy Corry**, Box 310, West Hyannisport, MA 02672; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Certainly the high point of our Newport mini-reunion was our evening at Rosecliff. The dinner was exquisite, concluding with strawberries served with a subtly elusive sauce in dishes made of chocolate. Yes, friends, your classmates ate even the dishes at Rosecliff. Such was the allure of the Newport cottages that a number of us braved the poison ivy to take the Cliff Walk the next day. We did not even notice where the refurbished walk ended, but clambered over rocks and chasms for another half mile or so, until a friendly fisherman suggested that we sneak back to civilization through someone's yard. So much for guides who remember how it used to be. . . With the practice reunion behind us, we now must prepare for the real one, the 40th, coming up in 1987. For this one we anticipate making a splendid gift to the Institute, and, indeed, everything we will have given since 1982 and everything pledged to be contributed by 1992 will be included in our 40th reunion gift. Your gift committee, under the leadership of **Harl Aldrich**, has met several times to determine which of the many Institute needs we would like to help meet with our class project. We decided to fund a class of '47 chair, the occupant to be appointed by the provost. The Class of '47 professors will reach generations of future M.I.T. students, and will be able to concentrate more on teaching, since occupying a funded chair releases one from the necessity of raising half of one's salary through research grants. The current gift committee includes (to be joined by others, we hope): **Claude Brenner, Tom Dorste, John Fennessey, Hugh Flomenhoft, Virginia Grammer, Norm Holland, Bob Horowitz, Arnold Judson, Byron Lutman, Ken Marshall, Jim Phillips, Jack Rizika, Marty Schwartz, Parker Symmes, Don van Greenby, Mary Frances Wagley**, and **David Yablong**.

Kudos to **Paul Cook**, chairman of the board and chief executive officer, Raychem Corp., Menlo Park, Calif. Paul was elected to the National Academy of Engineering of the United States of America "for his pioneering research into the application of radiation chemistry to polymers and the development of innovative technologies in engineered materials." Election to the academy is the highest professional distinction that can be conferred on an engineer. . . . **John Cowan**, senior vice-president, administration and finance, and treasurer of United Air Lines, Inc., Chicago, Ill., has added to his duties those of executive vice-president, Finance, of a subsidiary. . . . **Ed Hylas** recently assumed the position of engineering manager in charge of the North Warning Program being conducted for the U.S. Air Force by the Sperry Corp. at the Sperry C3I Center, Waltham, Mass.

Mary Frances Wagley has been appointed to the new medical management board of the medical department of M.I.T. The book *Public-Private Partnership: New Opportunities for Meeting Social Needs*, published by the Ballinger Publishing Co., contains the results of a study carried out by people brought together by the American Academy of Arts and Sciences. Their purpose was to consider the opportunities and limitations for increasing the role of corporations in meeting social needs, especially the delivery of services traditionally supplied by the public sector. Participant **Jordan Baruch** authored the chapter, "Structuring Markets for Public Goods and Services." . . . **Aaron Newman** has taken early retirement from Ebasco. He continues to be available for an occasional consulting assignment, however. . . . **Walter Kern** is still at Teradyne, and is now getting involved in robotics. But he finds time for his tennis twice a week. Challengers? . . . **Leslie Martin** has retired from Aetna Life and Casualty after 38 years of service.

Ken Marshall retired from his position as vice-president of planning and administration at Sherwood Medical Co. in St. Louis some time ago, but he is as active as ever. He is devoting almost full time to his duties as president of the United States National Senior Olympic Committee. There have been roughly 50 regional senior Olympic competitions throughout the country, but next year's event will be the first national meet. Some 4,000 entrants over age 55 are expected to compete. The rest of his time Ken gives to his job as chairman of the Board of Trustees of Deaconess Hospital in St. Louis. . . . **Dave Knodel** died on September 20 of complications following a dozen years of dialysis for kidney dysfunction. Dave was a graduate of Course XVI, and took a master's degree in 1951. He worked in the naval supersonic laboratory at the Institute in the late forties and early fifties, joining Allied Research Associates, Inc. on its founding as one of its first engineers. After a dozen years with that organization, he joined Mithras Corp. which was later acquired by Sanders Associates where he spent the last 22 years of his career. While Dave was dependent on thrice weekly dialysis sessions of six hours each, he continued to live a full and rich life, travelling to Europe, the Caribbean, and to southern and western states to visit friends. He was an active swimmer and gardner. He used his time wisely and well. He leaves his wife, Pat, and three children, Kristene Turco, David, and Kathlene.—**Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

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Milton Slade has been a very supportive alumnus for the past 15 years. Milton is a member of the Alumni Council. He has been a member of the reunion committee for our last three reunions. Currently he is treasurer of our class and will have a big job during our 40th reunion in 1988. He has worked for the Alumni Fund as co-chairman of the personal solicitation drive in his area and as a participant in many fund telethons. His wife, Jean, has often joined in the telethons and made calls. Milton is responsible for program management in G.T.E.'s Communication Systems Division in the area of communication switching. He is on IEEE's Board of Directors for the Automatic Test Committee. Jean is a secretary in the Guidance Department of Minuteman Vocational High School in Lexington. They have a lake front cottage in Harrison, Maine, where they can relax and pick blueberries. Last June their youngest child graduated from college. . . . **Bob Sandman** has shared in the work of making our class events a success. At our 25th Reunion, he managed a successful program for the children who came with us to the reunion. At the two following reunions he was responsible for major events. He has accepted **George Clifford**'s request to be chairman of our 40th Reunion. Bob's company is Sandman Electric in Braintree, Fitchburg, and Pawtucket. The company specializes in the electrical equipment problems of commercial and industrial businesses. Bob enjoys the challenge of application engineering and has an extensive list of satisfied customers. In April, Bob and his wife, Tel, visited Belgium and Luxenburg. They rented a car and drove all over the country. People were friendly and glad to see them. After their return home, their summer visitors were twin grandsons from Oakland, Calif.

Don Noble was chairman of our last reunion, and he served on many previous reunion committees. Don is in business for himself as a manufacturer's representative selling equipment for HVAC applications. He has an energy management contracting company that uses automatic temperature controls and other techniques to lower energy costs in buildings. Don's business is very cyclical, and he has developed several unique concepts to fit the needs of the changing market for HVAC. He is promoting ice storage techniques that allow the production of ice when electrical rates are lower, and then use the cooling properties of the ice during other times of the day when the electrical rates are higher. Don's wife, Nancy, teaches English as a second language. Don and Nancy have seven children, including an adopted daughter who came here from Vietnam, and is now a senior in high school. Another daughter earns her B.S. from Vassar next year. Four children are married. . . . Don's roomate in college was **Mitch Silverstein**. Mitch has sold his home in Illinois and has a home in Florida. Mitch's son is operating Mitch's business.

Verity Smith was class treasurer for ten years and has been on virtually all of the reunion committees. Verity founded and operates Vaponics Corp. in Plymouth, Mass., with offices for subsidiary companies in England and Bangkok. Half of his business has been international, with sales of high purity water equipment to the Republic of China and to Czechoslovakia. The equipment uses distillation, ion exchange, and reverse osmosis to prepare high-purity water for pharmaceutical and semiconductor applications. . . . Verity and his wife, Anita, enjoy their family homestead in Little Compton, R.I. One daughter is in mechanical engineering at the University of New Hampshire; another daughter is at Dana Hall; three of Verity's children work for Vaponics. Vaponics employees **Norman Everett** and **Bill Revoir** are members of our class. Norman is technical service director, and Bill is chief engineer. Norm just returned from a trip to China. . . . **John M. D. Walch** is chairman of the membership committee of IEEE Power Engineering Society. . . . **Lucien A. Schmit, Jr.**, professor of mechanics and structures at U.C.L.A., was elected to the National Academy of Engineering. He was given this honor for his pioneering work in structural synthesis, combining finite element analysis and nonlinear programming algorithms to create a powerful class of modern structural design methods.

Four days after writing this, I leave for Nepal and three weeks of trekking in the Himalaya. I plan to fly to 9,000 feet and begin walking. I will spend six hours a day on the trail, enjoying the majesty of peaks, ridges, valleys, rock, and rivers.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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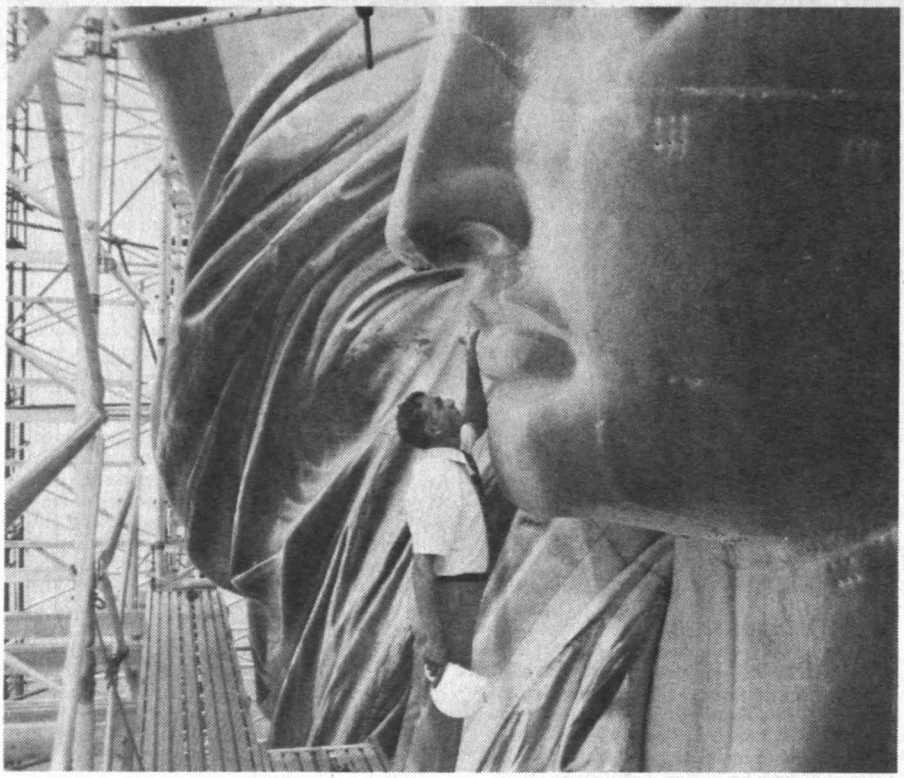
Len Newton and Ruby are sending their youngest to B.U. this year but are using their time preparing to lead their fourth small group visit to China in May of '86. Besides exotic scenes, Emperor Chin's dig (240 B.C.) and endless culinary delights, this very special tour includes social occasions with M.I.T. and Harvard educated Chinese business, government, and academic leaders. The eight areas to be visited will appeal to those who have about three weeks and $4,000. To receive



"Restorations can be every bit as challenging to an engineer as designing new bridges, transportation systems, or structures," says Pat DiNapoli, '54 (above). Employed by Ammann and Whitney in New York City, he is project manager for all engineering related to the renovation and restoration of the Statue of Liberty.

Solutions must be faithful to the original materials and intent of the historical design, yet they must meet modern building codes and standards for comfort and safety, DiNapoli points out. In addition to requiring technical competence, the work involves historical research, detective work, innovation, imagination, and perseverance.

Work on the program includes not only the statue but the design of a new museum for the "Story of the Statue of Liberty."

the free *M.I.T. Visits China* Newsletter, contact **Len Newton**, (609) 924-0861, 90 Dempsey Ave., Princeton, NJ 08540.

James P. Gordon is among the 67 scientists honored by the National Academy of Engineering of the United States of America. Election to the Academy is the highest professional distinction that can be conferred on an engineer and honors those who have made important contributions to engineering theory and practice, including significant contributions to the literature of engineering, or who have demonstrated unusual accomplishments in new and developing fields of technology. Gordon is honored for "fundamental contributions to quantum electronics, including demonstration of the first maser and demonstration of the information theory of optical communication channels. Gordon is a technical staff consultant in the Electronics Research Laboratory, At&T Bell Laboratories, Holmdel, N.J.

I wrote previously of the death of Dr. **William Haddon, Jr.** in March 1985. Reports about Dr. Haddon's life and his contributions (perhaps saving your life or mine) are still being published frequently. He has been described as "a medical giant, a 20th century version of Dr. Louis Pasteur." It was he who set the first federal safety standards as the nation's first director of the National Highway Traffic Safety Administration. Those standards "saved more than 80,000 lives and many, many times that many serious injuries. Dr. Haddon took strong exception to the conventional wisdom that the way to cut highway deaths was to modify the behavior of individuals. He believed it to be far more effective to build safer cars; far easier to change the engineering of cars than to get 130 million people to buckle up for every trip. His research supports his advocacy of both automatic crash protection (airbags) and seat belt laws. His work has saved the lives of unknown millions.

These notes were possible because a number of people took the time to get information to me. Please let me know what is going on in your part of the planet. If you are too busy to write or don't like to, perhaps you would give me a call at (617) 323-1539. Your classmates are interested. You are reading these notes aren't you? Please note my change of address.—**Barbara Feeney Powers**, Secretary, 200 Temple St., West Roxbury, MA 02132

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David E. Gushee, chief of the Environmental and Natural Resources Policy Division of the Library of Congress' Congressional Research Service, has been named a fellow of the American Institute of Chemical Engineers (AIChE). In honoring the Vienna, Va. resident, the Institute's governing council saluted his use of chemical engineering expertise in the formulation of legislative policy. David joined the Congressional Research Service in 1972, after stints with Du Pont's Grasselli Chemicals Department and the American Chemical Society (ACS). At ACS, he started as technology editor of *Chemical and Engineering News* and moved on to become publisher of all ACS journals and books.

A former chairman of AIChE's National Capital Section, he also served the Institute as a member of its Speakers Bureau, as chairman of a task force on future demand for chemical engineers, and as a member of the research committee.

David is a founding member of the National Energy Resources Organization and a technical consultant to the World Health Organization. In 1979, he was a U.S. representative to the East-West Energy Conference in Vienna, Austria. He has also toured Europe and the Middle East on behalf of the U.S. Information Agency.

Philip K. Pearson, Jr., of Farmington, Conn., has been named director of metallurgy and materials at the Fafnir Bearing Division of Textron, Inc., New Britain. Philip joined Fafnir as a metallurgist in 1970. Since then, he has held positions of increasing responsibility, most recently as chief metallurgist and chief engineeer, materials. He holds a U.S. patent on ductility testing of metals to indicate fatigue life, and was instrumental in Fafnir's recent development of fracture resistant bearings for advanced gas turbine engines.

We regret to inform you of the death of **Rene G. Lamadrid**, who passed away November 21, 1984.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Place, 10H, Boston, MA 02114

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George L. Turin, dean, School of Engineering and Applied Science, University of California, Los Angeles, was elected to membership in the National Academy of Engineering for his outstanding contributions to communication theory and practice and for leadership in engineering education. . . . **W. Gerald Austen**, chief of surgical services at Massachusetts General Hospital was named chairman of the medical management board, a new governance plan for the M.I.T. medical department. Dr. Austen is a member of the M.I.T. Corporation and has chaired the medical department's visiting committee and its medical administration board, which preceded the medical management board. . . . **Marvin L. Baker** has started his own business, High Technology Associates. He states his mission is to develop business opportunities in the U.S. (acquisitions, joint ventures, market development, technology licensing, etc.) for European companies, or vise versa. He would like to hear from other alumni with similar interests.—**Gregor J. Gentleman**, Secretary, 600 Holcomb, Suite 1, Des Moines, IA 50313

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It's a pleasure to be able to report that several of our classmates have received honors recently. A newspaper item informs us that **Charles Taft** has been given the University of New Hampshire's first Outstanding Innovator award. This award recognizes his unusual creativity and entrepreneurship at that university. Charles is a mechanical engineer who is internationally known for his studies on feedback control engineering and dynamic and digital systems. . . . In July, **J. Charles Forman** of Darien, Conn. was elected president of the Council of Engineering and Scientific Societies Executives. During his one-year term, he plans to stress the council's role as a forum for the exchange of informal ideas. Charles is also head of

PHOTO: MASA FUKUGIMA

the American Institute of Chemical Engineers. . . . From a news release, we learned that **Stephen A. Kliment** has been appointed head of the new book division of Practice Management Associates, Ltd., which concentrates on publishing management surveys, seminar workbooks, and related works. Steve is the author of several books, including *Creative Communications for Successful Design Practice*, a text on marketing communications for design professionals.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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These notes are written on a bright, crisp, late September afternoon. A light breeze rustles the leaves. Quite a difference from 24 hours ago, when Hurricane Gloria blew by us. From my study window, the front yards on Peppberbush Lane look as neat and clean as ever. Everybody was out early; the yards have been cleared, raked, cut, and trimmed. We were lucky. We did not lose electric power, there are no problems with our water, no trees were uprooted, and even the larger, six-inch limbs and branches which were blown off the trees managed to hit the ground without even touching a house, overhead wire or car. But this block-long street in southwestern Connecticut is a small oasis of tranquility. As near as the next street and for hundreds of miles beyond, more than half of the population have serious problems. My reponsibilities at the University of Bridgeport include decisions on canceling classes, closing the institution, or taking other action in an emergency; this emergency began at noon on Wednesday, when we were put on a "hurricane watch." As it turned out, that gave us just under 48 hours to get ready. But we were lucky: Damage to the campus amounted to the loss of many trees, a few broken windows, and only minimal damage to the buildings.

Obviously, I have not yet heard how other members of the class weathered the hurricane. But we do have a few notes from earlier correspondence. **Bob Anslow** has taken on a real challenge as general manager of Plessey Solid State, a small semiconductor company which is part of a British parent operation, the Plessey Co. Bob's task is to get a bigger share of a seriously slumping market. Previously, he was director of strategic planning at the Semiconductor Products Division of Rockwell International Corp. . . . Corning Glass Works has reorganized, and **Joe Hurley** has been named as director of manufacturing systems, a newly created position. He will be responsible for helping the company's manufacturing plants to plan and implement computer-integrated manufacturing projects and full systems.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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News from the Class of ' 55 will be co-anchored for the next five years by **Robert P. ("Bob") Greene** on the East Coast and **DuWayne ("Pete") Peterson** on the West Coast. We are delighted to be jointly reporting the activities of our classmates, and we look forward to being in contact with many of you. Our platform is simple and straightforward. We plan for each issue of the *Technology Review* to include something in the '55 notes—even if we have to create it! If you don't tell us what you are up to, we will invent something. Make sure your organization's public relations department has the *Review* on their mailing list for press releases issued about you. Your classmates are still really interested in you, so please drop us a line and let us know what you are doing.

East has won the toss so Greene will begin. **Allann C. Schell** ad **Marc Gross** are going to be tough acts to follow. As a team, they have kept us informed and entertained for more than ten years with the antics and careers of our classmates. They have done so with regularity, editorial skill, and a keen sense of humor. On behalf of the entire class, let me convey our sincere appreciation and gratitude to them for a job well done. Allan, in particular, deserves that proverbial gold watch for his (was it really 20 years) of service to the class.

Congratulations are in order for the new slate of officers selected by accolade at our 30th reunion on Martha's Vineyard last June. **Paul H. Attridge** is our new president. He and Polly live in Needham, Mass. Paul has been in the insurance business in Boston since graduation from M.I.T. He became an honorary truck driver, recently, after driving one of the 15-gear semi-trailer rigs before judging the annual national driving skill competition. With the entrance into Wellesley College of their daughter, Jody, this fall, they have joined the empty nest club. . . . **Glen D. Jackson, III** is our newly elected vice-president. He is the East Coast representative for Pigment Dispersions, Inc. When he is not selling chemicals, he provides his classmates and friends with scenic flights around the Vineyard in his fleet of two airplanes. Glen and Mary Anne and their son Pete live in Hingham, Mass. when they aren't on the Vineyard. . . . **Edward "Ed" Ehrlich** wears several hats as vice-president and treasurer of the class. He commutes to the edge of the combat zone in Boston to his position as associate director of New England Medical Center Hospitals. He and Jan live in Natick where Ed is on the Zoning Board of Appeals. Their six children are scattered and include Susan, a married doctor; Cathy, an insurance actuary; Stephen, a civil engineer; Jim, a senior, and Karen, a freshman, at Columbia; and John, a junior at Bucknell. All of the Ehrlich clan are outstanding competitive swimmers. . . . **Peter ("Pete") Toohy** continues as our class agent. In Houston, Tex., he is manager, plastic sales for Chevron Chemical Co. Jane and Pete have three daughters—Nora, a law student, and Kate and Sheila, who are undergraduates. They are both tennis buffs, as we discovered at the reunion—so bring your racket if you are heading for Houston on business or pleasure and give them a call.

Your East Coast co-secretary and Edie, his bride of almost 30 years, are rattling around their colonial house in Sherborn, which they have used as home base since 1966 when I returned to the Boston and joined the administrative staff at the Institute. Daughters Patricia and Brenda are married, and Ann is in Sudan teaching English at a boys school outside of Khartoum. Most of my activities at M.I.T. have involved project management of international collaborative programs including three years in Indonesia with the Ford Foundation and two tours, totalling five years, in Egypt at Cairo University as the M.I.T. representative for the Technology Adaptation Program. Since returning from Cairo about a year and a half ago, I have been the assistant director for administration and finance at the newly formed Media Laboratory. The Media Laboratory is the principal accupant of the Wiesner Building, a new and exciting facility that brings together the arts and media technology at M.I.T.

The West Coast will write next month's notes, so I will leave it to DuWayne to report directly on his activities.

Let us know what you are doing!—**Robert P. Greene**, Eastern Co-Secretary, 37 Great Rock Rd., Sherborn, MA 01770; **DuWayne J. Peterson, Jr.**, Western Co-Secretary, 1841 Warwick Rd., San Marino, CA 91108

56 30th Reunion

There were no class notes in the previous issue for lack of news from class members. This month there are enough contributions to make a good column. Please let us hear from you.

A number of our classmates have embarked on new ventures. **Ron Massa** and **Bill Northfield** have formed the Lorron Corp. in Burlington, Mass., to provide "creative solutions in data processing, computer security, and analytic physical security using high performance computer architectures." I also got a call from **Nelo Sekler**. He retired from retirement, and formed Tecni Queso in Caracas, Venezuela, to manufacture "analog cheeses." He is also the proud father of a baby girl, Dana, who was born on May 23, 1985. His older daughter, Eugenia, is a first year medical student in Caracas, thus following in her mother's footsteps; Eva is a member of the medical faculty at the same University. Their son, Julio, is a high school junior.

Bill Peter and his wife, Dot, are now operating Delaware Business Consultants, Inc., an international consulting firm founded ten years ago, on a full-time basis from their home in Kennebunkport, Me. Bill took early retirement from Du Pont this year after 26 years of service. While at Du Pont, Bill was involved in marketing, sales, manufacturing, research, and strategic management. . . . **Edwin H. Baker** has joined the New York office of Epstein, Becker, Borsody, and Green, P.C. Ed is a specialist in taxation, estate planning, and trust and estate law. . . . **Klaus Kubierschky** is president and founder of Kay Kube Corp. in North Reading, Mass. Kay Kube provides analog electrical circuit design and consultant services.

We have some noted academicians in our class. I received an announcement inviting me to attend a conference on software tools for artificial intelligence and expert systems that will be held at the Westin Hotel in Boston on November 18, 1985. I noticed that the Conference is being organized and sponsored by no one else but our own classmate, **Warren G. Briggs**, who is a member of the faculty in the School of Management at Suffolk University in Boston.

Charles A. Berg, chairman of the Mechanical Engineering Department at Northeastern University, was elected a fellow of the American Society of Mechanical Engineers.

I also have to report the death of two classmates. **Anthony L. Galvagna** passed away on March 25, 1985. He was a senior engineer with Western Electric in North Andover. **Dalton L. Baugh, Sr.** president and founder of D. Baugh and Associates, an architectural engineering firm in Mattapan, Mass., and one of the first black officers in the U.S. Navy, passed away on January 3, 1985 at the age of 72. Dalton received a master's in mechanical engineering with our class, and remained at M.I.T. for another 16 years as a supervisor and instructor of fluid engineering in the gas turbine lab. On behalf of the class, I would like to offer condolences to the families of both these classmates.

By the time you read these notes, you should have received your second invitation to attend our 30th reunion in Newport, R.I. **Ron Massa** and the reunion committee have planned well ahead, and will be working hard from now on to provide all of us with a memorable weekend. *I urge you all to reserve June 5-8 and attend the 30th Reunion of the Class of 1956.*—**Robert Kaiser**, Eastern Co-Secretary, 12 Glengarry, Winchester, MA 01890, (617) 729-5345; **Caroline D. Chihoski**, Western Co-Secretary, 2116 Davies Ave., Littleton, CO 80120, (303) 794-5818

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It's that snowflakes-are-falling, let's-get-cozy time of year (if you live in southern California, pretend)—a good time to read about your classmates and to write what you have been doing. So get out your typewriter, word-processor, quill, or stone-chisel.

Our mailbag has no direct communications, but I do have some material from press releases. **Jim Champy**, former executive vice-president of the

Alumni Association, is vice-president and general counsel at Index Systems of Cambridge. Index is a management consulting firm. He is responsible for the company's practices in education, change management and human resources. After graduating with us, Jim got his S.M. in civil engineering from the 'Tute and his J.D. from Boston College Law School; his career has been in management and planning. . . . The founder, chairman and president of Index Systems is **Tom Gerrity**. Tom stayed at Tech to get his S.M. in electrical engineering and Ph.D. in management. He recently announced opening an Index office in London (under the name Index International). . . . Corning Glass Works in Corning, N.Y., announces that **Howard Leibowitz** has been promoted to director of distribution in the consumer products division. Howard went to Corning in 1965 and has been there since.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218, (301) 889-3890

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Ron Gilman sends a clipping from a Memphis newspaper, announcing his election as speaker of the Tennessee Bar Association's House of Delegates. This position also makes Ron a member of the state bar's Board of Governors. Ron is a partner in the Memphis law firm of Farris, Hancock, Gilman, Branan and Hellen. He is also active in the Memphis and Shelby County Bar Association. Ron's *real* claim to fame: he is vice-president of the Society of Memphis Magicians. They hold monthly meetings and put on magic shows for children at local hospitals. Ron also uses magic in his lectures to fellow lawyers. . . . In a recent American Geophysical Union publication, **Chuck Counselman** was profiled as a candidate for the position of president-elect of the A.G.U.'s Geodesy Section. He is professor of planetary science at M.I.T., where Chuck joined the faculty in 1969 after receiving his Ph.D. in instrumentation. He has served on a variety of international commissions and groups concerned with space geodesy, radio astronomy, celestial mechanics and marine positioning, and he has authored 81 technical publications. Chuck and I were both Baltimoreans prior to enrolling at M.I.T. and were in the instrumentation program together.

A commentary written by **Neil Orloff** appeared in the *Wall Street Journal* in December, 1984. In it, he addresses the issue of possible overemphasis in our society of the fear of pollutants and toxic substances. Neil is director of the Center for Environmental Research at Cornell University and also professor of enviromental engineering. After leaving M.I.T. he earned an M.B.A. at Harvard and a J.D. at Columbia. Prior to joining the Cornell faculty in 1975 he was on the staff of the World Bank, the E.P.A. and the President's Council on Evironmental Quality. His current research focuses on the regulation of toxic substances and is aimed at developing frameworks for rational government decisions in the presence of considerable uncertainty about degrees of risk. Neil's commentary points out the complexity of our society and the difficulty in accounting for cultural factors underlying people's fear of chemicals.—**Joe Kasper**, Secretary, 3807 Benton St., N.W., Washington, DC 20007, (703) 734-4100

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David MacFadyen is project director for the "Smart House," a priority project of the research arm of the National Association of Home Builders which is intended to overhaul the traditional wiring systems currently used in American homes, and achieve a new integrated home-wiring system that will provide power and signal distribution that is safer, less costly and more functional than the 120-volt alternating-current system common in the United States and Canada. . . . **George Howison** is presently serving as vice-president and treasurer of Burlington Northern's Plum Creek Timber Co. in Seattle, Wash. . . . **Ken Ogan** is a senior staff scientist doing basic and applied research in analytical instrumentation with Perkin-Elmer Corp. in Norwalk, Conn. Ken has two sons, Erik, 12, and Craig, 8, and is president of M.I.T.'s Fairfield County alumni group. . . . After eight years with EG&G in Los Alamos, N.M., **Gordon De Witte** is now working on electron-beam lithography with Hewlett Packard in Santa Rosa, Calif.—**Jim Swanson,** Secretary, 878 Hoffman Terr., Los Altos, CA 94022

71 15th Reunion

David J. Sales is currently chief of gastroenterology at Northwest Community Hospital in Arlington Heights, Ill. and on the associate faculty of the University of Chicago. He recently visited Gary Stahl, '73 who's thriving productively as faculty in neonatology at the University of Pennsylvania. . . . **Kerry R. Mull** has joined CENTEC Corp., Reston, Va. as a software engineer in August 1985. . . . **Sara ("Sally") N. Harvey** was installed as director of Region F of the Society of Women Engineers (SWE), a non-profit educational service organization of graduate engineers dedicated to the advancement of women in the engineering profession. She is a senior member of SWE and a past president of the Boston section. She will represent SWE members and students in the six New England states during her term. Sally received her M.B.A. from the Harvard Business School and is senior manager, Management Sciences, at Digital Equipment Corp. . . . My wife, Lucy, and I have our third child, Peter Baker Moorman, who was born on July 25.—**R. Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

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James M. Lamiell has been promoted to the rank of lieutenant colonel in the U.S. Army. James is a critical care officer at Letterman Army Medical center in San Francisco.

News is short this month. Please let us know what is new! Hope you all had a great fall and happy holiday season.—**Wendy Elaine Erb,** 531 Main St., Apt. 714, New York, NY 10044

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There wouldn't be much to write about, save one pass-along from the company called Index Systems of Cambridge. We learn from it that **G. Michael Ashmore** is now a principal with Index, specializing in the Development of hardware/software architecture and technical resource deployment strategies. That's it.

Life goes on, winter comes, and our new solar panel better be doing its job heating our place as you read this. Write!—**Robert M.O. Sutton, Sr.,** Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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The fall colors were spectacular this year. Like a hillside of gum balls, this year Ma Nature showed us what she could really do. God, it's great to be alive. How's by you? Your faithful scribe just returned from hiking Franconia Notch this weekend with these immortal words of advice: surrender to life, it's got us surrounded.

I saw an ad recently in the local rag showing a picture of the Great Dome at M.I.T. next to a picture of a computer store. The ad copy read: "Guess where more people go to learn about computers." More, of course, is not necessarily better.

Thank you all for your generous support of the Alumni Fund. We won an award. The class of '74 was awarded a presidential citation, for our outstanding 10th reunion gift. Class president **Sandy Yulke** received the citation from Alumni Association president E. Milton Bevington at the National Alumni Conference this past October.

Heading off the news this month, Marcy and **Tom Wolff** have baby news! Their first, Ilana Esther, came into being September 17 tilting the scales at 6 pounds 3 ounces. . . . **Ron Kuppersmith** has baby news of his own, Michael Louis, born March 11. Ron's wife Diane is "busy raising the family" (no surprises there), and four-year-old Leah has also been quite a help. Ron is director of services at Bay State Milling Co., where in addition to milling, they are official statisticians for the American League (baseball) and U.S. Football League. He developed a portable computer system being used by the teams to capture and report game statistics. And he's working in real estate sales for ERA, in case you're looking to buy or sell. Thanks for the letter, Ron.

Rich Sternberg (er, I mean Dr. Richard J. Sternberg, M.D.) has received his board certification from the American Board of Orthopaedic Surgery. He was flying high on that one when I talked with his secretary. He's also on the Educational Council as of this fall. . . . **Mark Abkowitz** has been promoted to associate professor in the civil engineering department of Rensselaer Polytechnic Institute. Mark lives in Ballston Lake, N.Y. . . . And rounding out this month's column, a note from **John Hixson**. John's living in Cambridge and is director of Salem Harbor Community Development Corp.

I was calling up members of the class for the Alumni Association (remind me to tell you how much *fun* that is), when I chanced to call the abode of **Charles Calhoun**. It seems Chuck is home recovering from a skull fracture. It was truly inspirational to listen to his courageous powerhouse of a wife Terry describe the occurrence (Chuck fell while walking to work), hospitalization, and his at-home convalescence. Then I got to talk to the man himself. He's doing his exercises and getting better daily. If you knew Chuck or even if you didn't but just want to do something to make yourself feel good today, send him a get-well card at 106 Harmon Ave., Pelham, NY 10803 or give him a call at (914) 738-1806.

Finally, a little quote from Abraham Lincoln to keep you warm in the January snows: "A friend is a person who, after you've made a fool of yourself, doesn't think you've done a permanent job." . . . Personal notes to me (Lionel) or Jim with news are always welcome. Please write and tell us directly before we read about it in the papers.—Co-secretaries: **Lionel Goulet**, 21 Melville Ave., Dorchester, MA 02124; **Jim Gokhale**, 45 Hillcrest Dr., Arlington, MA 02174

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Hello, everyone! Happy New Year! This is my first column in five years and it's great to be back. Thank you for reinstating me as your class secretary at our 10th reunion in June. I'm sorry I had to miss it, but there was this extenuating circumstance called the New York bar exam—and, predictably, the only weekend my review course scheduled classes was our reunion weekend. Them's the breaks! At least I got to hear about it firsthand the next week when I met **Peter** and **David Dinhofer** and **A.J. Willmer** for drinks in Manhattan. We had some good laughs reminiscing about life and times on McCormick's 6 West.

Since the class news is sparse this month, I'll fill you in on what I've been up to—or haven't been up to, as the case may be. I finally finished my doctorate in biochemical engineering at the Institute in 1981. I was then saved from a fate with fermentors by S. Leslie Misrock, '49, who offered me an opportunity and radical career change at Pennie and Edmonds, an intellectual property law firm in New York. For the past four years, I have worked at Pennie and Edmonds as a patent agent, specializing in biotechnology patents, while attending Fordham University Law

"You have to recruit the best people and create the best work you can—you can't worry about whether or not it'll be a success."

Andrew Silver, 64,
Moviemaker:

A Head for Business, A Heart for Art

Filmmaker Andrew Silver, '64 (above right) makes a suggestion to Karlene Crockett and John Walcutt during the shooting of his new film **Return.** *Silver holds two business degrees from M.I.T. and a doctorate from Harvard Business School. He has taught theatre at Brandeis University and has produced numerous award-winning short subjects and PBS programs. He is currently working on a PBS series on Korea with his wife, Yong-Hee Silver.*

Its billing as at once a love story, a murder mystery, and a tale of the supernatural excites curiosity about a new movie called *Return*. But two essential facts are still to be told: it's the first feature-length film created by **Andrew Silver,** '64, and it won a plate of awards before opening its first commercial engagement in Boston last November.

Although the commercial success of his film is important, Silver focusses on the creative aspects of filmmaking. "You have to recruit the best people and create the best work you can—you can't worry about whether or not it'll be a success," he explains. "I trust the actors and the process and I trust the audience," he says.

Return is a love story between a woman and a man who under hypnosis is capable of possessing the personality of his lover's long-deceased grandfather. The story was adapted from Donald Harington's novel, *Some Other Place, The Right Place*. Silver claims he was attracted to this work because he wanted to do a story about the paranormal that was positive, and not based on fear. It's not a horror film. The supernatural scenes take place in daylight as opposed to darkness; the surroundings are ones of natural beauty—fall in rural Massachusetts, a mountain in Arkansas; and the outcome is ultimately healing and transforming. Truth rises to the top and is settling, says Silver.

During his early days at M.I.T., Silver became intrigued with film as an art form. It was a whole new language, he said, and he began to study how the imagery of film speaks.

In *Return* water is an important image. It covers the grandfather's former town, just like the family secrets that have been long buried under layers of emotions. It becomes a symbol for cleansing when the young couple in the film bathe in a waterfall. And as it flows over rocks carrying leaves and flowers, one senses the freedom of an ongoing spirit. A leaf held up to the sunlight becomes transparent as the couple begin to unfold the family mystery. And a series of night scenes speeding along expressways with city lights flashing by suggest alterations of time and space, passages into other dimensions of consciousness.

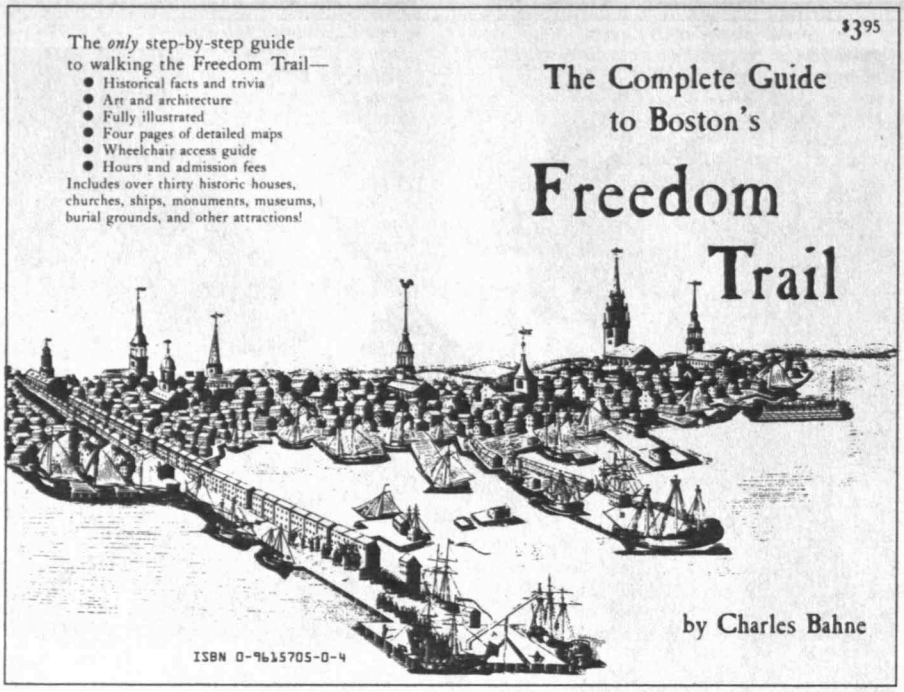
The music score by Ragnar Grippe and Michael Shrieve is varied, a combination of synthesizer, rock, and classical sounds, at times rhythmic and soothing and at times erratic and ominous. "The grandfather is portrayed with music instead of using flashbacks," says Silver. "You 'hear' his character."

Silver emphasizes the importance of the element of surprise in creativity. Contrary to some business practices where there are tight controls and a lot of structure, he lets the controls down during the filmmaking process, is flexible, and amplifies the enthusiasm of his cast and crew.

A director is like a gardener, says Silver. He isn't the charismatic. He absorbs the conflicts, facilitates, allows the others to shine. A gardener can't be the flower, he points out.

Return has won awards at European and American festivals, including Best Film (Philadelphia), Best Actor (John Walcutt, at the Sitges, Spain Festival), Best Use of Music in Film (Belgium), Silver Award (Houston), and Gold Award (Virgin Islands). In January it leaves Boston and goes to Toronto, London, and New York. "We are making a commitment to *Return* because of the highly favorable reviews the film received at the *Boston Phoenix* Film and Video Festival, where it played to a capacity house and was enthusiastically received," said Alan Friedberg, president of Sack Theaters at whose Cinema Copley Place *Return* opened.—*Sandra Knight* □

PHOTO: SILVER PRODUCTIONS



What's Boston's longest, oldest, most historic, and most visited attraction? The Freedom Trail, says Charles Bahne, '74, and he's written a book about it. **The Complete Guide to Boston's Freedom Trail** ***(published by Newtowne Publishing, Box 1882, Cambridge, MA 02238, $3.95) is full of facts, advice, maps, and illustrations of the more than 30 sites along the Freedom Trail.***

Bahne, who studied urban studies and planning while at M.I.T., has recently worked as a Boston historian with the National Park Service. It was obvious that there was a great need for this guide, Bahne points out. "The Freedom Trail today receives half a million visitors a year, and no visit to Boston is complete without a walk along it," says Bahne.

School at night. I received my J.D., cum laude, last May and am presently awaiting the bar results. I think my formal education is finally over, but with me, who can tell? I am now living in Brooklyn after four years cooped up on the Yupper West Side.

Congratulations are in order for **Martha Donahue Callaway** and her husband Michael on the birth of their daughter Sara Elizabeth, born March 17, 1985. She is their second child, little sister to Christopher. Writes Martha, "We're gettinng used to having two children, a real delight. Three-year-old Chris is a real doting big brother who is sometimes over-zealous. I'm back at work in the Air Force Reserves, making up for what I missed when Sara was small. We expect to be in California two more years; after that, who knows?"

Tony ("Bakos") Isaac has joined the Residence Inn Co. as senior vice-president of the hotel division. Prior to joining the Residence Inn Co. he was vice-president and general manager of Marriott Corp.'s Vacation Ownership Division. . . . **George Fawcett, Jr.** has been promoted to market manager for the network products area by Test and Measurement Systems/3M. Previously, he was engineering manager in the network products and the construction maintenance products departments. His 3M career dates back to 1978. Prior to joining Test and Measurement Systems/3M, he worked for Texas Instruments. Congratulations, gentlemen!

Unfortunately, that's it for this issue. Please be in touch—this inquiring mind would love to know what you are doing with your life.

One final word of thanks to **Rich McCarthy** for preparing our last two class notes columns while I was otherwise indisposed. I have already seen the October issue, at the time of this writing, and know he did a splendid job.—**Jennifer Gordon,** Secretary, 18 Montgomery Pl., Brooklyn, NY 11215

76 10th Reunion

We are sorry to report the death of **Edward S. Cooper, Jr.** in June 1985. Edward started with us but left the Tute in 1975. Our sympathy goes out to his family.

From the *Boston Herald*, we have an excellent write-up on **Joel Berez**. Joel is the president of Infocom, the leading developer of computer games. Among the games he has co-invented is Zurk, familiar to anyone who has done any hacking on DEC 10s and DEC 20s. He and some friends started the firm in 1979, after he had worked for one year at the Programming Technology Division of the Laboratory for Computer Science, and two years in his family's business. The company did $10 million in sales in 1984, which, in your secretary's opinion is outstanding for a new venture.

From the mails. **Steven Gasworth** has joined G.E. at their research and development center in Schnectady as a research scientist. Steve got his S.M. in 1981 and Ph.D. in 1985 from the Tute as well, all in electrical engineering and computer science. . . . And **William Petro** writes: "Received Ph.D. in physics from Stanford, June 1985. Am working at Fairchild Research Center doing research and development of VLSI processing. Daughter, Stephanie, born May 1984. Enjoying sailing on San Francisco Bay." . . . **Frank Ruiz** writes: "Just joined Monsanto Co. in Kenilworth, N.J., working on diaper film. It's a field, that as a bachelor, was quite new to me but quite fascinating." . . . **Deborah Stein Sharpe** has just changed jobs—she is assistant director of marketing and sales for Northland Chemical, a distributor of specialty and commodity organics in Providence. She says, "We're enjoying our return to New England and looking forward to next year's 10th reunion." . . . And from **Frederick Walter:** "Still living off the public dole, doing science in Boulder. Greetings to all the NRSA persons (or whatever they've turned into)." . . . **Burt Rubinstein** has been promoted to vice-president of Index Technology Corp. in Cambridge. He is also director of research and technology.

The *Sunday New York Times Magazine* of August 11, 1985 did a nine-page article about our classmate **Peter Hagelstein** and his contributions to x-ray laser research and its implications in the Strategic Defense Initiative (Star Wars Defense). He is, and I quote the *Times*, "father of the nuclear-powered x-ray laser," which is quite an honor. This device is the core of President Reagan's defense plans, so its importance can not be stressed enough. Being able to chronicle, no matter how poorly, our classmates' accomplishments both professional and technical, has made this job such a pleasure. Our kudos once again to Peter.

Finally, after 9.5 years, a letter from **Roy DeMeo**: ". . . I went to Princeton for a Ph.D. in topology, and after that to IDA in Princeton, then to NSA in Fort Meade, Md. . . . Well, you know where I am now? WALL STREET! To be specific, I work for Morgan Stanley as an analyst specializing in theoretical pricing of options and convertible bonds. It's a nearly 100 percent technical job, involving mainly numerical mathematics and programming in Fortran and APL. I landed this job in mid-April after a long series of Wall St. interviews which began when a headhunter called me at my parent's house out of the clear blue the day before Thanksgiving last year. I am very happy to be back in New York after such a long absence. The job is fascinating and challenging, although the hours are long (60 hours per week). I also bought a condo."

Rita and I spent a fortnight touring Israel. Jerusalem is quite a change from New York. Remember, our 10th reunion is coming this June. Amazing how so much time has passed so very quickly.—**Arthur J. Carp,** Secretary, 110-07 73rd Rd., Forest Hills, NY 11375, (718) 544-5136

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This issue I am happy to report that I received four contributions for my boring postcard collection. First, there was **Ed Nadler**'s postcard of a "cone-headed grasshopper," a comely creature, if ever I've seen one. Ed recently finished his Ph.D. in applied math at Brown University. Now he's moved to Israel to do a postdoc at the Technion for a year. . . . **Rich Perlstein** also sent me a postcard of grasshoppers, as well as one of family life in San Francisco in 1961 (Rich calls it "Back to the Future"). Rich writes, "New job with TAI Associates Architects, office in San Fran, near Union Square. Excited about being part of their office—well-respected young firm with positive ideals and an open forum for ideas." . . . Last postcard, and certainly not least boring is **Mike Geselowitz**'s contribution: an idyllic scene of the most boring farm family in the entire country of Ireland. Mike was in southwest Irleand (County Clare) doing archeological field work. He adds, "Getting psyched for the 10th Reunion."

A welcome back to my old buddy **Jean Gregory**, who writes, "I am back in the U.S., and landed in the last place I would have expected to: the Midwest. I'm working at the McDonnell Douglas Research Labs, studying corrosion behavior and (I hope eventually) fatigue micro crack propagation. St. Louis is actually a neat city. There's a yuppie section suitable for homesick Cantabrigians, and buildings from St. Loui's heyday years are being restored, rather than eliminated, giving the city an elegant look." . . . **Roby**

Rosen Marcou and **John Marcou** sent us a note to announce the birth of their son, Kevin MIchael Marcou. They also have plenty of other news: John graduated from Stanford last June with his engineer's degree in petroleum engineering; at about the same time Dr. Roby completed her pediatrics residency at Stanford. Now, after a summer off, the Marcous have moved to Anchorage, Alaska, where John is working for ARCO, and Kevin and Roby will take it easy for a while. . . . I also got a note from John's fraternity roomate, **Todd Buikema**. Like John, Todd is working for ARCO (in Dallas as a senior petrophysicist), and, also like John, Todd and his wife, Linda, had their first child this past summer. Do you guys coordinate these things or something?

Last column I wrote about the wedding of our class president. This time it's treasurer **Karyn Altman**. Karyn tied the knot with Ray Velazquez on July 20 in Boston. Of course, the crowd was filled with notables from the class and from Baker House, including **Jim Bidigare** and **Diane Curtis**, **Alan Presser** and wife Dorothy Anderson, **Sue Ann Hanson**, **Paul Malchodi**, **John Richardson** and the ever-present Jim Moody, '76. Shortly after the honeymoon, Karyn and Ray bought a house in Lynn, Mass. now Karyn is working as a full-time member of M.I.T.'s athletic department staff, coaching, among other teams, her championship women's volleyball team. . . . **Peter Coffee** announces that he is manager of planning and integration, microcomputer systems and communications at an aerospace firm in L.A. Peter and his wife, Carolyn Major, '80, are also running a software services company with the catchy name of SolveWare. . . . **Ed Lewandowski** got his Ph.D. in ocean engineering from Stevens Tech in New Jersey in 1984. Now he has gone to work for Stevens's Davidson Laboratory. . . . Lastly, there's me. My wife, Yuko, started at the Sloan School in September and is loving every minute . . . well, every other minute. As for me, I gave notice just yesterday at Blue Cross; by the time this is published I will be a planning analyst at University Hospital in the South End of Boston. I will also be trying to establish myself moonlighting, doing some light consulting for Massachusetts health care providers and agencies.—**David S. Browne**, Secretary, 50 Follen St., #104, Cambridge, MA 02138, (617) 491-5313

79

Happy New Year to you all. I hope this is a healthy and prosperous year for everybody.

I heard some good news from two friends that I met on my first day at M.I.T. First, **Sharon Gardner** and husband Tom Jacobs, '75, produced a 6 lb., 15-1/2 oz. bundle named Will Gardner Jacobs on April 5, 1985. Hearty congratulations! Sharon also pitched in recently during the Alumni Association fund-raising telethon. . . . Second, another R/O week pal, **Dan Nathan**, wrote last August (it's now late September so don't blame me for long delays in the news) to let me know that he was "getting married, changing jobs, and leaving town all at once." He says, "My wedding will be on September 8, 1985, in West Hartford, Conn., where I will be marrying Dori Bernstein, a co-alum of New York University Law School. This marriage should have gone well beyond the rumor stage and indeed may have entered some archives by now, coming at the end of a 19-month engagement, which only recently made the *New York Times*! We will be honeymooning for a month in Italy. Dori and I will set up house in Washington, D.C., where we both are starting jobs with the Feds: she with the Civil Rights Division of the Justice Department, and me at the Securities and Exchange Commission. We are both highly enforcement-minded, so people had better watch out when they are around us—we have complete authority to frisk anyone we think is hiding something!" Before the move, Dan was an associate with the law firm of Kaye, Scholer, Fierman, Hays, and Handler in New York City. Congratulations, Dan, and never let it be said that you like to take things one step at a time!

David Fillmore finished his M.D. at Yale in 1984 and has bought a house in Tucson with fellow ex-Bexleyite Russ Chipman, '76. David is doing a diagnostic radiology residency at the University of Arizona, and is keeping busy planting trees in his backyard and taking advantage of Tucson's excellent biking and hiking weather.

Paul Denney worked for four years for the Naval Research Lab in Washington, D.C. He writes, "In May, I got the chance to 'jump ship', so to speak, and go to work for the private sector with Westinghouse Electric Corp. R&D Center in Pittsburgh (yes, I've been told several times that I would be moving to the Number 1 city in the U.S.). The group that I work for is involved in the application of high power lasers in materials processing, which is what I was doing in the navy. The switch to private industry has been enjoyable, as has been the city of Pittsburgh. I'm living in the Yuppie part of town (Shadyside) and have joined an athletic club downtown. I've switched from my days of M.i.T. crew to running, squash, and Nautilus. I'm thinking about continuing my Ph.D. work (I was going part-time to George Washington University when I was in D.C.). By the time you read this, I will have been home to Missouri for my high school's tenth reunion.

"In between jobs, I went to visit **Tom Potter** and Sandy McCarley, '80, while they were on their Peace Corps mission in the Seychelles (a group of islands off the east coast of Africa). That's the place where they filmed the Bo Derek version of *Tarzan* and the new movie *Pirates*. The two weeks there were really great. I doubt that all Peace Corps assignments are as good as what Tom and Sandy have. They have a nice home with electricity, a brewery on the island, and a collection of Bruce Springsteen tapes. (Hey, what more could you ask for?!) Tom works for the government's transportation departmenet doing such things as designing parking lots near the market areas, building bus terminals, and planning and installing road signs (it's difficult because they drive on the left). He is also coaching a basketball team. Sandy works for the water department in the planning and building of water treatment systems on the different islands. She is also trying to continue her work in acid rain by setting up a sampling center on the island before they leave next year. Another ex-Bakerite, **John Thayer**, is managing the diesels that are used to generate the electricity for the island."

Mark R. Schwartz wrote to announce the birth of Rebecca Lynn on December 7, 1984. Mark and wife Sharon already have a 3-year-old, Matthew. Says Mark, "They are quite a handful. I don't think we'll have any more—one of each is plenty! We are finishing up our tour at Seymour Johnson Air Force Base in Goldsboro, N.C. In two weeks we will head south to Homestead AFB, Florida, where I will be an F-4 instructor pilot. They will be getting the newest fighter jet, the F-16, at Homestead within the next year or two, and I hope to be flying one soon. My old Baker House roommate, **Mark Stern**, came for a visit in July. He was in Raleigh, N.C., on business, and came over for dinner. He is working for IBM in Boca Raton, Fla. I was unable to attend our 5th reunion due to military duties, so Mark filled me in on how everyone was doing."

Mark also has more information on the death of classmate **David Erwin Miller** on July 1, 1985. "Dave and I were in AFROTC together, and he was cadet group commander during our senior year. He served his tour on active duty as a flight test engineer, and then got out of the air force. He elected to join the air national guard as an F-4 weapons system officer and was undergoing F-4 flight training at McConnell AFB, Kansas. I had not seen or talked to Dave since graduation, but I serve as my squadron's flight safety officer so I receive reports on all F-4 accidents. It was in this way that I learned of Dave's death in a flight mis-

Tom Potter, '79, and Sandy McCarley, '80, hold one of the largest coconuts in the world. This coco de mer, weighing about 45 pounds, grows only in the Seychelles, a group of islands off the east coast of Africa, northeast of Madagascar. They are in the Seychelles on a Peace Corps mission, Tom working for the government's transportation department and Sandy for the water department. **(See class of '79 column, this page.)**

PHOTO: PAUL DENNEY, '79

hap. The report noted that Dave was considered exceptionally smart by his colleagues and instructors and had finished at the top of his class in all his military training courses." Thank you, Mark, for the information.

As for your faithful secretary, I am settling into my new job. As you may recall, as of July 1 I became the supervisor of Mobil's telephone network control center. I'm located just down the hall from where I worked before, but the atmosphere is quite different. Mobil has it's own private-line voice and data network which spans the U.S. and has recently added some European locations. The Control Center receives trouble reports from all Mobil locations that are on the network and deals with the vendors (such as AT&T) to implement repairs and changes. There's never a dull moment, and just when you think it's a slow day, some location will go down completely. I'm certainly learning a lot, and it's the first time that I have people reporting to me. All in all, I've got more gray hairs but I'm never bored!—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

82

Hello, Classmates! **David Humphreys** was married last year to Sharon Dorn, a native of Seattle, Wash. and a Chem. Engineering graduate of University of Washington (1984). David says she is "an artist, a scholar, and a beauty." David himself is still in physics grad school at M.I.T., hoping to finish by 1987. . . . Postcard of the Month goes to **Mat Womack** for his lovely photo of the beautiful downtown Boulder, Colo. mall. Mat was in Boulder, along with **Danny Rubin** and **Dave Kieda**, to attend the wedding of **Damon Clark** to Lori Decker. Also at the wedding were Mark Fink '81, Steve Hoberman '80, and Steve's wife Mindy. Damon "picked up" a master's at Stanford and is a consulting software engineer. Danny is an application's engineer in the Boston area. Dave is getting his Ph.D. at the University of Pennsylvania, and Mat is still in Houston as an engineer for Goodyear. . . . **Hajime Sano** is keeping himself busy with work, ice speed skating (even in LA!), helping out with Cal Tech hockey, and being an M.I.T. Educational Counselor. Hajime was back in Boston for the Theta Xi M.I.T. Centennial and was quite impressed with all the changes that the city, the 'Tute, and Theta Xi have undergone.

Anne Serby received her J.D. last year from Hofstra University. For fun, she is an M.I.T. Educational Counselor on Long Island. . . . **John Ritter** was married to Jane Viera. Jane graduated from Worcester College and is assistant director of Crisis Line Open house at the Cape Fear Substance Abuse Center. John is a development engineer for Corning Glass Works in Wilmington, N..C. . . . **Larry Wooters** is working at Genetic Institute in Cambridge. . . . By the time this column gets to you, **Stephen Bart** should have received his master's in electrical engineering from M.I.T. . . . **Michelle Gabriel** writes that she, **Elena Rozier**, and **Lucinda Linde** descended upon the hotel room of **Eric Leiser** for a wild July 4th weekend in San Jose. Eric is now leaving the country, for Merck in Germany. The "Fab Four" ate their way from Castro St. to Polk in San Francisco, ending up in Alcatraz. On Saturday they were joined by Carl Linde, '85, in a decadent evening at Marrakesh Palace. Waving $100 bills, Carl went wild, in the den of iniquity, stuffing money down the cleavage of the belly dancers. P.S. Lucinda is at Harvard Business School and worked for HP for the summer. Elena is a first Lieutenant in the Marine Corp. and will be going to Okinawa soon.

Ralph Inglese married Laurie Miller, Simmons '82, a couple of years ago. They toured Italy for their honeymoon and loved every minute of it! Ralph is working as an engineer at Intel in Sacramento. He was visited last February by fellow alums **Bruce Peacock**, **Mitch Rosenberg**, **Jeff Sakaguchi**, **Dave Harrahy**, and **Rich White** for skiing in Lake Tahoe, Nev. . . . **Rhonda Peck** is at the UCLA Graduate School of Management. I ran into **Ben Wise** and **Phillip Apley**, who were attending an AI conference at UCLA. Ben is working on his Ph.D. at the Carnegie-Mellon School of Engineering and Public Policy. He hopes to be out any day now. He married Kim Denney, who is a management consultant for Arthur Andersen. They have a dog name Quinn. Ben is working on experimental comparisons of ways of reasoning with uncertainty and also on distributive problem solving. Phillip is working on digital typography on LISP machines at BITSTREAM. In his spare time he studies parallel architectures. Also in an architectural vein, he just bought a house in Allston with a hot-tub and a trampoline. He's offering free trampoline lessons to anyone with a brass rat. . . . Well write to me soon at my new address or call if you're in town.—**Rhonda Peck**, 11728 Mayfield Ave., No. 4, Los Angeles, CA 90049, (213) 820-0964

83

Happy new year, fellow classmates. I hope 1985 was good to all of you. Did you make any new year's resolutions? I am sure I have mentioned how difficult it is to write this column several months in advance of publication. It is currently October, for example, and I am trying to set my mode for next year.

Two letters I received in the last four months were incorrect, one signed from **Ken Dumas** and one from **Mike Lopez**. Mike called to say he never wrote a letter to me. He says he recently married and is now attending business school at the Univeristy of Michigan with his wife. He spent this past summer working for Mobile in New York City. Congratulations on your recent marriage, Mike, and good luck! . . . Since **Ken Dumas** also did not write the letter I received, I am not sure where he is. Ken, drop me a line if you get the chance. I hope things are going well.

Our celebrity '83 of this issue goes to none other than **Karl Frey**. Karl first shocked the M.I.T. community a few years back with his profound comments regarding a homecoming queen at M.I.T. Karl said that homecoming nominations should be opened to Boston College because it was the best looking campus in the U.S. (He was the star pupil of the Eric Johnson School of Pretty Women.) Unfortunately, Karl's desire for open nominations was not met but his quest for a BC bride was. Yes folks, this is the truth. Karl has turned in his amateur status and has gone pro. It was only four years ago that Lisa Fitzpatrick climbed throrugh the packed BC stadium to get to Karl's lap. I guess it was love at first sit. I know I am speaking for the entire M.I.T. community when I say good luck. Congratulations!

John Taylor will be attending his second year at University of Pennsylvania Medical School. He says he has been spending a great deal of time in lab research and has set his sights on coming up with a cure for cancer. "At first," John says, "I was turned on by all of the money that I could extract as a doctor, or even a surgeon, but I soon began to realize that all doctors are rich, but not all are famous." With JT's new quest for the cure, he has had little time for many outside activities. He has decided to dedicate his energies to the Cancer Research Club, of which he is president, the church bible study group, and his lovely wife Maria.

Al Bashawaty has decided to celebrate September 26 as the worst day of the year from now on. It seems that Al had all of his possessions stolen from a locker in Penn Station while attending a Morgan Guarantee boat cruise. Al and the other members of Morgan were celebrating the completion of their training program. Al says that he did not mind having to replace his wardrobe because he will need a new set of threads for his next assignment in the accounting department, FAD. While describing the event, Al tells me that he didn't just lose his possessions, he lost his identity. Sorry to hear that, Al. Good luck in FAD!

As for myself, things here have been crazy. I accepted a new position in Long Island with IBM. I finally completed my training at the end of September. I was placed on Quota October 1. It looks like it is going to be a lot of fun. I certainly do no miss standing in hot subways. I hope all is well with everyone. Please write and send me some more news.—**John E. De Rubeis**, Secretary, 47 Gillette Ave., Sayville, NY 11782

85

Hello again, beloved classmates! I had the great pleasure this month (September) of meeting with some fellow classmates and many other alumni at the National Alumni Conference in Boston. I confess, I had a super time—not just getting together with **Inge Gedo**, **Larry Shapiro**, **Dave Libby**, and other recent grads, but also with the older alumni. I encourage everyone to contact your local club (the Alumni Association can give you the number) and see what events they have planned. They sponsor seminars, luncheons, parties, and more; you are also welcome to organize an event you'd like to happen. Anyway, now that I've sold you on that idea—which you'll hear more about in our class newsletter coming out soon—I'll move on to the latest news on you folks!

In California **Adrian Wang** had a memorable trip to Redwood National Park with a friend from Wellesley—they were chased out of the woods by a bear cub! **Gary Wyetzner**, on the other hand, is busy at University of Southern California studying? Oh no, he's been chasing those women like that "fluffy" bear cub! In fact, Gary is having such a great time that he has convinced **Aaron Wang** to join him and others in southern California.

Although I haven't heard from many classmates, I have received many address updates from your parents. **Michael Wall**'s mother wrote a delightful letter with his address, which happens to be a couple blocks away in Sunnyvale! Please let me know where you are—you might be surprised that another recent grad is nearby. If anyone is passing through the Des Moines area, **J. Michael Druding** would love to see you. He was relocated to Iowa State University in Ames, Iowa (9153 Buchanan Hall) after a summer working for Corning. He makes up 12.5 percent of the first year chemistry grad students and hopes to receive a Ph.D.

While in Boston I stopped by the alley party at Kappa Sig and ATO. I saw **Aaron Wang**, **John Newton**, and **Steve Creighton**. Steve was a real surprise, last time we ran into each other on the street in Berkeley! Now he plans to fulfill his lifelong fantasy of living in Japan.

Here's the update on the guys from PBE: **Scott Dudevoir** is at the University of California, Los Angeles, attending medical school (studying anatomy no doubt!). . . . **Jay Elson** is with the E.I.P. at Los Alamos Labs in New Mexico. . . . **Sam Cable** is at University of Texas at Austin studying physics. . . . Also in Texas is **Steve Martin** finishing his VI-A with TI while finding time to get engaged to Caroline Adamaidis from Simmons. . . . Some people have graduated and joined the ranks of the employed. **George Fan** is in Atlanta working for IBM in technical marketing and **Ron van Veen** (the maker of "unrememorably" good margaritas) is in Philly working for Burroughs. . . . **John Ragan** is studying chemistry at Yale near four of his fraternity brothers who remained at the 'Tute. . . . **Frankie Law** is researching "ice flows." . . . **Dave Karohl** is attending practice school in Course X. . . . **Ted Clampitt** is in Course VI grad school. . . . **Jaime Guillen** is back in Cambridge recovering from a year at the University of Lowell.

Finally, even if you don't have anything to write about, let me know what someone else you know is up to! It will fun for them to read! —**Stephanie Scheidler**, Secretary, 2 Carver St., Apt. B, Somerville, MA 02143, (617) 629-2069

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Whether the occasion was a seminar with Robert Frost in 1947 (top) or a panel on the vitality of American theater in 1985 (below), the adherents of Course XXI have been intense about their humanistic values.

Celebrating 30 Years of Course XXI

Alumni of Course XXI admit to experienceing a level of "bunker fever" surrounded as students, by a science-and-technology-oriented community.

It must have been particularly gratifying, then, for them to hear that their humanistic values are being accorded more weight than ever before in present discussions of curriculum change at M.I.T.

Speaking at the Course XXI 30th Anniversary Convocation in October, Professor of Literature Irene Tayler reported that an impetus to change the undergraduate curriculum is coming from both the technological and the humanistic departments, and it is being nurtured by a network of committees in the schools and the Provost's Office.

"You have come out of M.I.T. having experienced a greater range of educational opportunity than some of the engineers and scientists," she said to assembled graduates of the humanities program. "Please tell us what you believe were the strengths of your educational experience . . . What was missing?" She urged alumni to write to her on the subject.

Tayler was one of nine speakers at the panel discussion which was the high point of the convocation program. Other events exposed participants to materials research in archeology, pioneering efforts to use computers in language teaching, the debate on the vitality of American theater, consideration of the Middle Eastern view of the U.S., and almost an excess of riches in the way of student musical and dramatic offerings.

The panel focused on the current status of relations between the "two cultures," some 30 years after C. P. Snow wrote his seminal book. It was clear that finding a wise and satisfying balance between technology and the liberal arts, in one's life or in an educational program, is still a subject of intense concern and a goal of considerable difficulty.

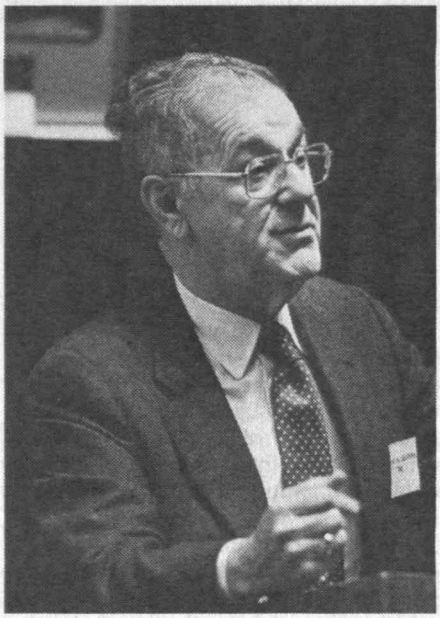
We can only give a sampling of the panelists' remarks:

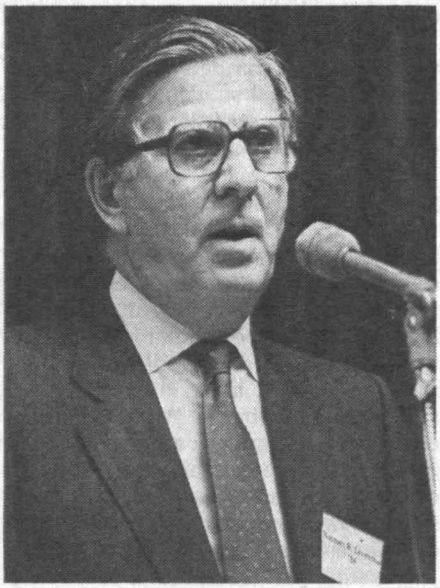
"Snow made the point that the major change in recent history has been the explosive growth of science and technology, while those who govern us are largely ignorant of it . . . Rather than talk about scientists versus humanists, the real issue is the relative ignorance of each of the society in which they both live . . ."—*Anthony French, professor of physics.*

"The most memorable aspects of my own college education partook more of play rather than work, specifically playing chamber music and sports . . . A mind that is early immersed in beauty and logic and a body capable of alertness and endurance are good receptacles for whatever else you want to put into them . . . I was happy to discover that Plato agreed that these were good places to start . . ." —*John Harbison, Class of 1949 Professor of Music.*

"I think the way to deal with C. P. Snow's two cultures is to declare victory. . . . (Thanks to the pervasiveness of computers) we have turned people with liberal educations into engineers, applying technology to solving problems . . . Scientific and humanist intellectuals *can* communicate—they use a modem!"—*George McQuilken, '65, chairman of the board of Spartacus Computers.*

PHOTOS: M.I.T. MUSEUM; FRANK REVI, '86; BRADFORD HERZOG





At its 1985 meeting last fall, the Corporation Development Committee (CDC) paid tribute to three of its members (counterclockwise from above): James R. Killian, Jr. '26, received a special citation for his lifetime of devotion to the Institute, as chronicled in* The Education of a College President. *Samuel A. Goldblith, '40, was saluted for 11 years as vice-president—resource development (see article below). And the CDC's Dalton Award went to Norman B. Leventhal, '38, for "exceptional service to M.I.T.," including presidency of the Alumni Association. Leventhal, member of the CDC since 1970, is a Lifetime Member of the Corporation and was a key figure in establishing the Center for Real Estate Development.

"Last semester I took a seminar from Salvador Luria called 'Perspectives About Life and Biology.' Luria used art and poetry to talk about science, and science to explain art and poetry. That was beautiful, and if more courses at M.I.T. were taught like that, we would be (truely) educated."—*Lauren Seeley, '86.*

"What is missing (in education) is the kind of initial sensual immersion in the nature of the world, rawly taken, before you start discussing it . . . Often in science the thinking refers back to real things in the experience; without the experience, it's like a eunuch talking about love . . . I would abolish the first year and replace it with laboratories and playgrounds and other sensual things, rather than the immediate immersion into learning a great deal . . ."—*Jerome Lettvin, '47, professor of communications physiology.* □

Simonides Adds Corporation Duties

Constantine B. Simonides, '57, vice-president of M.I.T., has a new assignment: he is now also secretary (and ex-officio member) of the Corporation, succeeding in those duties Vincent A. Fulmer, S.M.'53, who retired after 34 years of service.

As vice-president, Simonides has served as secretary of the Executive Committee of the Corporation since 1971, and he was thus "a natural choice to assume the formal responsibilities of the secretary," says President Paul E. Gray, '54. As vice-president, Simonides is the senior officer for admissions, athletics, career services, personnel, the Medical Department, campus and external information services, and the M.I.T. Press. He says he will delegate some of the "complex tasks" of supporting the Corporation and its visiting committees to a professional staff that is now being recruited.

"Our goal is to harness the energies of trustees, alumni, and other friends of M.I.T. in the service of this university," Simonides said in his first appearance before the Corporation as its secretary. □

Goldblith Retires

After eleven years of outstanding success, Samuel A. Goldblith, '40, is stepping down as vice-president—resource development. He'll return to teaching in the Department of Applied Biological Sciences next June but will give continuing attention to M.I.T.'s development efforts in Japan and Europe as part-time senior adviser to the president.

President Gray credits Goldblith with "remarkable skills in organizing and managing the essential and never-ending task of raising funds."

Goldblith assumed the vice-presidency in 1978, when his first task was to complete the last two years of a five-year Leadership Campaign that ultimately exceeded a $225 million goal by $25 million.

Since then he has designed and led an effective development program and been centrally involved in the generation of increased gifts from overseas.

Goldblith's first assignment in the development area was as director of the Industrial Liaison Program from 1974 to

1978, when ILP more than doubled the number of companies enrolled. □

Haystack: Two Decades of Leadership

For two decades, the 150-foot white radome has been a landmark in Westford, Mass.—a huge white golf ball towering 14 stories amid the treetops to mark the site of the M.I.T. Haystack Observatory. It is the largest enclosed radio telescope in the world.

The radome encloses a fully steerable, 120-foot dish antenna, which was designed, built, and operated in the 1960s by Lincoln Laboratory. In 1970 it was turned over to a consortium of universities known as the Northeast Radio Observatory Corp. (NEROC). M.I.T. operates Haystack under agreement with NEROC.

Teams from 30 to 40 universities or scientific institutions worldwide work at Haystack annually, and last summer the observatory hosted astronomers from across the United States, Europe, Canada, Mexico, and Japan for a conference marking its 20th anniversary.

Today Haystack is used in three different modes:

□ As a radio telescope, Haystack picks up signals at frequencies up to 50 gigahertz emitted by distant stellar objects. It monitors galactic masers, molecular matter in intersteller space, and moving clouds of gas in regions where astronomers believe new stars are forming.

□ Haystack operates in tandem with other radio telescopes in the United States, Europe, and Japan as part of the very-long-baseline-interferometers (VLBIs) that can produce results ranging from high resolution, astronomical maps of quasars to geodetic data so precise as to reveal the motion of the Earth's plates and changes in the Earth's rotation rate. For VLBI applications, Haystack has one of the most powerful correlators to interweave and analyze data taken simultaneously by all participating observatories.

□ Haystack can be also used as a radar system. In this mode, it generates a 10 gigahertz microwave beam and detects echos returned by reflection from the moon and planets.

"It is Haystack's flexibility and the versatility and competence of the staff that have made it so valuable to astronomers and other scientists," says Joseph E. Salah, Haystack director.

Still Tracking Satellites

Most of the radar mapping that Haystack once did has now been transferred to the radio observatory at Arecibo, Puerto Rico, so about half of Haystack's time is spent in the mode of a single radio telescope, observing and measuring celestial objects. Another 25 percent is devoted to work as part of a VLBI network. And Lincoln Laboratory still claims 10 percent of Haystack's time for satellite tracking and space communications research, says Salah.

Haystack originated the idea of a global measurement program focused on the Earth's thermosphere during 1984-85. The study was headed by William L. Oliver, Jr., a research scientist at Haystack, and Dr. Salah, and it involved 30 radar and optical instruments in 14 countries, including the U.S.S.R. The first results were reported at Haystack last summer.

The thermosphere, which is 90 to 1,000 kilometers above the Earth, is the region where satellites operate, and their orbits are affected by variations in the density of thermospheric gases. Moreover, ionized particles produced by solar radiation in the thermosphere feed into the higher ionosphere, where they have an impact on radio propagation and communications. □

M.I.T. Loses Innovator in Giving Programs, Inspired Teacher of Energy Issues

David J. Rose, 1922-1985: A Holistic View of Technology and Society

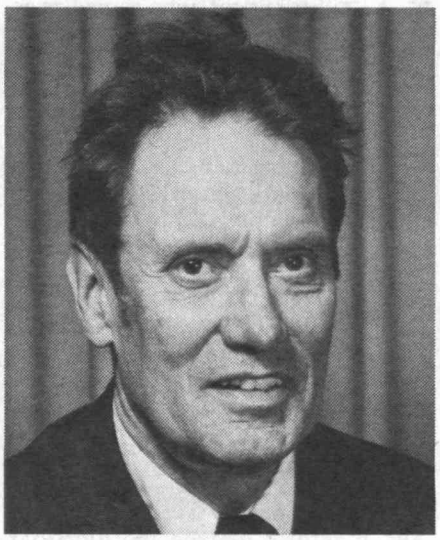
David J. Rose, Ph.D.'50, professor of nuclear engineering who had unique concerns for the interaction of social institutions and technological change, died on October 24 at Mt. Auburn Hospital, Cambridge. He was 63, the victim of a long and courageous struggle with emphysema.

Of many tributes, it was probably the simplest that would have appealed most to Rose: ". . . the best teacher I ever had at M.I.T.," wrote Simson L. Garfinkel, '86, in *The Tech*. "His subject (Energy—22.08) was the single most influential subject in determining . . . my future."

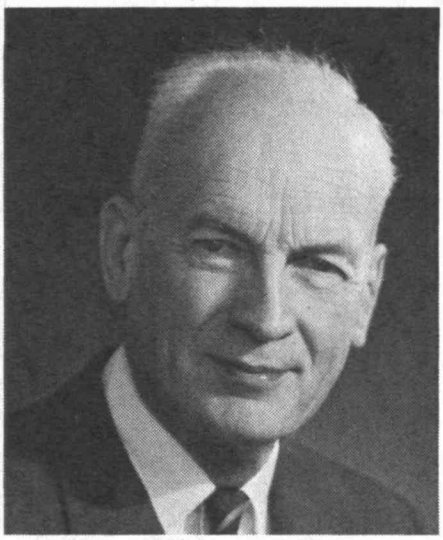
Writing for *Tech Talk*, one of Rose's faculty colleagues paid tribute to his "forceful and persuasive expounding of the fundamental indivisibility of the environmental and energy problems, their transcendence of regional, national, sectoral, and disciplinary boundaries, and the limited capability of existing institutions to address effectively holistic problems of this kind." Four years earlier, when citing Rose for the 1979-80 James R. Killian, Jr., Faculty Achievement Award, the selection committee noted that "a recitation of his accomplishments is incomplete and sterile unless accompanied by the prophetic dynamic of his personality that is integral to those accomplishments."

Rose, a native of Victoria and a graduate of the University of British Columbia, cherished his Canadian heritage but made his entire career in the U.S. after coming to M.I.T. He worked for several years at Bell Laboratories after receiving the doctorate in physics, returning to Cambridge in 1958 to organize a program of teaching and research in controlled thermonuclear fusion.

After 1970, when he was on leave as founder and first director of the Office of Long Range Planning at Oak Ridge National Laboratory, Rose turned his attention to a whole range issues raised by technological change. By 1976 he was associated as a consultant with the World Council of Churches, and he was a principal architect of that organization's 1979 world conference at M.I.T. on "Faith, Science, and the Future."



D. J. Rose



D. F. Carpenter

Rose retired from the M.I.T. faculty a year ago but continued part-time teaching while working also at the East-West Center in Honolulu.

Donald F. Carpenter, 1899-1985: Adviser to Five Presidents

Donald F. Carpenter, '22, whose record of service to the Corporation and to the Alumni Association has few parallels, died on September 28 in Mendenhall, Pa.; he was 86.

Carpenter's association with his alma mater was long, varied, and innovative. The foundations for this active role were laid as an undergraduate, when Carpenter was a class officer, editor of *Technique*, and contributing editor of *The Tech*. Less than a decade after graduating, Carpenter became a key figure in expanding the Institute's visiting committees, serving on many.

By 1943 he was a member of the Corporation, on which he continued active participation for the rest of his life. In addition, he was for 12 years a member of the Executive Committee, the 71st president of the Alumni Association (1964-65), and a founding life member of the M.I.T. Sustaining Fellows.

Carpenter was the first to establish a deferred giving program at M.I.T., and he was instrumental in creating the Class of 1922 Professorship and the Class of 1922 Career Development Professorships, in each case the first class project of its kind. He was awarded the Bronze Beaver in 1966.

Carpenter had a long and successful career with E.I. du Pont de Nemours and Co., which he joined upon graduating in general engineering from M.I.T. By the beginning of World War II he was vice-president and assistant general of Remington Arms Co., a du Pont subsidiary, and after government service during the war he returned to major responsibilities in the Wilmington headquarters, retiring in 1963 as general manager of the Film Department.

Billy E. Goetz, 1904-1985

Billy E. Goetz, emeritus professor of management in the Sloan School, died on September 26 of a heart attack in Santa Fe, N.M., his retirement home; he was 81.

Goetz came to M.I.T. in 1954 with de-

grees from the University of Chicago and teaching experience at Chicago, Buffalo, Illinois Tech, American University, and Antioch. He specialized in production management and managerial accounting, giving special attention to the information needs of managers for effective planning and control.

Following his M.I.T. retirement, Goetz continued teaching at Florida Atlantic University until 1975, when he moved to Santa Fe.

William Speer, 1911-1985

William Speer, who served as associate dean at M.I.T. for 22 years beginning in 1953, died of respiratory failure in a Bryn Mawr, Pa., nursing home on September 29; he was 74.

Before coming to M.I.T. as associate dean of students, Speer had been headmaster of the Loomis School in Windsor, Conn. and director of admissions and director of student life at Rutgers. In 1956 he became M.I.T.'s first associate dean for student counseling, the title he held upon retirement in 1975. Speer was a graduate of the Hotchkiss School and Princeton (A.B. 1933).

Robert Lockett, 1955-1985

Robert Lockett, a candidate for a master's degree in the Sloan School of Management, died on October 7 after a long illness; he was 30.

Lockett came to M.I.T. in 1980 for graduate study in mechanical engineering, having completed B.A. and M.S. degrees in that field at Rice University. He was an industrial liaison officer from 1980 to 1983, then returned to full-time graduate study, this time in management.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

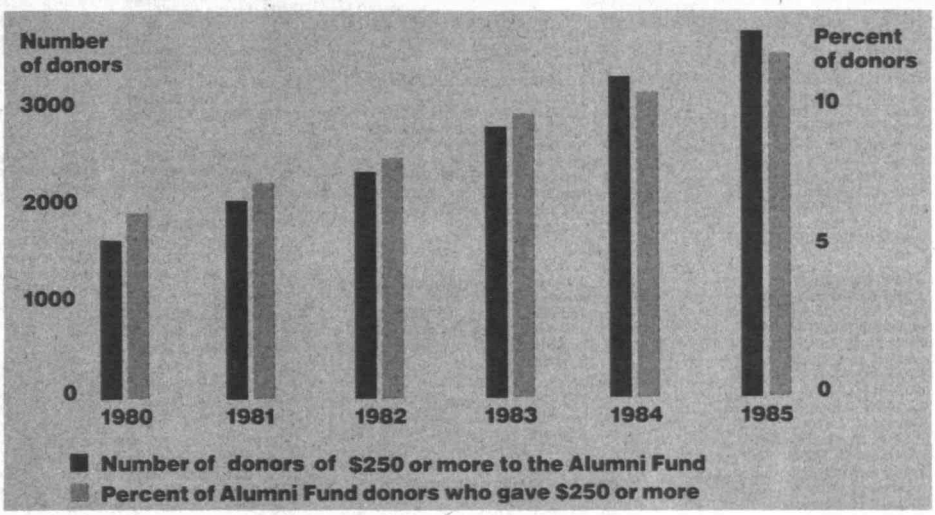
Hazel J. Goodrich, '98; February 24, 1976; Palm Springs, Calif.
Florence H. Luscomb, '09; October 27, 1985; Watertown, Mass.
Joseph L. Champagne, '12; September 17, 1985.
William G. Horsch, '13; April 2, 1985; Delran, N.J.
John T. Bauer, '15; 1978; Mobile, Ala.
Myron H. Clark, '20; June 22, 1985; Farmington, Conn.
Edward Cousins, '20; September 20, 1984; Akron, Ohio.
Josiah D. Crosby, '21; September 28, 1985; Sarasota, Fla.
Donald Fell Carpenter, '22; September 28, 1985; Mendenhall, Penn.
James H. Evans, '23; August 15, 1985.
Albert A. Gordon III, '23; September 26, 1985; South Yarmouth, Mass.
Willard J. Allphin, '25; September 30, 1985; Danvers, Mass.
Albert Newman, Jr., '25; August 15, 1985; Stratford, Conn.
Francis A.J. Brown, '26; April 17, 1985; Lancaster, Penn.
Ward L. Hamilton, '26; August 1985; Rochester, N.Y.
George S. Killam, '26; May 11, 1985; Chatham, Mass.
John E. Jacobson, '27; September 14, 1985; Texas City, Tex.
James D. Green, '28; August 9, 1985; Chicago, Ill.
Jue T. Hu, '28; October 7, 1985.
Carl M. Loeb, Jr., '28; August 13, 1985; Greenwich, Conn.
Arthur R. Babcock, '29; August 27, 1985; Crystal Falls, Mich.
Ralph C. Young, '29; October 5, 1985; Phoenix, Ariz.
Emilio N. MacKinney, '30; February 25, 1985; Mexico DF 21 177, Mexico.
John A. Fellows, '32; October 19, 1985; Glendale, Calif.
John E. Meade, '32; October 18, 1985; Lexington, Mass.
John A. Osterman, '32; July 30, 1985; Darien, Conn.
Rolf V. Wallin, '32; April 10, 1985; Whispering Pines, N.C.
Dupuy F. Cayce, '33; March 30, 1984; Paradise Valley, Ariz.
Bruce J. Ennis, '33; October 3, 1985; Kansas City, Mo.
J. Bassett McLean, '33; July 1, 1985; Bath, Maine.
Frederick W. Vaughan, '34; August 1985; Islip, N.Y.
Frederick R. Haigh, '35; 1984; Sarasota, Fla.
James D. Parker, '35; September 29, 1985; Riverside, Conn.
W. Vernon Osgood, '36; March 7, 1985; Kaneohe, Hawaii.
Winthrop A. Stiles, Jr., '36; May 21, 1985; Aptos, Calif.
R. Spencer Rutherford, '37; August 1, 1985; Harford, Penn.
Myron A. Cantor, '39; February 9, 1985; San Diego, Calif.
Peter W. Shunk, '39; June 17, 1985; El Paso, Tex.
Richard O. Spalding, '40; September 11, 1985; Fremont, Ind.
William Alden Brockett, '43; 1984; San Diego, Calif.
Carl R. Hirschberger, '43; July 9, 1985; Fitzwilliam, N.H.
Carl Lindeman, Jr., '44; 1985; South Freeport, Maine.
Alexander S. Goodfellow, '46; 1985; Coronado, Calif.
Erman A. Pearson, '47; August 31, 1985; Lafayette, Calif.
John H. Hughes, '48; August 24, 1985; Marion, Mass.
Priscilla M. Endicott, '49; July 1985; Essex, Conn.
James Joseph Beach, Jr., '50; August 27, 1985; Garden City, N.Y.
David J. Rose, '50; October 24, 1985; Cambridge, Mass.
Robert E. Wohler, '50; 1985; Norwood, Mass.
Edward E. Adams, '52; July 19, 1985; Palo Alto, Calif.
Warren L. Whalley, '53; October 3, 1985; Tulsa, Okla.
Allan Harris James, '54; September 4, 1985; Salt Lake City, Utah.
George F. Smith, Jr., '55; August 28, 1985; Pittsburgh, Penn.
Harry F. Huf, '57; April 30, 1981; Warminster, Penn.
John W. Lindner, Jr., '57; August 31, 1985; Los Angeles, Calif.
Robert N. Watts, '57; October 10, 1985; Westfield, N.J.
Egon Sohmen, '58; 1985.
Charles E. Hammond, '60; June 2, 1985; Branson, Mo.
E. Viet Howard, '61; July 22, 1985; Boise, Idaho.
Claus A. Wulff, '62; September 18, 1985; Essex Junction, Vt.
William H. Foley, Jr., '65; October 18, 1985; Arlington, Tex.
Rafael Lusky, '72; 1985.
Thomas W. Aplington, '77; March 16, 1985; Peoria, Ill.
Robert R. Lockett, '85; October 7, 1985; Cambridge, Mass.
Randall "Brad" Smith, '86; September 1985; Owensboro, Ky.

Recognizing Our Friends: Sustaining Fellows, President's Fund, Great Dome Associates

Sustaining Fellows as of July 1, 1985

The M.I.T. Sustaining Fellows program was established in 1979 to recognize individuals whose support of the Institute is particularly exemplary. Sustaining Fellows membership is extended to alumni and other friends of M.I.T. making annual gifts of $3,000 or more for unrestricted purposes, endowment, professorships, or student aid. Life membership is offered to donors whose cumulative gifts exceed $25,000. Donors requesting anonymity are not shown.

In all, 3,244 alumni boosted the 1985 Alumni Fund with gifts over $250—more than double the number of such gifts received in 1980. □



"Upgrading" has been a key goal of the Alumni Fund since 1980—increasing the number and level of major gifts. The chart shows the program's success—doubling the number of gifts of $250 or more in the five-year period since 1980.

Founding Life* and Life Members

1908
Mr. and Mrs. Harold S. Osborne*

1912
Mrs. John W. Connolly*

1913
Mr. Julian E. Adler*

1914
Mrs. Vashti L. Magoon*

1915
Mr. C. Ellis Ellicott, Jr.*
Mrs. Edmund R. Stearns*

1916
Mrs. J. B. Carr*
Mr. Barnett D. Gordon*
Mrs. Francis E. Stern*

1917
Mr. and Mrs. Walter J. Beadle*
Mr. A. Raymond Brooks*
Mr. E. P. Brooks*
Mrs. Stanley M. Lane*
Mrs. Richard T. Lyons
Mrs. William H. McAdams*

1918
Mr. and Mrs. Julian M. Avery*
Mrs. Malcolm J. Baber
Mrs. John W. Kilduff*
Mr. and Mrs. Max Seltzer
Mrs. Harold C. Weber

1919
Mr. Benjamin H. Bristol*
Mr. and Mrs. Royden L. Burbank*
Mr. John L. Riegel*
Mrs. Dean K. Webster, Jr.*

1920
Mr. Henry W. Hills*
Mr. and Mrs. Edwin D. Ryer*
Mr. and Mrs. L. G. Thomas*

1921
Mr. T. B. Davis*
Mr. Sumner Hayward
Mr. Irving D. Jakobson*
Mr. Samuel E. Lunden*
Mr. and Mrs. Edmund J. MacDonald
Mr. Robert L. Moore*
Mr. Donald G. Morse
Mr. and Mrs. Antonio Helier Rodriguez*
Mrs. Raymond A. St. Laurent*
Mrs. Arthur G. Wakeman*
Mr. and Mrs. Robert E. Waterman

1922
Mr. and Mrs. Edward L. Bowles*
Mr. Crawford H. Greenewalt*
Mr. Oscar H. and Mrs. Mary C. Horovitz*
Mr. and Mrs. Albert J. R. Houston*
Mr. H. W. and Mrs. S. Catharine McCurdy*
Mr. Theodore T. Miller*
Miss Marjorie Pierce
Mrs. Thomas H. West*

1923
Mr. and Mrs. Jonathan Y. Ballard*
Mrs. Philip L. Coleman*
Dr. and Mrs. Cecil H. Green*
Mr. Earle A. Griswold*
Mr. and Mrs. Harry Kalker
Mr. Ragnar and Mrs. Margaret Naess*
Mrs. David W. Skinner*
Mr. and Mrs. Robert C. Sprague*
Dr. and Mrs. Julius A. Stratton*
Mr. Chaplin Tyler

1924
Mr. and Mrs. Edward A. Abdun-Nur
Mr. and Mrs. Philip Blanchard*
Mr. Harry G. Burks, Jr.
Mr. and Mrs. Austin G. Cooley*
The Honorable Luis A. Ferre*
Mrs. Edward J. Hanley*
Mrs. Andrew P. Kellogg*
Mr. Herbert W. Kochs
Mr. Louis Sudler
Mr. Paul Tishman*

1925
Mr. John M. Campbell*
Mr. Edward H. de Coningh
Mr. and Mrs. Frederick W. Greer*
Mr. and Mrs. Edwin E. Kussmaul
Mr. Edward M. Lee
Mr. and Mrs. Samuel R. Spiker*
Mr. Donald R. Taber
Mr. and Mrs. Karl R. Van Tassel*
Mr. C. L. Zakhartchenko

1926
Mr. and Mrs. George E. Armington
Mr. and Mrs. Leonard Block
Mr. and Mrs. Robert T. Dawes*
Mr. and Mrs. William E. P. Doelger*
Mr. George P. Edmonds*
Mr. William A. Forrester, Jr.
Mr. and Mrs. Eben B. Haskell*
Mr. John B. Jacob
Mr. I. Austin Kelly III*
Dr. and Mrs. J. R. Killian, Jr.*
Mr. John R. Kimberly*
Mrs. George J. Leness
Mr. and Mrs. Henry C. Rickard
Mr. and Mrs. Wm. Crighton Sessions*
Mrs. George Warren Smith*
Mr. and Mrs. Elton E. Staples
Prof. and Mrs. Gifford H. Symonds
Mr. and Mrs. James P. Warner*
Mr. and Mrs. John B. Wright*

1927
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Mr. and Mrs. Harold W. Fisher*
Mr. B. Allison Gillies
Mr. and Mrs. Ernest W. Hahn
Mr. William Kaplan
Mr. and Mrs. Thomas A. Knowles
Mr. Frank Massa
Mr. John W. Norris, Sr.*
Mr. Howard W. Page*
Mr. Russell P. Westerhoff*
Mr. and Mrs. Clarence L. Wynd*

1928
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Mr. and Mrs. Roland D. Earle
Mrs. Thomas E. Garrard
Mr. Elisha Gray II*
Mrs. Harold L. Hazen*
Mr. and Mrs. Henry N. Lacroix*
Mr. and Mrs. George P. Palo
Mr. and Mrs. Walter J. Smith*
Mr. and Mrs. Abraham Woolf*

1929
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Mr. J. Russell and Mrs. Dorothy V. Clark*
Mr. Harry Dickinson*
Mr. Arnold W. Ewan
Mr. and Mrs. Kenneth W. Martin
Mrs. Hilda F. Niedelman
Mr. and Mrs. Dexter T. Osgood*
Mr. John C. Trahey
Mr. Everett P. Weatherly, Jr.
Mr. John J. Wilson*

1930
Mr. Alan C. Bemis*
Mrs. Ernest B. Dane*
Mr. Robert M. Jacobs
Mr. and Mrs. Allen Latham, Jr.*
Mr. Gordon K. Lister*
Mr. Gregory Smith
Dr. Walter W. Soroka*
Mr. and Mrs. Richard M. Wilson
Prof. Ching T. Yang*

1931
Mr. David W. Bernstein*
Mr. Kenneth R. Bolles
Dr. and Mrs. Gordon S. Brown*
Mr. George M Bunker*
Mr. and Mrs. Emilio G. Collado*
Mrs. James B. Fisk*
Dr. and Mrs. Norman D. FitzGerald
Mr. and Mrs. Kenneth J. Germeshausen*
Mr. J. K. Jamieson*
Mr. and Mrs. Claude F. Machen*

SUSTAINING FELLOWS

Mr. Arnold L. Nylander
Mr. Max Palevsky
Dr. Spencer S. Prentiss*
Mr. and Mrs. Howard L. Richardson
Mr. and Mrs. Robert Sanders

1932
Mr. Bennett Archambault*
Mr. and Mrs. Wendell E. Bearce
Mr. Cecil Boling*
Mr. Donald W. Brookfield
Mr. John J. Brown*
Mr. and Mrs. Howard F. Carver
Mr. and Mrs. Alexander D. Daunis*
Mr. Byron E. James
Mr. Gaynor H. Langsdorf
Mr. John Navas*
Mr. and Mrs. Eric P. Newman*
Mr. Robert B. Semple*
Mr. and Mrs. Richard M. Stewart
Mrs. Carroll L. Wilson

1933
Dr. Dayton H. Clewell*
Mr. Ralph and Mrs. Eloise Cross*
Mr. Pierre S. du Pont*
Mr. and Mrs. G. Russell Eddy
Mr. Herbert E. Grier*
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Mr. Warren J. Henderson*
Mrs. George O. Henning
Mr. and Mrs. C. D. Marshall*
Mr. and Mrs. Malvin J. Mayer*
Mr. Richard S. Morse*
Mr. Niazi I. Mostafa
Mr. Frederick V. Murphy, Jr.*
Mr. Otto A. Putnam
Dr. and Mrs. John Sterner
Mr. and Mrs. Harris A. Thompson
Mr. and Mrs. James E. Turner*

1934
Mr. Albert Abramson
Mr. and Mrs. Gordon K. Burns
Mr. and Mrs. Thomas M. Burton
Mr. and Mrs. James P. Eder
Mr. Peter Nicholas Goulandris
Mr. Samuel A. Groves*
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Mr. Russell Hastings
Mr. and Mrs. Albert A. Hopeman, Jr.
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Mr. Wilfred D. MacDonnell
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Mr. Richard H. Sanders*
Col. Graves H. Snyder
Mr. Daniel D. Strohmeier
Mr. Edmund Q. Sylvester
Mr. Harold E. Thayer
Mr. Samuel Untermyer

1935
Mr. and Mrs. Bissell Alderman*
Mr. Leo M. Beckwith*
Mr. Hal L. Bemis*
Mr. Edward C. Edgar
Mr. and Mrs. Harold K. Farr
Mr. Wesley H. Loomis III*
Mr. and Mrs. John F. Taplin*
Mr. Max Wasserman*

1936
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Mr. and Mrs. W. B. Bergen*
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Mr. Ralph B. Chapin*
Mr. and Mrs. Robert W. Cloud*
Mr. George S. DeArment*
Mr. P. H. Dreissigacker
Mr. James M. Ewell*
Mr. and Mrs. Herbert F. Goodwin*
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Mr. and Mrs. William J. McCune, Jr.*
Mr. August H. Schilling*
Mr. and Mrs. Carl G. Sontheimer

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Mr. Richard B. Young

1939
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Leonard Mautner*
Mr. and Mrs. Harold J. Muckley*
Mr. and Mrs. Harold R. Seykota*

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Mr. I. M. Pei*
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Mr. H. Garrett Wright

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Mrs. E. Kirkbride Miller*
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Mr. and Mrs. Frank S. Wyle*

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Mr. Frederick M. Dierks*
Mr. and Mrs. Morton E. Goulder*
Mr. Floyd A. Lyon*
Lee and Geraldine Martin
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Mr. and Mrs. Edward O. Vetter*
Mr. Leopold S. Wyler

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Mr. Rudolph Hurwich*
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Mr. S. James Spitz, Jr.*

1944
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Mr. Albert P. Hildebrandt
Mr. John A. Lednicky*
Mr. Robert E. Meyerhoff*
Bernard and Ann Rabinowitz
Mr. Peter M. Rinaldo
Mr. Edwin G. Roos
Mr. Thornton Stearns*
Mr. Eric M. Wunsch*

1945
Mr. William F. Blitzer
Mr. David R. Clare
Mr. James A. Levitan*
Mr. and Mrs. J. Spencer Standish
Emily V. and Jeptha H. Wade III*

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Mr. and Mrs. S. James Goldstein*
Mr. Angus N. MacDonald*
Roger and Joan Sonnabend*
Mr. James L. and Mrs. Faith P. Waters*

1947
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Mr. Philip R. Jonsson*
Mr. John Karmazin, Jr.
Dr. and Mrs. Henry Lee, Jr.
Mr. and Mrs. Bernard G. Palitz*
Dr. and Mrs. Robert L. Solnick
Dr. Mary F. P. Wagley*
Mr. and Mrs. C. Norman Winningstad

1948
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Mr. E. W. Hiam*
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Mr. George M. Keller*
Mr. Warren J. King*
Lois and Philip Macht*
Mr. and Mrs. George Macomber
Mr. Solomon Manber
Mr. Denman K. McNear*
Mr. Peter M. Saint Germain*
Mr. C. Vincent Vappi*
Mr. and Mrs. William J. Weisz*
Mr. William R. Zimmerman*

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E. Milton and Paula Lawton Bevington
Mr. and Mrs. Leonard Bezark, Jr.*
Mr. and Mrs. George F. Clements, Jr.
Mr. Russell N. Cox
Mr. Alexander V. D'Arbeloff*
Mr. Bradford M. Endicott*
Dr. George N. Hatsopoulos*
Mr. John and Mrs. Geraldine Kunstadter*
Mr. and Mrs. Jack C. Tang*

1950
Dr. and Mrs. Francis F. Lee
Mr. Kenneth H. Olsen*
Mr. and Mrs. Harry Tecklenburg*
Dr. William D. Walther*

1951
Mr. and Dr. David A. Bossen
Mrs. Joan Goody
Dr. Marvin Grossman*
Mr. Breene M. Kerr*
Dr. and Mrs. Anthony D. Kurtz*
Mr. Walter Rajki*
Mr. Charles H. Spaulding
Mr. and Mrs. Albert L. Zesiger

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Mr. Alexander L. M. Dingee, Jr.
Mr. and Mrs. Herbert H. Dow*
Mr. Ernest A. Grunsfeld III*
Mr. J. Burgess Jamieson
Mr. and Mrs. Joe F. Moore

1953
Mr. Gunther W. Balz*
Mr. and Mrs. Frederick R. Cronin
Mr. and Mrs. James D. Kolb
Dr. Martin Wohl*

1954
Mr. and Mrs. James J. Baker*
Mr. Alex W. Dreyfoos, Jr.*
Paul E. and Priscilla K. Gray*
Mr. and Mrs. Andrew S. Kariotis
Mr. Ronald A. Kurtz*

1955
Mr. George P. Edmonds, Jr.*
Mr. Jean Montagu*
Mr. L. Dennis Shapiro*

1956
Mr. C. Gordon Bell
Mrs. Joseph Gaziano
Mr. and Mrs. Michael Schiller
Dr. and Mrs. Andrew J. Viterbi

1957
Mr. Charles G. Koch*
Dr. and Mrs. Leslie M. Orloff
Ray and Maria Stata

1958
Mr. and Mrs. Joseph J. Gal
Mr. and Mrs. James Simons
Dr. F. Helmut Weymar*

1959
Mr. Albert P. Hinckley, Jr.
Mr. David J. McGrath, Jr.*
Mr. Robert A. Muh*
Mr. and Mrs. Barry Weinberg

1960
Mr. Fred Kayne*
Mr. John W. Norris, Jr.
Dr. and Mrs. Jorge E. Rodriguez

1961
Mr. and Mrs. John S. Reed*

1962
Mr. David H. Koch*
Dr. William I. Koch*
Mr. Martin N. Rosen
Mr. R. E. Wilhelm

1963
Mr. John K. Castle*
Dr. and Mrs. Ching Chih Chen

1964
Mr. and Mrs. Robert E. Thurber

1966
Mr. Paul Rudovsky*

1967
Mr. Charles Ying*

1968
Dr. Richard A. Blanchard
Dr. Robert M. and Mrs. Robyn S. Metcalfe
Mr. Richard Ying*

1969
Mr. and Mrs. Robert A. Swanson

1972
Mr. and Mrs. Terrence A. Tobias*

Aeronautics and Astronautics
Dr. and Mrs. Yao T. Li*
Dr. and Mrs. Robert C. Seamans, Jr.*

Architecture
Mr. Armand P. Bartos*

Chemical Engineering
Dr. Samuel W. Bodman III
Mr. and Mrs. Vernon O. Bowles*
Mr. and Mrs. David Brown*
Mrs. Edwin R. Gilliland*
Mr. Robert C. Gunness*
Mr. John C. Haas*
Mr. C. J. Harrington*
Mr. George S. Harrington
Dr. and Mrs. Frederic Holloway
Dr. and Mrs. Ralph Landau*
Dr. John P. Longwell
Mr. Jan W. Mares*
Mr. Charles B. McCoy*
Mr. Ralph D. Patch*
Dr. Charles E. Reed*
Mr. and Mrs. William C. Rousseau
Dr. Arch C. Scurlock*
Dr. Charles A. Stokes
Mr. Chih Tsang
Mr. George R. Vila*

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Dr. Robert and Mrs. Alma Breckenridge*
Mr. Edward R. Kane*
Dr. and Mrs. Howard O. McMahon
Dr. Howard S. Turner*

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Dr. Roy W. Carlson
Mr. and Mrs. Charles W. Johnson
Mr. James G. McCurdy*

Earth and Planetary Sciences
Dr. and Mrs. Louis Berger*
Dr. and Mrs. Norman E. Gaut*

Economics
Dr. Richard J. Kruizenga
Dr. and Mrs. Thomas M. Marill
Mr. and Mrs. George P. Shultz

Electrical Engineering
Dr. Ge Yao Chu
Mr. and Mrs. Abraham Dranetz*
Mr. William R. Hewlett*
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1934
Walter W. Bird
Alexander M. Blakely
Virginia Davidson Blakeman
Leo A. Carten
Constant W. Chase, Jr.
Edgar B. Chiswell, Jr.
Roger T. Coffey
Robert R. Cull
Robert Ebenbach
Joseph Fishman
Robert M. Franklin
George Irvin Gahm
E. Philip Kron
Douglas C. MacMillan
John J. McHugh
Aldo A. Minotti
Jean M. Raymond
Walter F. Read
Theodore N. Rimbach
Charles E. Sanders
Theodore Steinberg
Bernard N. Stiller
Albert M. Talbot
Max Winer
Walter L. Wise, Jr.

1935
John H. Anderson
Willard F. Bixby
Chester E. Bond
Lester A. Brooks
William W. Buechner
James E. Castle
Arthur H. Cohen
Leo H. Dee
George C. Dunlap
Ellis M. Flink
Louis B. C. Fong
Brydon Greene
Alexander F. Hamilton
Richard L. Hughes
Philip P. Johnston
George P. Knapp
Clyde M. Leavitt
George N. Lykos
Robert C. Madden
Vincent J. Mooney
Paul S. Mormino
Bernard H. Nelson
Richard L. Parli
Charles A. Piper
Eugene F. Schwarzenbek
Nelson H. Thorp
Frank S. Walters
Kasmierz J. Winiarski

1936
Kenneth J. Arnold
W. Boynton Beckwith
T. Ledyard Blakeman
Herbert M. Borden
Leonard B. Chandler
Edward E. Christopher
Kathleen V. Cummins
Vincent T. Estabrook
Richard B. Fox
Eli A. Grossman
William A. Healy
Anton E. Hittl
Aurelius P. Hornor, Jr.
Semon E. Knudsen
Gerald S. McMahon
Harold F. Miller
Roman L. Ortynsky
James F. Patterson
Lawrence G. Peterson

1937
Frederick J. Altman
E. L. Bartholomew, Jr.
John A. Benson
John H. Fellouris
Robert C. Glancy, Jr.
Thomas L. Hallenbeck
Daniel J. Hanlon, Jr.
Charles F. Healey
Gilbert C. Mott
Melvin A. Prohl
Harold E. Prouty
James H. Schipper
Edward F. Tibbetts
Duane O. Wood

1938
Franklin S. Atwater
Howard Banzett
Albert M. Clogston
Paul R. Des Jardins
Roy C. Hopgood
Harold James
Solomon Kaufman
John C. Kinnear, Jr.
Frederick J. Kolb, Jr.
H. Bruce Leslie
James Maguire
Harold J. McGillivray
James P. Pollock
Frederick E. Ray
Frederic W. Reuter, Jr.
D. Sinclair Scott
Ascher H. Shapiro
Harold H. Strauss
George B. Wood

1939
James W. Barton
George Beesley
Philip D. Bush
Louis S. Castleman
Richard E. Christie
John H. Crankshaw
George S. Dadakis
David S. Frankel
Charles F. Freyfogle
Frederick B. Grant
Michael V. Herasimchuk
John I. Herlihy
Benjamin T. Howes
August B. Hunicke, Jr.
Burkhart A. Kleinhofer
B. Leonard Krause
Lawrence M. Lyons
George P. Morrison
William A. Murphy, Jr.
Irving Peskoe
W. Hewitt Phillips
Gordon A. Pope
Harold W. Pope
Robert W. Pratt
Burton D. Rudnick
Paul E. Sandorff
Samuel Sensiper
Julian M. Spencer
Alexander Squire
Robert A. Stone
Irwin K. Weiss

1940
J. William Blattenberger
Paul V. Bollerman
Harvey H. Brown
Charles Forbes DeMailly
Richard P. Dickson
N. Bruce Duffett
Richard J. Eberle
Donald R. Erb
James E. Fifield
David R. Goodman
Harold Graham
Edward G. Hellier
Winfield H. James
Joseph K. Knight
David F. Lowry
Marshall D. McCuen
Richard F. McKay
Robert G. Millar
Schrade F. Radtke
Philip A. Stoddard
Ralph N. Thompson
John A. Vanderpoel
L. D. Wheaton
George M. Wolfe

1941
Robert E. Bailey
Albert L. Bensusan
Robert Wallace Blake
Robert W. Blake, Jr.
Roger G. Blum
Albert H. Bowker
George S. Burr
William T. Butt
Ivor W. Collins, Jr.
Joseph E. Dietzgen
Martin L. Ernst
Robert M. Fano
Rudolph W. Hensel
William E. Lamar
Robert A. Mallory
James W. Mar
Eugene A. March
Charles F. Peck, Jr.
Harold Radcliffe
John F. Sexton
Frederick H. Thompson

1942
Arthur W. Avent
Lawrence E. Beckley
Charles E. Bossi
David Christison
Robert H. Crosby, Jr.
Luther Davis, Jr.
Alfred T. Dengler
Philip E. Fox
Richard X. Gannon
Robert B. Greenes
Harvey Kram
John W. Lacy
Bernard Levere
Warren S. Loud
Charles D. Magdsick
Adrian G. Marcuse
Joseph R. McHugh
David B. Nichinson
Milton M. Platt
Robert N. Secord
Morris A. Steinberg
Edward P. Todd

1943
Richard L. Ackerman, Jr.
George W. Bartlett
Frank E. Briber, Jr
Frank A. Clauson
Paul R. Coulson
Ira G. Cruckshank
Edward J. Czar
Thomas K. Dyer
David M. Falk
Ralph R. Feuerring
Howard S. Gleason
Ward J. Haas
Charles A. Hathaway
Steven Heller
Bedrich V. Hettich
James F. Hoey, Jr.
William R. Lacy
Charles J. Lawson, Jr.
Hung Liang
T. Kemp Maples
James O. McDonough
John M. Miller
Robert S. Reebie
Robert L. Rorschach
F. Curtis Smith
Morton F. Spears
D. Read Stevens, Jr.
Herbert G. Twaddle
William A. Verrochi
William J. Vallette
John E. Ward

1944
Robert E. Benedict
Richard S. Bettes, Jr.
L. C. Biedenharn, Jr.
Henry N. Bowes
Robert G. Breck, Jr.
Robert M. Byrne
Herbert L. Carpenter, Jr.
John Chamberlain
Louis R. Demarkles
Lee C. Eagleton
John G. Floden
Holton E. Harris
Robert V. Horrigan
Warren H. Howard
John L. Hull
Irwin M. Jennis
John H. Kellogg, Jr.
Lorenzo A. Lamadrid
Jean-Claude C. Landau
Han Tang Liu
Robert S. Nobles
Arthur F. Peterson, Jr.
William S. Richardson
Paul M. Robinson, Jr.
Eugene A. Schnell
Norman I. Sebell
Ralph Seferian
Joseph Shrier
Leland F. Stanley
John Upton, Jr.
James Woodburn
Aaron Zicherman

1945
Christopher G. Boland III
Edwin Y. Chung
Kenneth H. Fischbeck
Reynold A. Grammer, Jr.
Sing Leong
Robert N. Maglathlin
Andrew A. Marocchi
William G. Martin, Jr.
William J. Meade, Jr.
Warren H. Miller
David O. Richards
Eugene S. Rubin
Max E. Ruehrmund, Jr.
Luigi J. Russo
Malcolm L. Schoenberg
Clinton H. Springer
Edward Stoltz, Jr.

1946
Richard M. Adler
Lyal D. Asay
Louis B. Barber
Raymond E. Benenson
Ralph H. Berman
Lawrence G. Body
Ernest U. Buckman
Charles E. Cloud
M. Louise Curley
Richard Dreselly
Ernest G. Jaworski
Mason I. Lappin
Robert H. Marks
A. William McEwan
James S. Murphy
Barbara R. Murray
Richard G. Rauch
Frederick J. Ross
Arthur Schiff
Warren H. Turner
Jacob W. Ullmann

1947
Robert A. Aquadro
Harold Brown
John A. Contegni
William J. Crawford III
Steffen F. Dieckmann
Carl E. Eyman, Jr.
Wilfred L. Freyberger
John G. Holmes
Arnold S. Judson
William J. McCurdy
Leslie C. Merrill
James L. Phillips
Edwin A. Rosenberg
Martin D. Schwartz
Irving L. Schwarz
Carol Tucker Seward
Wm. Reid Smith-Vaniz, Jr.
Donald M. Van Greenby
Ferdinand S. Veith
Howard A. Zwemer

1948
Harold L. Abroms
Eugene Ashley
William Bangser, Jr.
Robert H. Bliss
Kenneth S. Brock
Thomas J. Cahill
Albert F. Carr
Cassius M. Clay
Richard J. Conlan
Robert Crane
Milton R. Daniels, Jr.
George S. Dundon
Paul A. Erskine
Daniel J. Fink
Thomas W. Folger
James W. Frevert
Robert S. Friedman
Curtis S. Green
Peter A. Guercio
Elton F. Hammond, Jr.
Robert W. Hanpeter
John W. Hawkins
Edwin E. Hebb, Jr.
Frank W. Heilenday
John C. Henderson
John W. Herbert
Robert O. Hirsch
William N. Hosley
Frank J. Iskra
Frank A. Jones, Jr.
William J. Joyce
J. Karl Justin
Irving Kagan
William E. Katz
Harry L. Kopp
Louis F. Kreek, Jr.
Norman H. Kreisman
Philip M. Lally
James P. Landis
Irwin L. Lebow
James Leon
John D. C. Little
James E. Manson
Manuel L. Matnick
Adolf F. Monosson
Robert R. Mott
John E. Nicholson
Julian F. Pathe
Russell S. Paulnock
John M. Randolph
Gilbert V. Rohleder
J. Norman Rossen
George E. Sherman
Arnold M. Singer
Earl K. Solenberger
Philip J. Solondz
Peter H. Spitz
Ellarson R. Stout
Donald F. Towse
John M. D. Walch
William Wallace, Jr.
Robert H. Welsh
Harvey B. Willard
Robert A. Wofsey
Backman Wong

1949
Angelo R. Arena
Marvin A. Asnes
John W. Barriger IV
Orlien N. Becker
James K. Berman
Robert O. Bigelow
William A. Black
William R. Bohlman
Frederick I. Brown, Jr.
Norman A. Chrisman, Jr.
Leslie W. Cline, Jr.
Robert C. Cowen
Ira Dyer
John Fairfield, Jr.
Guilford W. Forbes
Donald L. Gillespie
Gerald J. Grott
Frank B. Harris, Jr.
Charles K. Holmes, Jr.
Sidney C. Howell
Frank T. Hulswit
David R. Israel
William R. Kincaid
Karl F. Kirchner
Otto E. Kirchner, Jr.
John A. Knowlton, Jr.
Thomas J. Lamphier
A. Scheffer Lang
Richard E. Lang
Ray E. Larson
Albert A. Levingston
William S. Lewis
Robert F. Mahar
John O. Merrill, Jr.
Ford F. Miskell
Richard D. Morel
Paul B. Ostergaard
Henry S. Rowen
Bernard J. Ruskin
John R. Saxe
Earl F. Smith
Nathan O. Sokal
Herbert L. Spivack
Garland S. Sydnor, Jr.
Edward T. Thompson
J. Thomas Toohy
Thomas Tsotsi
Vernon P. Turnburke, Jr.
James Veras
Charles M. Walker
E. Zapata H.

1950
David D. Adams
Walter S. Attridge, Jr.
George A. Basta, Jr.
Lowell S. Bensky
Sterling G. Brisbin
Richard C. Brogle
Thomas C. Buchanan
Robert C. Carruthers
John W. Craig, Jr.
Harry G. Foden
James W. Geiser
Malcolm Green
Charles F. Grice
John A. Gutai, Jr.
Donald A. Harnsberger
Lawson P. Harris
Edward J. Hayes
Herbert L. Hochberg
Francis X. Hogan
Richard H. Holmberg
James A. Hooper
Carroll I. Johnson
John C. Kern
Walter J. Kocher, Jr.
Raymond A. Kretschmer
Reginald A. Krystyniak
John B. Lawson
Gerald A. Lessells
Daniel P. Lundgren
Stanley Martin, Jr.
John T. McKenna, Jr.
Donald R. Miller
Raymond M. Moeller
William Murphy, Jr.
Will F. Nicholson, Jr.
Alfred M. Petrofsky
Robert L. Plouffe
Richard P. Price
Harry F. Raab, Jr.
Mariano A. Romaguera
Henry C. Sharp, Jr.
Thomas E. Shepherd, Jr.
Vinson R. Simpson
Myles S. Spector
John M. Swick
Dan R. Test
Norman F. Tisdale, Jr.
Constantine T. Tsitsera
Robert E. Wilson

1951
William L. Benfer
John H. Bergmann
Christian C. Bolta
Edward L. Bronstien, Jr.
David I. Caplan
Donald K. Crockett
John F. Dennis
Charles W. Ellis
Allan Elston
Frederick D. Ezekiel
Richard L. Foster
Richard T. Greenhill
Rodney G. Huppi
Gerald S. Ikelheimer
Morley D. Kahn
Hubert E. Knipmeyer
J. Franklin Koehler
L. Keith Koehler
George L. Larse
Robert A. Lindquist
Daniel E. Magnus
George H. Myers
Robert G. Norton
William D. Pinkham, Jr.
Lester W. Preston, Jr.
John S. Prigge, Jr.
David V. Ragone
William G. Rhoads
Laurence L. Rubin
Samuel Rubinovitz
Joseph N. Sherrill, Jr.
Harold A. Siegel
Howard E. Simmons, Jr.
Paul G. Smith
George R. St. Pierre
Frank H. Thomas III
D. R. von Recklinghausen
Frederick W. Weitz
John J. Welch, Jr.
Harry J. Zimmer

1952
Richard C. Aquadro
Arthur I. Auer
Clyde N. Baker, Jr.
Stanley I. Buchin
Michael J. Cambon
Bock M. Chin
Milton S. Dietz
Nicholas J. Haritatos
Clifford H. Heselton, Jr.
Oscar W. Kaalstad
Paul D. Kaminsky
Harry S. Kradjian
Arnold A. Kramer
Richard F. Lacey
William H. Lane
Jack Larks
Alex S. Malaspina
Robert M. Lurie
Paul A. Lux
Richard E. Lyle
Michael Nacey
Kevork V. Nahabedian
Clifford M. Sayre, Jr.
Collin W. Scarborough III
F. Garrett Shanklin
Stanley J. Solomon
H. Stephen Spacil
Donald F. Tarinelli
Emil J. Volcheck, Jr.
Seymour S. Weintraub
David W. Weiss

1953
David M. Berg
E. Fred Brecher
Norman C. Ford, Jr.
Morton J. Friedenthal
Gilbert D. Gardner
Kent F. Hansen
Charles R. Johansson
Lionel L. Kinney
David L. Klepper
S. Eric Kondi
Nelson C. Lees
Richard I. Linde
Marion C. Manderson
Douglas L. Meyer
Joseph F. Mullen
Bernard H. Paiewonsky
Robert R. Piper
Jean-Pierre A. Radley
Burton M. Rothleder
Wilson H. Rownd
Willard B. Spring
Howard S. Stern
Maurice L. Torti, Jr.
Tollyn J. Twitchell
James A. Zurbrigen

1954
Gordon Aitken
Robert E. Anslow
Barbara A. Black
John Blair
Wallace P. Boquist
Frederick H. Bowis
Coleman Bresee
Morton M. Davis
Donald M. Dix
William J. Eccles
Wilbur P. Fiske
Camillo A. Ghiron
George Inada
James E. Klapmeier
Samuel J. Losh
Louis E. Mahoney III
Leroy G. Malouf
Charles J. Masison
Aristides Miliotes
Raymond D. Mintz
Alfredo J. Peralta-Maninat
George L. Perry
J. L. Perry
John M. Peterson
John E. Preschlack
Frederick Rubel, Jr.
Allen M. Schultz
George G. Schwenk
Marilyn Leader Shilkoff
Charles M. Smith
David F. Springsteen
Harvey I. Steinberg
Robert W. Stewart, Jr.
George M. Thurlow
David B. Whelpley
Klaus M. Zwilsky

1955
Paul H. Attridge
Richard I. Bergman
Pierre D. Casimir Lambert
Gilbert Davidson
F. Eugene Davis IV
Joyce P. Davis
William T. Deibel
James H. Eacker
Robert P. Greene
Michael E. Halpern
John F. Hayes
Barrett R. Lucas
Roger D. Mackay
Gerald P. Maloney
Thomas A. Marlow II
Sheldon H. Moll

Max D. Musgrove
Richard D. Nordlof
Theodore G. Papastavros
Stuart S. Peltz
Frank E. Perkins
Karl A. A. Reuther
Gregory L. Robillard
Randall S. Robinson
Walter Rubin
Bernard J. Sadoff, Jr.
W. Chandler Stevens, Jr.

1956
Howard S. Bertan
R. Gordon Black
Bernardo Blaschitz
Bruce B. Bredehoft
Renato Cervantes
Ronald C. Clark
Michael G. Damone
William R. Dickson
Irwin Dorros
James A. Dugelby
Frank Foster III
Arthur Frank
Samuel S. Friedman
Gideon I. Gartner
Larry R. Goldberg
Richard A. Jacobs
Richard I. Johnson
Charles C. Joyce, Jr.
David L. Kaufman
William M. Layson
Robert B. Meeker
Edward K. Moll
Clifford K. Monzeglio
John A. Morefield, Jr.
John D. Mueller
Wendyl A. Reis
Axel E. Rosenblad
Jesse A. Rothstein
Gottfried T. Schappert
Craig C. Sherbrooke
Richard E. Skavdahl
John D. Stelling
Philip A. Trussell
Michael A. Turin
Stuart Z. Uram
Stanley T. Wray, Jr.
Thomas Yonker

1957
Paul R. Ammann
Richard L. Baird
Arthur E. Bergles
Bruce Blanchard
George H. Borrmann, Jr.
Alan S. Borstein
Joseph J. Carty
John T. Christian
Stewart M. Crawford
John B. Crews
John A. Currie
William H. Doughty
Karl M. Duff
Lee H. Fister, Jr.
Martin L. Gerson
A. Dickson Hause
Steven H. Hawkins
Patrick B. Hutchings, Jr.
Harry M. Johnson
Trond H. Kaalstad
Ronald W. Keefe
Richard M. Langendorf
Norman C. Lerner
S. William Linko, Jr.
Donald C. MacLellan
Terrence K. McMahon
Gerson E. Meyers
Richard R. Monsen
Donald A. Norman
John P. Penhune
Silvester Pomponi
John J. Rinde
Thomas C. Robinson
Henry E. Salzhauer
Peter A. Samton
W. Selden Saunders
Herbert F. Schwartz
Constantine B. Simonides
Harold P. Smith, Jr.
Robert M. Sterrett II
Erwin H. Straehley
William B. Thompson
Ralph J. Warburton
Stephen Weisskoff

1958
James G. Barber
Paul L. Busch
Peter B. Carberry
Stephen Corman
Leslie C. Dirks
John F. Fallon, Jr.
Richard A. Finn
Ernest R. Flemig
John B. Forrest, Jr.
Frank L. Galeener
O. Michael Gordon
Stephanos S. Hadjiyannis
William R. Hauke, Jr.
Alfred G. Hortmann
Richard H. Hough
Alan T. Johnson
Robert D. Jones
McClaran Jordan
Kenneth H. Langley
Paul Z. Larson
John H. Leigh
Calvin J. Morse
Hugh J. Murphy
John A. Murphy
Martin J. O'Donnell
Robert E. Oleksiak
Robert Bruce Parente
Cornelius Peterson
Allen R. Philippe
Robert A. Phinney
David J. Rachofsky
Conrad S. Revak
Robert M. Rose
Paul H. Rothschild
George A. Russell
George H. Schade, Jr.
Antonia D. Schuman
Leonard S. Simon
Matthew F. Smith
Steven R. Tannenbaum
Theodore J. Van Iderstine
Edward Wanger
D. Daryl Wycoff

1959
Hayward R. Alker, Jr.
Emile A. Battat
Laurence H. Bishoff
Larry C. Boyd
John W. Brackett
Robert E. Brooker, Jr.
James H. Brown
Edward W. Cheatham
Gilbert Y. Chin
George H. Connor, Jr.
George J. Elbaum
Norman A. Fujiyoshi
George T. Haymaker, Jr.
Michael D. Intriligator
Martin F. King
Alfredo G. F. Kniazzeh
Frank S. Koppelman
Thomas A. Lewis, Jr.
William R. Malone
John K. Mitchell
Donald E. Murray
David F. Pawliger
Adul Pinsuvana
Philip M. Richardson, Jr.
Joseph P. Seidel
Oliver E. Seikel
Daniel I. Wang
Jonathan B. Weisbuch
Stephen K. Whittemore
William S. Widnall
Marie M. Wray
Martin E. Zimmerman

1960
Anthony Aldrich
Alan S. Bloom
Peter B. Brandt
Edward A. Bulanowski
Ronald M. Burde
E. Patrick Coady, Jr.
Richard Dattner
Jaime H. De Sola
Abe Feinberg
Charles J. Garbarini
David H. Geisler
John W. Gintell
Jerome Goldstein
Standley H. Goodwin
Samuel Gorovitz
Richard L. Greene
Kenneth E. Hagen
Timothy P. Hart
Gerald H. Kaiz
Donald A. King
Deena A. Koniver
Morris J. Kriger
Andrew Larsen
Larry R. Martin
Richard L. McDowell
Gordon S. Mutchler
Richard H. Oeler
Howard L. Rosenthal
George A. Schnabel
Susan E. Schur
Arthur C. Silverman
S. C. Simonson III
Robert V. Storer
Carl V. Swanson
Robert S. Troth
Norman Vadner
Leonard B. Vaughn
Joseph A. Verderber
Robert M. White
Sheila Widnall
Raymond G. Wilkins

1961
Peter R. Bankson
John W. Baxter
John C. Blinn III
Leo J. Cannon
Dorsey C. Dunn
Reed H. Freeman
Thomas L. Geers
Peter R. Gray
William C. Grimmell
Ted J. Hammack
William J. Hecht
Lawrence A. Horowitz
W. Edwin Jarmain
Maynard R. Johnson
William E. Jouris
William B. Lenoir
Richard F. Otte
Gerald E. Pollon
William M. Richardson
David A. Roberts
Joseph R. Skenderian
Edward H. Sonn
William Strauss
Peter Ver Planck
Stephen R. Waltman
Robert F. Weimer
Bennett M. Zarren

1962
Robert E. Anderson
Lloyd Armstrong, Jr.
Richard A. Bronson
Thomas G. Burns
Vito A. Caravito
Arthur Roger Cooke
Edward A. Feustel
Barry J. Fidelman
Albert F. Gleim
Jeremy R. Goldberg
Robert L. Goldsmith
Michael H. Kaericher
Dwight A. Kellogg
Theodore P. Labuza
Robert F. Morse
Darold W. Rorabacher
John D. Rothschild
Thomas S. Rowe
Judith E. Selvidge
Norman P. Soloway
David S. Stare
Daniel E. Thornhill
Jerome A. Winston

1963
Michael C. Bertin
Thomas R. Bogan
Dean W. Boyd
Edwin F. Brush, Jr.
James A. Champy
Frederick E. Cunningham
Steven R. Ditmeyer
Marshall S. Flam
John K. Flicker
Tomas Goldberger E.
Milton J. Grebler
Jeremy A. Klainer
Maurice H. Lanman III
Robert M. Levin
Peter M. Mlynaryk
Russell E. Prins
Alan O. Ramo
Daniel R. Ross
Michael J. Schaffer
Victor D. Scheinman
Joel E. Schindall
Charles C. Schumacher
Charles W. Selvidge
Daniel W. Shelley
Raphael Soifer
James Y. Tang
John B. Tytus IV
Peter T. Van Aken
Ronald A. Walter
Robert A. Warman
John H. Wasserlein
Grant M. Wilson
William J. Wolf, Jr.

1964
K. Andrew Achterkirchen
Walter M. Anderson, Jr.
F. Michael Armstrong
Wayne F. B'Rells
Leslie M. Boring, Jr.
Thomas B. Cheek
Ernest M. Cohen
Ronald H. Cordover
Theodore J. Cruise
John P. Downie
Michael B. Godfrey
Jon D. Gruber
John N. Hanson
Robert H. Hobbs
Roger L. Hybels
Mark Joseph
Leon M. Kaatz
Stephen F. Kraysler
Glenn A. Larson
David F. Manchester
Stephen B. Miller
Emilio Sardi
Steven M. Schlosser
Peter J. Sherwood
Andrew J. Silver
Jay M. Tenenbaum

1965
Arnold R. Abrams
William R. Brody
Edward A. Bucher
Edmund L. Burke
Arthur A. Bushkin
W. David Carrier III
Karl Chang
Calvin E. Cordulack
L. Scot Duncan
Howard M. Ellis
Peter G. Gerstberger
Frank P. Gerstle, Jr.
Robert B. Grady
Joel C. Greenwald
George L. Hadley
Roy V. Harris
Howard L. Helman
Edward P. Hoffer
Michael D. Huke
Dawn Friedell Jacobs
William N. Kavesh
Louis A. Kleiman
Jesse B. Lipcon
Walter L. Miller
Kayson Nyi
John A. Ottesen
Robert B. Reichelt
John D. C. Roach
Emile Sabga
Gregory L. Schaffer
Peter Sexton
Donald L. Shulman
Richard S. Shultz, Jr.
Douglas C. Spreng
Alan R. Stottlemyer
Richard L. St. Peters
G. Wayne Thurman
Carol E. Van Aken
Michael G. Weiss
Barry D. Wessler
Joel Westerman
Stephen L. Williams
David L. Yuille

1966
Michael R. Adler
David L. Anderson
Arthur N. Boyars
Paul A. Branstad
William L. Bunce
George C. Byrd
William O. Cain
Richard Y. Chung
Richard T. Cockerill
John R. Coffman
Peter M. Cukor
Ralph M. Davison
Steven H. Disman
Byron C. Gilchrest
A. Mark Glickstein
Carl Jones
Hans C. Juvkam-Wold
Roger E. Koch
William J. Kosinar
Michael R. Leavitt
Gerald B. Lichtenberger
Gerald F. Madea
Henry H. Perritt, Jr.
Michael D. Rinaldi
Victor L. Rosenberg
Ralph G. Schmitt
Joseph W. Sullivan, Jr.
Stephen N. Teicher
John Torode
John H. Turner, Jr.

1967
John Acevedo
Donald A. Belfer
Victor M. Bermudez, Jr.
William M. Bloomquist
Donald J. Bosack
James W. Carter
William L. Caton III
John M. Davis
David A. Dilling
Kenneth G. Follansbee
Gary Garmon
Barbara A. Gilchrest
Harold Granek
Lawrence C. Hall
Lutz P. A. Henckels
Edson C. Hendricks
Alan R. Hirsch
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Glenn A. Wanek

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ALLAN J. GOTTLIEB

Happy New Year: 1 to 100 in 1, 9, 8, and 6!

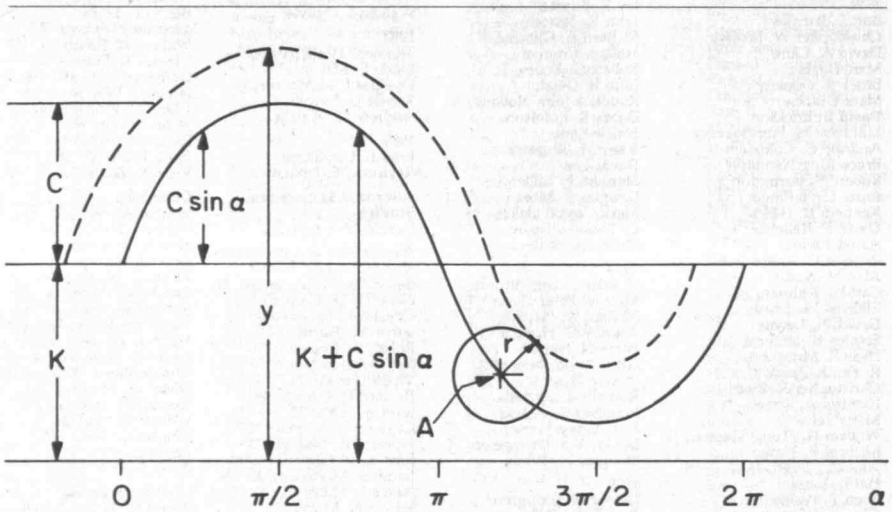
I have some very good news to report. At 1:06 a.m. on September 24, 1985, our second child was born. As with our first child David, my wife Alice and I attended Lamaze classes (this time just a "refresher" course) and so once again had a good "birthing experience." To paraphrase my own words from three and a half years ago, this column is dedicated to the fruits of Alice's labor, Michael Bendix Gottlieb.

This being the first issue of another year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 8, and 6).

Problems

Y1986. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 8, and 6 exactly once each and the operators +, −, × (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 8, and 6 are preferred. Parentheses may be used for grouping; they do not count as operators.

JAN 1. We begin with a ("no gimmicks") chess problem from Craig Presson, who requires White to move and mate in four.



JAN 2. Philip Hogin offers $100 for a solution to

$y = f(\alpha)$

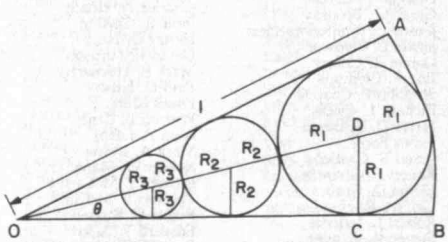
for given values of K, C, and r in the diagram at the top of this column. This is required for the design of a cylindrical cam which produces simple harmonic motion of the center of the follower (point "A"). The expression $y = f(\alpha)$ will be used to program a laser cutting machine. In the prototype design, the diameter of the follower is .5" (r = .250"), C = .75", K = 1.25", and the cam circumference is 3". If an exact solution is complicated, an accurate approximation would be acceptable.

JAN 3. George Byrd recalls, from the Dover *Diversions and Digression*, that the six-digit number 142857 has an interesting property. Consider

One times the number is 142857.
Two times the number is 285714.
Three times the number is 428571.
Four times the number is 571428.
Five times the number is 714285.
Six times the number is 851428.

Note that all these numbers are rotated versions of the original. Mr. Byrd would like to know if there are other numbers, X, having the property that multiplication by any positive integer not exceeding the number of digits of X produces a rotated version of X.

JAN 4. Howard Stern poses an interesting area maximization problem:



Consider the sector OAB of a circle of unit radius with angle 2θ. We can "fill up" the sector with an infinite series of circles with radii R_1, R_2. . . . Obviously, the ratio of the sum of the circles' areas to the sector's area is less than 1. For what θ is this ratio the largest and what is its value?

Speed Department

SD 1. Our first speed problem was attributed to Donald Knuth in the October

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

1985 *American Mathematical Monthly*. What is the next number in the sequence that begins with F4E, S9, SE5EN,...?

SD 2. We close with a question from the "freshman quiz" given by *The Tech*, M.I.T.'s student newspaper. I believe this problem actually originated in *Puzzle Corner* about ten or fifteen years ago. Translate the following into a limerick: $(12 + 144 + 20 + 3\sqrt{4})/7 + 5 \times 11 = 9^2 + 0$

Solutions

Y1985. This is the same problem as Y1986 (see above) with only one digit changed.

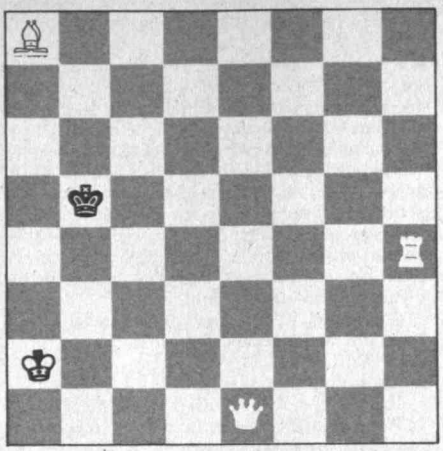
The following solution is from Avi Ornstein, who indicates with bold face those solutions using the digits in order:

1 1^{985}	51 59 − 8 × 1
2 1 + (9 − 8)^5	52 59 − 8 + 1
3 5 − 18/9	53 9 × 5 + 8 × 1
4 81/9 − 5	54 9 × 5 + 8 + 1
5 1^{98} × 5	55 **(19 − 8) × 5**
6 91 − 85	56
7 18/9 + 5	57 **19 × (8 − 5)**
8 9 − 1^{58}	58 59 − 1^8
9 1^{58} × 9	59 **19 + 8 × 5**
10 18/9 × 5	60 59 + 1^8
11 −1 + 9 + 8 − 5	61
12 (95 + 1)/8	62 (5 + 1) × 9 + 8
13 1 + 9 + 8 − 5	63 9 × 5 + 18
14 95 − 81	64 8 × (9 − 1^5)
15 15 × (9 − 8)	65
16 **19 − 8 + 5**	66 85 − 19
17 8 + 9 × 1^5	67 59 + 8 × 1
18 (89 + 1)/5	68 59 + 8 + 1
19	69 8 × (9 − 1) + 5
20	70
21 9 × 8 − 51 or	71 8 × 9 − 1^5
8 × 5 − 19	72 18 × (9 − 5)
22 81 − 59	73 8 × 9 + 1^5
23 1 + 9 + 8 + 5	74 89 − 15
24 8 × (9 − 1 − 5)	75 85 − 1 − 9
25 $5^{(18/9)}$	76 85 − 9 × 1
26 9 × (8 − 5) − 1	77 19 + 58
27 9 × 5 − 18	78 91 − 8 − 5
28 (8 − 1) × (9 − 5)	79
29	80 (1^5 + 9) × 8
30 (1 + 9) × (8 − 5)	81 5 × 18 − 9
31 8 × 5 − 1 × 9	82
32 19 + 8 + 5	83 98 − 15
33 91 − 58	84 89 − 5 × 1
34 51 − 9 − 8	85 89 − 5 + 1
35 (8 − 1^9) × 5	86 95 − 8 − 1
36 81 − 9 × 5	87 95 − 8 × 1
37 9 × 5 − 8 × 1	88 95 − 8 + 1
38 89 − 51	89 89 × 1^5
39 −1^9 + 8 × 5	90 89 + 1^5
40 1^9 × 8 × 5	91
41 1^9 + 8 × 5	92 98 − 5 − 1
42 (1 + 9) × 5 − 8	93 **1^{98} − 5**
43	94 **1 + 98 − 5 or**
44 (8 − 1) × 5 + 9	**1 × 9 + 85**
45 81/9 × 5	95 **1 + 9 + 85**
46 5 × 9 + 1^8	96 95 + 1^8
47 98 − 51	97 98 − 1^5
48 58 − 9 − 1	98 98 × 1^5
49 58 − 9 × 1	99 98 + 1^5
50 59 − 8 − 1	100

Also solved by Marion Berger, Jim Landau, Steve Feldman, Robert Kruger, Alan Katzenstein, Harry Zaremba, Allen Tracht, A. Holt, Frederich Furland, Dudley Church, Randall Whitman, Rik Anderson, Roger Wiethoff, Phelps Meaker, Peter Silverberg, George Aronson, and Ellen Kranzer.

A/S 1. White is to move and force a mate in two.

The following solution is from Gary Schlegelmilch and Marc Campbell:

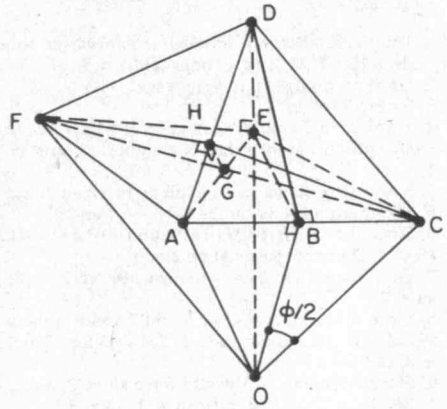


White must move Rook H4-A4.
If Black moves KxR (B5-A4), then White moves Bishop A8-C6 mate.
If Black moves King B5-B6, then White moves Queen E1-A5 mate.
If Black moves King B5-C5, then White moves Queen E1-B4 mate.

Also solved by Richard Hess, Alison Prince, Charles Rivers, Ruben Cohen, Nolan Kagetsu, David Cohen, Ron Raines, Jerry Horton, Jacob Bergmann, Matthew Fountain, Gardner Perry, Thomas Chang, Edward Gaillard, Ronald Ort, and William Maimone.

A/S 2. A reader wanted an approximation of a four-foot sphere for light-integration measurement. He made a dodecahedron of sheet metal, except that instead of flat surfaces, he substituted low five-sided pyramids. How should he have desiged the pyramids so that all the dihedral angles were equal? The following solution is from Harry Zaremba:

All the dihedral angles should equal 156°43'6.8". Each vertex at which five faces of a pyramid intersect should be 0.359 feet above the base of the pyramid, and each edge intersecting at the vertices should be 1.266 feet long. The foregoing values were determined as follows.



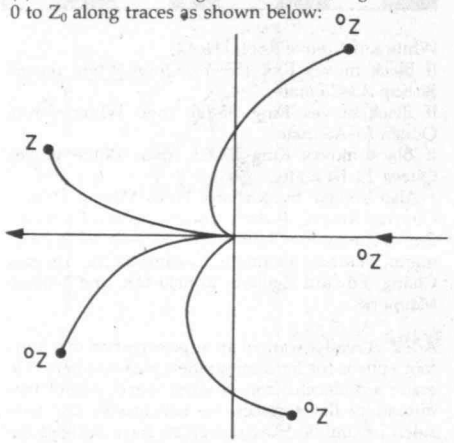
In the figure shown, 0 is the center of the sphere which circumscribes the dodecahedron, D is the vertex of a pyramid whose base is represented partially by triangles FEA and AEC, and the plane of triangle FHC is perpendicular to edge AD of the pyramid. Angles FHG, CHG, and DBO equal β which is one-half of the dihedral angle between the pyramid faces, angle EBO equals θ, and angle DBE equals β − θ. In congruent right triangles ABE and CBE, angles AEB and CEB = 36° and angles EAB and ECB = 54°. The radii FO, AO, and CO of the sphere equal 2 feet. From the (36°, 90°, 60°) spherical right triangle, which is not shown above the planar right triangle EBC, we have
cos36° = cos(φ/2) sin60°, or

$(\phi/2) = 20°54'18.57''$.
From the right triangle CBO,
$BC = AB = 2\sin(\phi/2) = 0.71364$
$BO = 2\cos(\phi/2) = 1.86834$
$AC = 2BC = 1.42729$.
In right triangle EBC,
$EB = BC/\tan 36° = 0.98225$
$EC = EA = (EB^2 + BC^2)^{1/2} = 0.98225$
$EC = EA = (EB^2 + BC^2)^{1/2} = 1.21412$
and in right triangle BEO,
$\cos\theta = EB/BO = 0.52573$, or
$\theta = 58°16'57.1''$
From right triangle BED, the distance of the pyramid's vertex above its pentagonal base is
$DE = EB \tan(\beta - \theta)$. (1)
Now from right triangle AGC,
$GC = AC\sin 54° = 1.15470$.
In right triangle CGH,
$CH = GC/\sin\beta$ and
$GH = GC/\tan\beta$
and from right triangle AHC,
$AH = (AC^2 - CH^2)^{1/2} = [AC^2 - (GC^2)/\sin^2\beta]^{1/2}$
Since right triangles AHG and RED are similar, we have,
$AH/GH = AE/DE$.
After substituting DE, GH, and AH into the equation above and noting that
$AC = GC\ E/EB$, we get
$[AC^2 - (GC^2)/\sin^2\beta]^{1/2} = AC/(\tan\beta\tan(\beta - \theta)$; or
$(1.42729^2 - 1.15470^2/\sin^2\beta)^{1/2} - 1.42729/[\tan\beta\ \tan(\beta - 58.282526)] = 0$.
Solution to above equation is, $\beta = 78.35928°$.
Thus the dihedral angles are $2\beta = 156°43'6.8''$.
From equation (1) above,
$DE = 0.359$ feet
and the length of the pyramid edges is
$AD = (DE^2 + EA^2)^{1/2} = 1.266$ feet

Also solved by Dennis White, Matthew Fountain, Thomas Chang, and Winslow Hartford.

A/S 3. A four-port device contains only passive linear circuit elements. Using a fixed-frequency sine-wave generator, you can measure the complex impedance Z between two of the terminals, A and B. A variable resistor R is connected across the other two terminals, C and D. What is the locus in the complex plane traced out by Z as R varies from zero (short circuit) to infinity (open circuit)?

The proposer, Randy Barron, claims (thus far without proof) that the curve traced is an arc of a circle. However, Richard Hess has sent us the following non-circular solution:
(1) Assume $Z_0 = x + iy$ and R is in parallel with it. Then, the totalimpedance is
$Z = Z_0R/(R + Z_0)$
$= (Rx + iRy)/(R + x + iy)$
$= (R^2x + Rx^2 + Ry^2 + iyR^2)/(R^2 + ZRx + x^2 + y^2)$
(2) The trace of Z as R goes from 0 to ∞, Z goes from 0 to Z_0 along traces as shown below:



A/S 4. Fill in the boxes with the digits 1,2,3...,9:
□□^{min}:□□^{sec} x □ = □□^{min}: □□^{sec}

William Maimone submitted the following solution:
The temporal multiplication problem may be reduced through the application of the following steps:

[x1] [x2] : [x3] [x4] × [x5] = [x6] [x7] : [x8] [x9]

1. Since the maximum number of minutes or seconds is 60, x1, x3, and x8 must all be ≤ 5.
2. Since no number can be repeated, x5 ≠1.
3. Since x5 > 1, × 1 ≤ 2.
4. Since x1 = 2 would force x5 = 3, which would yield a product greater than 60 minutes, x1 must be 1.
5. Since x3, x5, and x8 must all be between 2 and 5, no other positions can be between 2 and 5.
6. Since the smallest x3x4 is 16, and 4 × 16 > 60, x5 < 4. Therefore x5 must be 2 or 3.
7. Since the smallest x5 × the smallest x1x2 = 32, x6 ≠ 2.
8. Since no product of 2 or 3 and 7 yields a valid x9, x4 ≠ 7. This leaves only 2, 3, 4 or 5 for x3 and 6, 8, or 9 for x4.
9. Since letting x3 = 3 would force x5 = 2, and 2 × 36, 38, or 39 would force x8 = 1, x3 ≠ 3.
10. Since letting x3 =2 would force x5 = 3, and x × 26, 28, or 29 would force x8 = 1, x3 ≠ 2.
11. Since no number can be used twice, most possible seconds left multiplied by 2 or 3 can be eliminated, leaving valid x3x4 × x5 combinations of 48 × 2, 49 × 2, 49 × 3, and 56 × 3.
12. Obviously, x3 ≠ 2, x3 ≠ 3, and due to the products of these combinations, x8 ≠ 5, and x9 ≠ 9.
13. Since x3 and x6 cover 4 and 5, x8 ≠ 4.
14. Since x8 ≠ 4, 56 × 3 cannot work, so x3 ≠ 5, and x4 ≠ 6. Then x3 = 4 and x6 = 5.
15. Since x4 is 6, 8, or 9 and x9 is 6, 7, or 8, x5 ≠ 2, so x5 = 3 and x8 = 2.
16. Since x6 = 5 and x5 = 3, x2 ≠ 6.
17. Finally, x4 = 9, x9 = 7, x2 = 8, x7 =6. So the result is:

[1] [8] : [4] [9] × [3] = [5] [6] : [2] [7]

Also solved by Howard Stern, John T. Coleman, Ronald Ort, Dennis White, Harry Zaremba, David Cohen, Avi Ornstein, Matthew Fountain, Winslow Hartford, Steve Feldman, Rik Anderson, Jacob Bergmann, Charles Rivers, Victor Newton, Norman Spencer, George Peckar, Jerry Horton, Mary Lindenberg, Michael Hennessey, John Cushnie, and Ross Hoffman.

A/S 5. It began to snow on a certain morning, and the snow continued to fall steadily throughout the day. At noon, a snowplow started to clear a road at a constant rate in terms of the volume of snow removed per hour. The snowplow cleared two miles by 2 p.m. and one more mile by 4 p.m. At what time had the snowstorm begun?

This final solution is from John Cushnie:
Assumptions:
t = hours after start of snow
T = hours of snow before noon
D = snowfall rate, feet per hour
C = flow capacity (12" path), cubic feet per hour
Solution:
At t hours, snow depth = Dt feet and plow velocity = C/Dt feet per hour
d(distance) = (velocity)dt = (C/D)(dt/t)

$$\text{Distance} = (C/D) \times \int_{t_1}^{t_2} (dt/t) = (C/D)(\ln t)_{t_1}^{t_2}$$

For noon to 2 p.m., $t_1 = T$ and $t_2 = T + 2$ and distance =

$$(C/D)(\ln t)_T^{T+2}$$

For 2 p.m. to 4 p.m., $t_1 = T + 2$ and $t_2 = T + 4$ and distance =

$$(C/D)(\ln t)_{T+2}^{T+4}$$

Since 2 p.m. to 4 p.m. distance = 0.5 × noon to 2 p.m. distance,
$(C/D)(\ln t)_{T+2}^{T+4} = 0.5 \times (C/D)(\ln t)_T^{T+2}$

Therefore, $\ln(T + 4) - \ln(T + 2) = 0.5 \times \ln(T + 2) - 0.5 \times \ln(T)$
$\ln(T + 4) + 0.5 \times \ln(T) = 1.5 \times \ln(T + 2)$
$\ln(T + 4)\sqrt{T} = \ln(T + 2)\sqrt{T + 2}$
$(T + 4)\sqrt{T} = (T + 2)\sqrt{T + 2}$

Squaring,
$T^3 + 8T^2 + 16T = T^2(T + 2) + 4T(T + 2) + 4(T + 2)$
$T^3 + 8T^2 + 16T = T^3 + 2T^2 + 4T^2 + 8T + 4T + 8$
$T^3 + 8T^2 + 16T = T^3 + 6T^2 + 12T + 8$
$2T^2 + 4T - 8 = 0$

Solving for T,
$T = [-4 \mp \sqrt{16 - 4(2)(-8)}]/4$
$= (-4 \mp \sqrt{80})/4 = 1.236068$ hours before noon, or at 10 o'clock, 44 minutes and 50$^+$ seconds

Also solved by Richard Hess, Mary Lindenberg, Charles Sutton, Victor Newton, Norman Spencer, Pierre Heftler, Mike Hennessey, Ross Hoffman, Frank Carbin, Raymond Gaillard, Charles Rivers, Richmond Perley, Jerry Horton, Jacob Bergmann, Rik Anderson, Kelly Woods, Danny Mintz, Avi Ornstein, Gardner Perry, Sam Levitin, W. Gale Cutler, and the proposer, Bruce Calder.

Better Late Than Never

Jul 1. Dan Jones has responded.

Jul 4. Hal Vose has responded.

Proposers' Solutions to Speed Problems

SD 1. E1GHT.
Consider FIVE SIX SEVEN EIGHT and convert the Roman numerals to Arabic.

SD 2.

A dozen, a gross, and a score,
Plus three times the square root of four,
Divided by seven,
Plus five times eleven,
Equals nine squared plus not a bit more.

GIVE HER A DIAMOND WITH A FIRE TO MAKE THE STARS BURN WITH ENVY.

Every quality diamond of a carat or more is one of nature's rarest and most exquisite phenomena. Each is a visible reflection of you. Unique in all the world, possessing four vital qualities that set it apart forever. They are called the 4C's: Cut, Color, Clarity and Carat-weight. It is the 4C characteristics that determine the value of a diamond—and to an astonishing degree the beauty and value of your jewelry—no matter what the design.

Your jeweler is the expert where diamonds are concerned. His knowledge can help make the acquisition of a quality diamond of a carat or more the beautiful, rewarding experience it should be.

Give her a quality diamond of a carat or more. A truly rare and beautiful gift. Like the woman you love.

A diamond is forever.

The ring shown features a quality diamond of 2.04 carats.

A QUALITY DIAMOND OF A CARAT OR MORE.
A FIRE RARELY SEEN.

Why Computers May Never Think Like People

BY HUBERT AND STUART DREYFUS

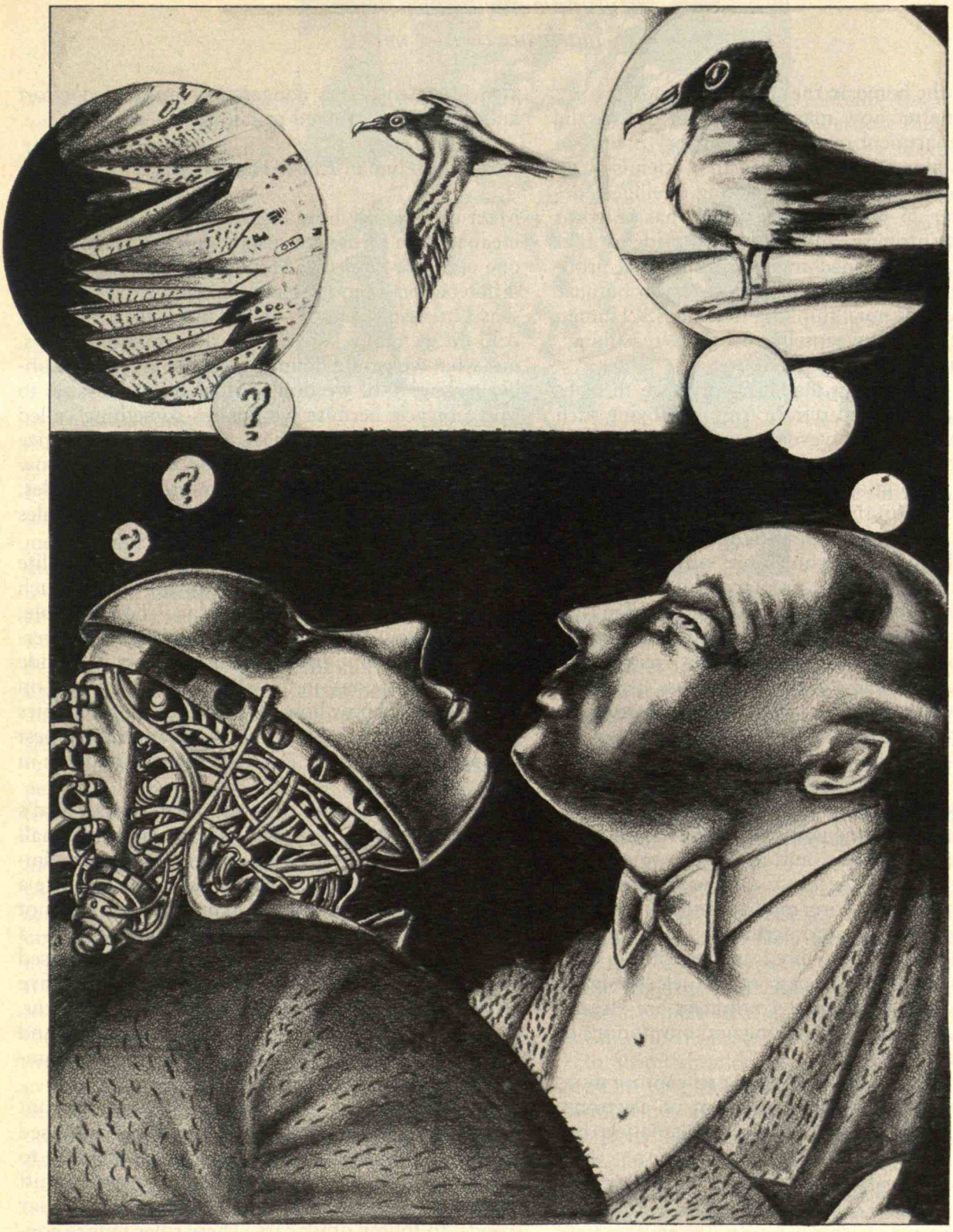
SCIENTISTS who stand at the forefront of artificial intelligence (AI) have long dreamed of autonomous "thinking" machines that are free of human control. And now they believe we are not far from realizing that dream. As Marvin Minsky, a well-known AI professor at M.I.T, recently put it: "Today our robots are like toys. They do only the simple things they're programmed to. But clearly they're about to cross the edgeless line past which they'll do the things we are programmed to."

Patrick Winston, Minsky's successor as head of the M.I.T. AI Laboratory, agrees: "Just as the Wright Brothers at Kitty Hawk in 1903 were on the right track to the 747s of today, so artificial intelligence, with its attempt to formalize common-sense understanding, is on the way to fully intelligent machines."

Encouraged by such optimistic pronouncements, the U.S. Department of Defense (DOD) is sinking millions of dollars into developing fully autonomous war machines that will respond to a crisis without human intervention. Business executives are investing in "expert" systems whose wisdom they hope will equal, if not surpass, that of their top managers. And AI entrepreneurs are talking of "intelligent systems" that will perform better than

Machine intelligence will probably never replace human expertise—in teaching, healing, or fighting wars—because we ourselves are not "thinking machines."

ILLUSTRATIONS: EUGENE YELCHIN



Human beings have an intuitive intelligence that "reasoning" machines cannot match.

we can—in the home, in the classroom, and at work.

But no matter how many billions of dollars the Defense Department or any other agency invests in AI, there is almost no likelihood that scientists can develop machines capable of making intelligent decisions. After 25 years of research, AI has failed to live up to its promise, and there is no evidence that it ever will. In fact, machine intelligence will probably never replace human intelligence simply because we ourselves are not "thinking machines." Human beings have an intuitive intelligence that "reasoning" machines simply cannot match.

Military and civilian managers may see this obvious shortcoming and refrain from deploying such "logic" machines. However, once various groups have invested vast sums in developing these machines, the temptation to justify this expense by installing questionable AI technologies will be enormous. The dangers of turning over the battlefield completely to machines are obvious. But it would also be a mistake to replace skilled air-traffic controllers, seasoned business managers, and master teachers with computers that cannot come close to their level of expertise. Computers that "teach" and systems that render "expert" business decisions could eventually produce a generation of students and managers who have no faith in their own intuition and expertise.

We wish to stress that we are not Luddites. There are obvious tasks for which computers are appropriate and even indispensable. Computers are more deliberate, more precise, and less prone to exhaustion and error than the most conscientious human being. They can also store, modify, and tap vast files of data more quickly and accurately than humans can. Hence, they can be used as valuable tools in many areas. As word processors and telecommunication devices, for instance, computers are already changing our methods of writing and our notions of collaboration.

However, we believe that trying to capture more sophisticated skills within the realm of electronic circuits—skills involving not only calculation but also judgment—is a dangerously misguided effort and ultimately doomed to failure.

HUBERT DREYFUS is professor of philosophy and STUART DREYFUS, his brother, is professor of industrial engineering and operations research at the University of California, Berkeley. This article was drawn from their forthcoming book Mind over Machine *(Macmillan: The Free Press, February 1986). The book explores the effects of the belief that people and computers think alike—on business management, education, national defense, medicine, law, and society at large.*

Acquiring Human Know-How

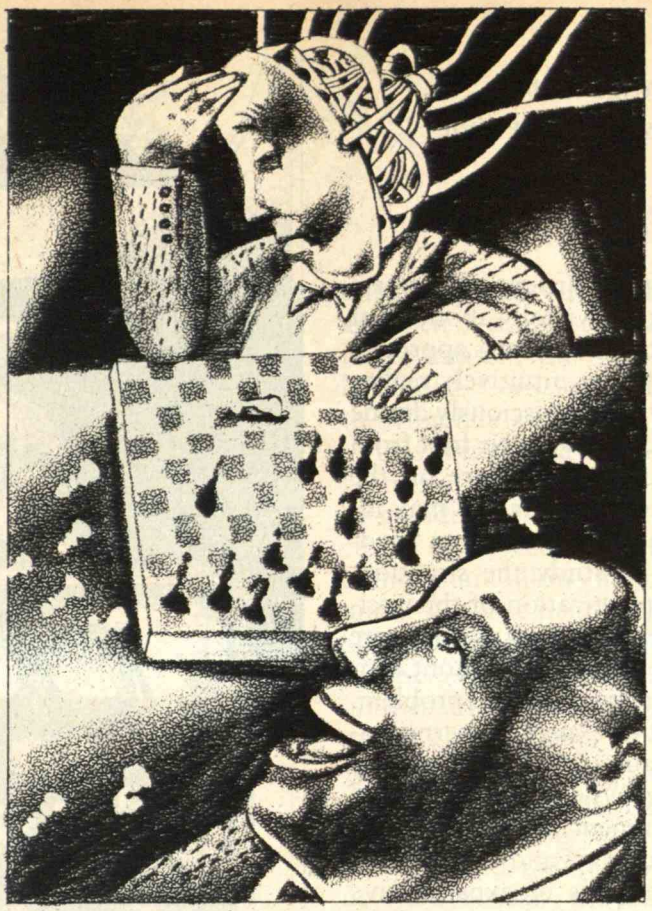
Most of us know how to ride a bicycle. Does that mean we can formulate specific rules to teach someone else how to do it? How would we explain the difference between the feeling of falling over and the sense of being slightly off-balance when turning? And do we really know, until the situation occurs, just what we would do in response to a certain wobbly feeling? No, we don't. Most of us are able to ride a bicycle because we possess something called "know-how," which we have acquired from practice and sometimes painful experience. That know-how is not accessible to us in the form of facts and rules. If it were, we could say we "know that" certain rules produce proficient bicycle riding.

There are innumerable other aspects of daily life that cannot be reduced to "knowing that." Such experiences involve "knowing how." For example, we know how to carry on an appropriate conversation with family, friends, and strangers in a wide variety of contexts—in the office, at a party, and on the street. We know how to walk. Yet the mechanics of walking on two legs are so complex that the best engineers cannot come close to reproducing them in artificial devices.

This kind of know-how is not innate, as is a bird's skill at building a nest. We have to learn it. Small children learn through trial and error, often by imitating those who are proficient. As adults acquire a skill through instruction and experience, they do not appear to leap suddenly from "knowing that"—a knowledge guided by rules—to experience-based know-how. Instead, people usually pass through five levels of skill: novice, advanced beginner, competent, proficient, and expert. Only when we understand this dynamic process can we ask how far the computer could reasonably progress.

During the novice stage, people learn facts relevant to a particular skill and rules for action that are based on those facts. For instance, car drivers learning to operate a stick shift are told at what speed to shift gears and at what distance—given a particular speed—to follow other cars. These rules ignore context, such as the density of traffic or the number of stops a driver has to make.

Similarly, novice chess players learn a formula for



assigning pieces point values independent of their position. They learn the rule: "Always exchange your pieces for the opponent's if the total value of the pieces captured exceeds that of pieces lost." Novices generally do not know that they should violate this rule in certain situations.

After much experience in real situations, novices reach the advanced-beginner stage. Advanced-beginner drivers pay attention to situational elements, which cannot be defined objectively. For instance, they listen to engine sounds when shifting gears. They can also distinguish between the behavior of a distracted or drunken driver and that of the impatient but alert driver. Advanced-beginner chess players recognize and avoid overextended positions. They can also spot situational clues such as a weakened king's side or a strong pawn structure. In all these cases, experience is immeasurably more important than any form of verbal description.

Like the training wheels on a child's first bicycle, initial rules allow beginners to accumulate experience. But soon they must put the rules aside to proceed. For example, at the competent stage, drivers no longer merely follow rules; they drive with a goal in mind. If they wish to get from point A to point B very quickly, they choose their route with an eye to traffic but not much attention to passenger comfort. They follow other cars more closely than they are "supposed" to, enter traffic more daringly, and even break the law. Competent chess players may decide, after weighing alternatives, that they can attack their opponent's king. Removing pieces that defend the enemy king becomes their overriding objective, and to reach it these players will ignore the lessons they learned as beginners and accept some personal losses.

A crucial difference between beginners and more competent performers is their level of involvement. Novices and advanced beginners feel little responsibility for what they do because they are only applying learned rules; if they foul up, they blame the rules instead of themselves. But competent performers, who choose a goal and a plan for achieving it, feel responsible for the result of their choices. A successful outcome is deeply satisfying and leaves a vivid memory. Likewise, disasters are not easily forgotten.

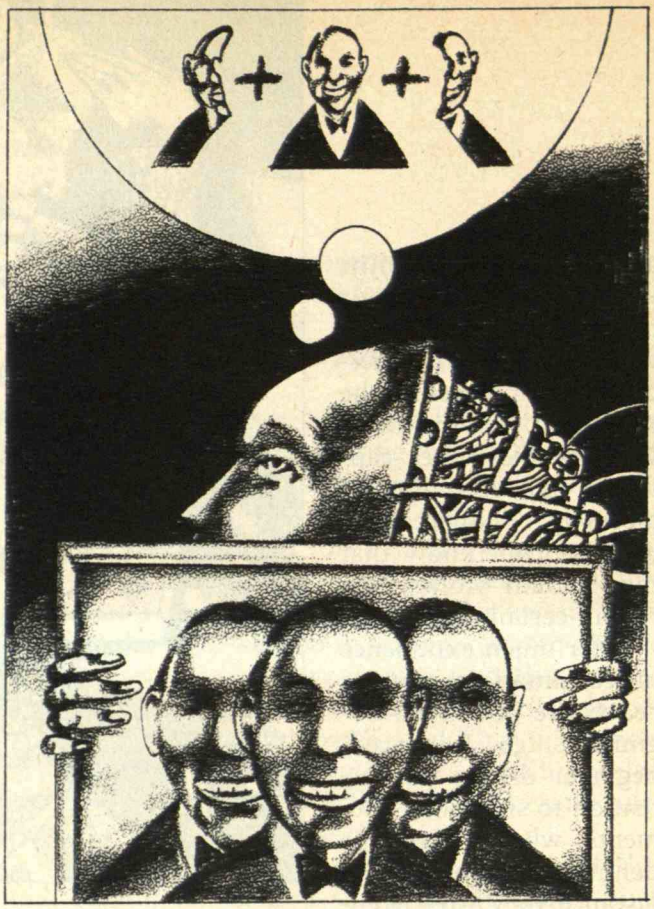
The Intuition of Experts

The learner of a new skill makes conscious choices after reflecting on various options. Yet in our everyday behavior, this model of decision making—the detached, deliberate, and sometimes agonizing selection among alternatives—is the exception rather than the rule. Proficient performers do not rely on detached deliberation in going about their tasks. Instead, memories of similar experiences in the past seem to trigger plans like those that worked before. Proficient performers recall whole situations from the past and apply them to the present without breaking them down into components or rules.

For instance, a boxer seems to recognize the moment to begin an attack not by following rules and combining various facts about his body's position and that of his opponent. Rather, the whole visual scene triggers the memory of similar earlier situations in which an attack was successful. The boxer is using his intuition, or know-how.

Intuition should not be confused with the reenactment of childhood patterns or any of the other unconscious means by which human beings come to decisions. Nor is guessing what we mean by intuition. To guess is to reach a conclusion when one does not have enough knowledge or experience to do so. Intuition or know-how is the sort of ability that we use all the time as we go about our everyday tasks. Ironically, it is an ability that our tradition has acknowledged only in women and judged inferior to masculine rationality.

Human beings seem to compare images in a way that computational procedures cannot capture.



While using their intuition, proficient performers still find themselves thinking analytically about what to do. For instance, when proficient drivers approach a curve on a rainy day, they may intuitively realize they are going too fast. They then consciously decide whether to apply the brakes, remove their foot from the accelerator, or merely reduce pressure on the accelerator. Proficient marketing managers may intuitively realize that they should reposition a product. They may then begin to study the situation, taking great pride in the sophistication of their scientific analysis while overlooking their much more impressive talent—that of recognizing, without conscious thought, the simple existence of the problem.

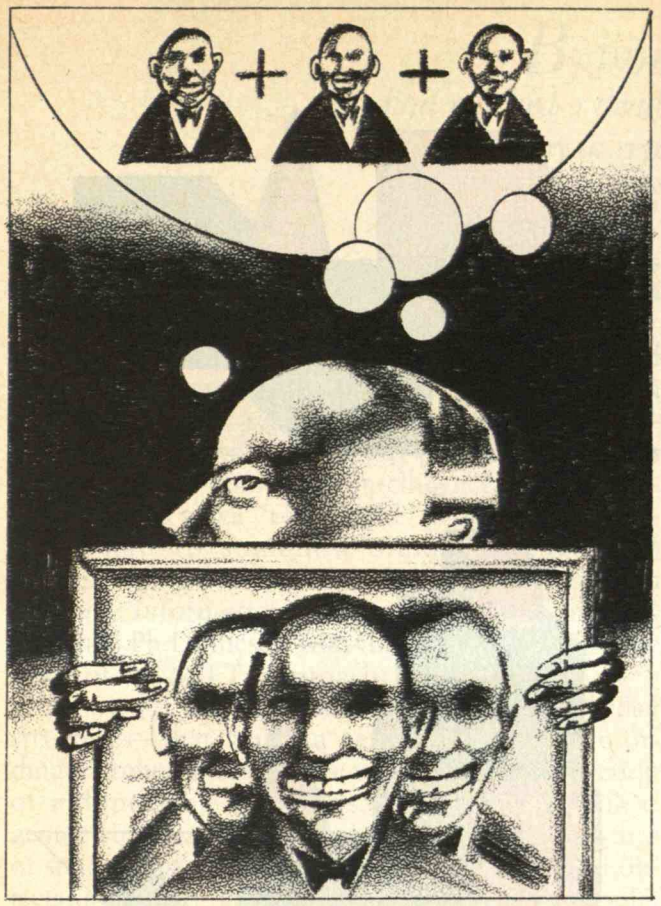
The final skill level is that of expert. Experts generally know what to do because they have a mature and practiced understanding. When deeply involved in coping with their environment, they do not see problems in some detached way and consciously work at solving them. The skills of experts have become so much a part of them that they need be no more aware of them than they are of their own bodies. Airplane pilots report that as novices they felt they were flying their planes, but as experienced pilots they simply experience flying itself. Grand masters of chess, engrossed in a game, are often oblivious to the fact that they are manipulating pieces on a board. Instead, they see themselves as participants in a world of opportunities, threats, strengths, weaknesses, hopes, and fears. When playing rapidly, they sidestep dangers as automatically as teenagers avoid missiles in a familiar video game.

One of us, Stuart, knows all too well the difference between expert and merely competent chess players; he is stuck at the competent level. He took up chess as an outlet for his analytic talent in mathematics, and most of the other players on his college team were also mathematicians. At some point, a few of his teammates who were not mathematicians began to play fast five- or ten-minute games of chess, and also began eagerly to replay the great games of the grand masters. But Stuart and his mathematical colleagues resisted because fast chess didn't give them the time to *figure out* what to do. They also felt that they could learn nothing from the grand master games, since the record of those games seldom if ever provided specific rules and principles.

Some of his teammates who played fast chess and studied grand-master games absorbed a great deal of concrete experience and went on to become chess masters. Yet Stuart and his mathematical friends never got beyond the competent level. Students of math may predominate among chess enthusiasts, but a truck driver is as likely as a mathematician to be among the world's best players. Stuart says he is glad that his analytic approach to chess stymied his progress because it helped him to see that there is more to skill than reasoning.

When things are proceeding normally, experts do not solve problems by reasoning; they do what normally works. Expert air-traffic controllers do not watch blips on a screen and deduce what must be going on in the sky. Rather, they "see" planes when they look at their screens and they respond to what they see, not by using rules but as experience has taught them to. Skilled outfielders do not take the time to figure out where a ball is going. Unlike novices, they simply run to the right spot. In *The Brain*, Richard Restak quotes a Japanese martial artist as saying, "There can be no thought, because if there is thought, there is a time of thought and that means a flaw . . . If you take the time to think, 'I must use this or that technique', you will be struck while you are thinking."

We recently performed an experiment in which an international chess master, Julio Kaplan, had to add numbers at the rate of about one per second while playing five-second-a-move chess against a



slightly weaker but master-level player. Even with his analytical mind apparently jammed by adding numbers, Kaplan more than held his own against the master in a series of games. Deprived of the time necessary to see problems or construct plans, Kaplan still produced fluid and coordinated play.

As adults acquire skills, what stands out is their progression *from* the analytic behavior of consciously following abstract rules *to* skilled behavior based on unconsciously recognizing new situations as similar to remembered ones. Conversely, small children initially understand only concrete examples and gradually learn abstract reasoning. Perhaps it is because this pattern in children is so well known that adult intelligence is so often misunderstood.

By now it is evident that there is more to intelligence than calculative rationality. In fact, experts who consciously reason things out tend to regress to the level of a novice or, at best, a competent performer. One expert pilot described an embarrassing incident that illustrates this point. Once he became an instructor, his only opportunity to fly the four-jet KC-135s at which he had once been expert was during the return flights he made after evaluating trainees. He was approaching the landing strip on one such flight when an engine failed. This is technically an emergency, but an experienced pilot will effortlessly compensate for the pull to one side. Being out of practice, our pilot thought about what to do and then overcompensated. He then consciously corrected himself, and the plane shuddered violently as he landed. Consciously using rules, he had regressed to flying like a beginner.

This is not to say that deliberative rationality has no role in intelligence. Tunnel vision can sometimes be avoided by a type of detached deliberation. Focusing on aspects of a situation that seem relatively unimportant allows another perspective to spring to mind. We once heard an Israeli fighter pilot recount how deliberative rationality may have saved his life by rescuing him from tunnel vision. Having just vanquished an expert opponent, he found himself taking on another member of the enemy squadron who seemed to be brilliantly eluding one masterful ploy after another. Things were looking bad until he stopped following his intuition and deliberated. He then realized that his opponent's surprising manuevers were really the predictable, rule-following behavior of a beginner. This insight enabled him to vanquish the pilot.

Is Intelligence Based on Facts?

Digital computers, which are basically complicated structures of simple on-off switches, were first used for scientific calculation. But by the end of the fifties, researchers such as Allen Newell and Herbert Simon, working together at the Rand Corp., began to exploit the idea that computers could manipulate general symbols. They saw that one could use symbols to represent elementary facts about the world and rules to represent relationships between the facts. Computers could apply these rules and make logical inferences about the facts. For instance, a programmer might give a computer rules about how cannibals like to eat missionaries, and facts about how many cannibals and missionaries must be ferried across a river in one boat that carries only so many people. The computer could then figure out how many trips it would take to get both the cannibals and the missionaries safely across the river.

Newell and Simon believed that computers programmed with such facts and rules could, in principle, solve problems, recognize patterns, understand stories, and indeed do anything that an intelligent person could do. But they soon found that their programs were missing crucial aspects of problem solving, such as the ability to separate relevant from

Will you please stack up both of the red blocks and either a green cube or a pyramid?

OK

Which cube is sitting on the table?

The large green one which supports the red pyramid.

Put a small cube onto the green cube which supports a pyramid.

OK

Put the littlest pyramid on top of it.

OK

How many things are on top of green cubes?

I'm not sure what you mean by "on top of" in the phrase "on top of green cubes." Do you mean:
1—Directly on the surface
2—Anywhere on top of?

2

Three of them.

Had you touched any pyramid before you put the green one on the little cube?

Yes, the green one.

When did you pick it up?

While I was stacking up the red cube a large red block and a large green cube.

Why?

To get rid of it.

Why did you do that?

To clear off the red cube.

Why did you clear off that cube?

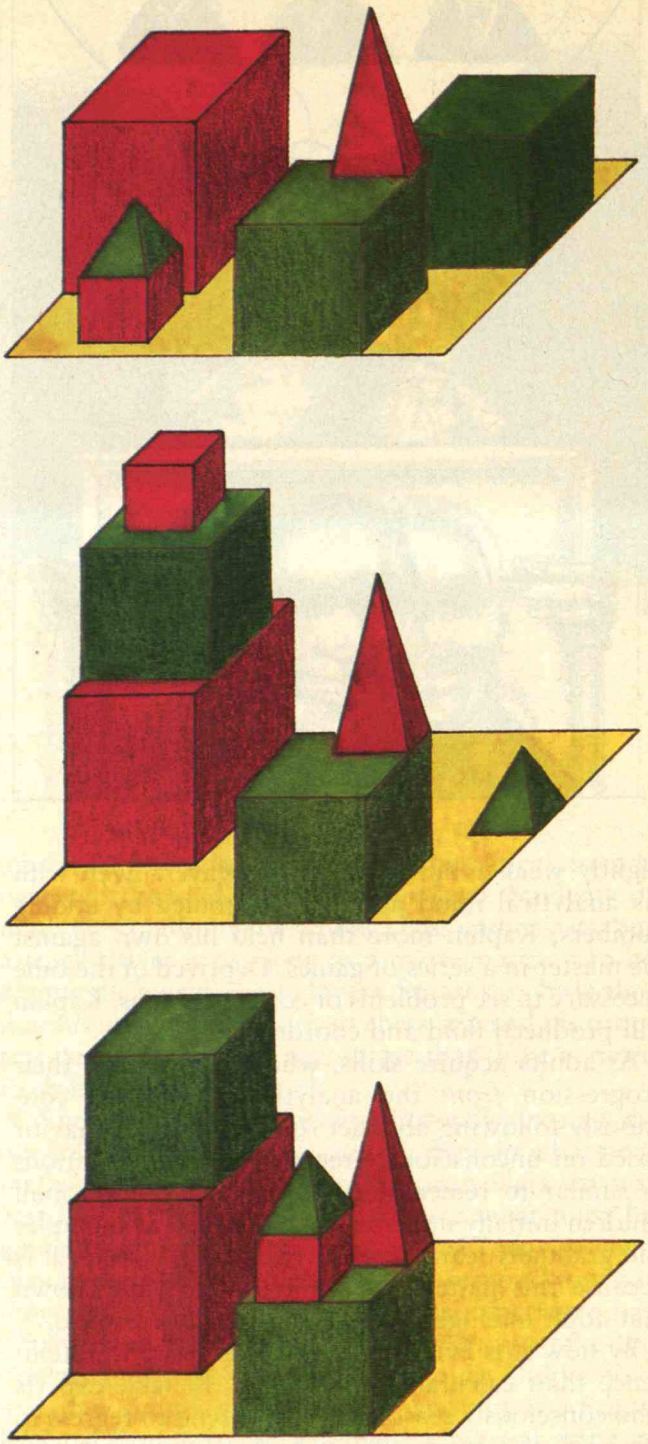
To put it on a large green cube.

Why did you do that?

To stack up the red cube, a large red block and a large green cube.

Why did you do that?

Because you asked me to.



In the mid-1970s, an M.I.T. graduate student devised a program that allows its user to engage the computer in a dialogue about moving colored blocks. The program, called SHRDLU, enables the user to pose questions, make statements, and issue commands to a simulated robot arm that moves the blocks. AI researchers hailed SHRDLU as a "major advance" in allowing computers to understand natural language. However, the program works only in a restricted "microworld": its techniques cannot be generalized to other problems in everyday life. (Diagram adapted from *Scientific American*)

DRAWING: CYNDY PATRICK

By 1970 AI research had reached a dead end, since it could not find a way to represent common-sense understanding.

irrelevant operations. As a result, the programs worked in only a very limited set of cases, such as in solving puzzles and proving theorems of logic.

In the late sixties, researchers at M.I.T. abandoned Newell and Simon's approach, which was based on imitating peoples' reports of how they solved problems, and began to work on any processing methods that could give computers intelligence. They recognized that to solve "real-world" problems the computer had to somehow simulate real-world understanding and intuition. In the introduction to *Semantic Information Processing*, a collection of his students' Ph.D. theses, Marvin Minsky describes the heart of the M.I.T. approach:

"If we . . . ask . . . about the common everyday structures—that which a person needs to have ordinary common sense—we will find first a collection of indispensable categories, each rather complex: geometrical and mechanical properties of things and of space; uses and properties of a few thousand objects; hundreds of 'facts' about hundreds of people; thousands of facts about tens of people; tens of facts about thousands of people; hundreds of facts about hundreds of organizations . . . I therefore feel that a machine will quite critically need to acquire on the order of a hundred thousand elements of knowledge in order to behave with reasonable sensibility in ordinary situations. A million, if properly organized, should be enough for a very great intelligence."

However, Minsky's students encountered the same problem that had plagued Newell and Simon: each program worked only in its restricted specialty and could not be applied to other problems. Nor did the programs have any semantics—that is, any understanding of what their symbols meant. For instance, Daniel Bobrow's STUDENT program, which was designed to understand and solve elementary algebraic story problems, interpreted the phrase "the number of times I went to the movies" as the product of the two variables "number of" and "I went to the movies." That's because, as far as the program knew, "times" was a multiplicative operator linking the two phrases.

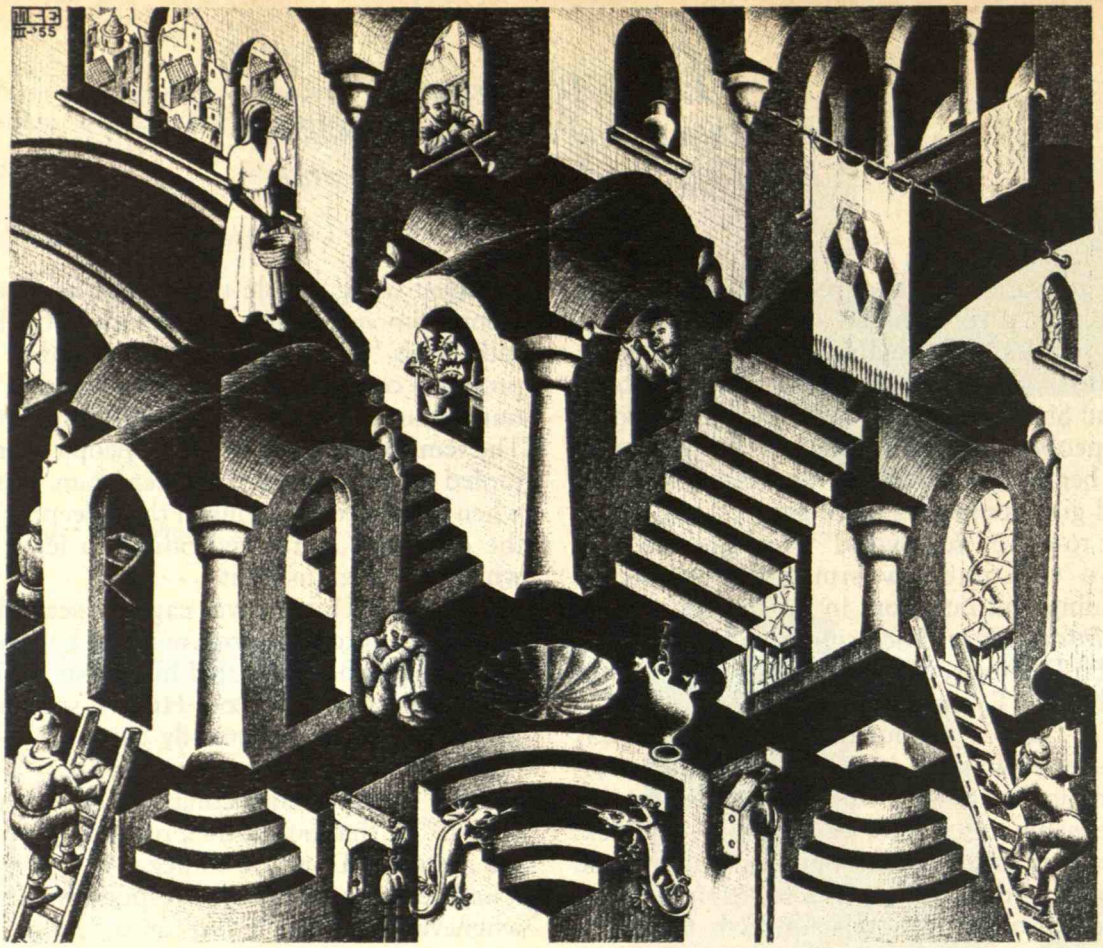
The restricted, ad hoc character of such work is even more striking in a program called ELIZA, written by M.I.T. computer science professor Joseph Weizenbaum. Weizenbaum set out to show just how much apparent intelligence one could get a computer to exhibit without giving it any real understanding at all. The result was a program that imitated a therapist using simple tricks such as turning statements into questions: it responded to "I'm feeling sad" with "Why are you feeling sad?" When the program couldn't find a stock response, it printed out statements such as "Tell me about your father." The remarkable thing was that people were so easily fooled by these tricks. Weizenbaum was appalled when some people divulged their deepest feelings to the computer and asked others to leave the room while they were using it.

One of us, Hubert, was eager to see a demonstration of the notorious program, and he was delighted when Weizenbaum invited him to sit at the console and interact with ELIZA. Hubert spoiled the fun, however. He unintentionally exposed how shallow the trickery really was by typing, "I'm feeling happy," and then correcting himself by typing, "No, elated." At that point, the program came back with the remark, "Don't be so negative." Why? Because it had been programmed to respond with that rebuke whenever there was a "no" in the input.

Microworlds versus the Real World

It took about five years for the shallowness of Minsky's students' programs to become apparent. Meanwhile, Hubert published a book, *What Computers Can't Do,* which asserted that AI research had reached a dead end since it could not come up with a way to represent general common-sense understanding. But just as *What Computers Can't Do* went to press in 1970, Minsky and Seymour Papert, also a professor at M.I.T., developed a new approach to AI. If one could not deal systematically with common-sense knowledge all at once, they asked, then why not develop methods for dealing systematically with knowledge in isolated sub-worlds and build gradually from that?

Shortly after that, M.I.T. researchers hailed a computer program by graduate student Terry Winograd as a "major advance" in getting computers to understand human language. The program, called SHRDLU, simulated on a TV screen a robot arm that could move a set of variously shaped blocks. The program allowed a person to engage in a dialogue with the computer, asking questions, making statements, and issuing commands within this simple world of movable blocks. The program relied on grammatical rules, semantics, and facts about blocks. As Winograd cautiously claimed, SHRDLU



was a "computer program which 'understands' language in a limited domain."

Winograd achieved success in this restricted domain, or "microworld," because he chose a simple problem carefully. Minsky and Papert believed that by combining a large number of these microworlds, programmers could eventually give computers real-life understanding.

Unfortunately, this research confuses two domains, which we shall distinguish as "universe" and "world." A set of interrelated facts may constitute a "universe" such as the physical universe, but it does not constitute a "world" such as the world of business or theater. A "world" is an organized body of objects, purposes, skills, and practices that make sense only against a background of common human concerns. These "sub-worlds" are not isolable physical systems. Rather, they are specific elaborations of a whole, without which they could not exist.

If Minsky and Papert's microworlds *were* true subworlds, they would not have to be extended and combined to encompass the everyday world, because each one would already incorporate it. But since microworlds are only isolated, meaningless domains, they cannot be combined and extended to reflect everyday life. Because scientists failed to ask what a "world" is, another five-year period of AI research ended in stagnation.

Winograd himself soon gave up the attempt to generalize the techniques SHRDLU used. "The AI programs of the late sixties and early seventies are much too literal," he acknowledged in a report for the National Institute of Education. "They deal with meaning as if it were a structure to be built up of the bricks and mortar provided by the words."

From the late seventies to the present, AI has been wrestling unsuccessfully with what is called the common-sense knowledge problem: how to store and gain access to all the facts human beings seem to know. This problem has kept AI from even beginning to fulfill the predictions Minsky and Simon made in the mid-sixties: that within 20 years computers would be able to do everything humans can.

Can Computers Cope with Change?

If a machine is to interact intelligently with people, it has to be endowed with an understanding of human life. What we understand simply by virtue of being human—that insults make us angry, that moving physically forward is easier than moving backward—all this and much more would have to be programmed into the computer as facts and rules. As AI workers put it, they must give the computer our belief system. This, of course, presumes that human understanding is made up of beliefs that can be

ILLUSTRATION: M. C. ESCHER

What we understand simply by virtue of being human cannot be programmed into computers.

readily collected and stored as facts.

Even if we assume that this is possible, an immediate snag appears: we cannot program computers for context. For instance, we cannot program a computer to know simply that a car is going "too fast." The machine must be programmed in a way free of interpretation—we must stipulate that the car is going "20 miles an hour," for example. Also, computers know what to do only by reference to precise rules, such as "shift to second at 20 miles an hour." Computer programmers cannot use common-sense rules, such as "under normal conditions, shift to second at about 20 miles an hour."

Even if all the facts were stored in a context-free form, the computer still couldn't use them because it would be unable to draw on just the facts or rules that are relevant in each particular context. For example, a general rule of chess is that you should trade material when you're ahead in the value of the pieces on the board. However, you should not apply that rule if the opposing king is much more centrally located than yours, or when you are attacking the enemy king. And there are exceptions to each of these exceptions. It is virtually impossible to include all the possible exceptions in a program and do so in such a way that the computer knows which exception to use in which case.

In the real world, any system of rules has to be incomplete. The law, for instance, always strives for completeness but never achieves it. "Common law" helps, for it is based more on precedents than on a specific code. But the sheer number of lawyers in business tells us that it is impossible to develop a code of law so complete that all situations are unambiguously covered.

To explain our own actions and rules, humans must eventually fall back on everyday practices and simply say, "This is what one does." In the final analysis, all intelligent behavior must hark back to our sense of what we *are*. We can never explicitly formulate this in clear-cut rules and facts; therefore, we cannot program computers to possess that kind of know-how.

Nor can we program them to cope with changes in everyday situations. AI researchers have tried to develop computer programs that describe a normal sequence of events as they unfold. One such script, for instance, details what happens when someone goes to a restaurant. The problem is that so many unpredictable events can occur—one can receive an emergency telephone call or run into an acquaintance—that it's virtually impossible to predict how different people will respond. It all depends on what else is going on and what their specific purpose is. Are these people there to eat, to hobnob with friends, to answer phone calls, or to give the waiters a hard time? To make sense of behavior in restaurants, one has to understand not only what people typically do in eating establishments but why they do it. Thus, even if programmers could manage to list all that is *possibly* relevant in typical restaurant dining, computers could not use the information because they would have no understanding of what is *actually* relevant to specific customers.

Thinking with Images, Not Words

Experimental psychologists have shown that people actually use images, not descriptions as computers do, to understand and respond to some situations. Humans often think by forming images and comparing them holistically. This process is quite different from the logical, step-by-step operations that logic machines perform.

For instance, human beings use images to predict how certain events will turn out. If people know that a small box is resting on a large box, they can imagine what would happen if the large box were moved. If they see that the small box is tied to a door, they can also imagine what would result if someone were to open the door. A computer, however, must be given a list of facts about boxes, such as their size, weight, and frictional coefficients, as well as information about how each is affected by various kinds of movements. Given enough precise information about boxes and strings, the computer can deduce whether the small box will move with the large one under certain conditions. People also reason things out in this explicit, step-by-step way—but only if they must think about relationships they have never seen and therefore cannot imagine.

At present, computers have difficulty recognizing images. True, they can store an image as a set of dots and then rotate the set of dots so that a human designer can see the object from any perspective. But to know what a scene depicts, a computer must be able to analyze it and recognize every object. Programming a computer to analyze a scene has turned out to be very difficult. Such programs require a great deal of computation, and they work only in special

cases with objects whose characteristics the computer has been programmed to recognize in advance.

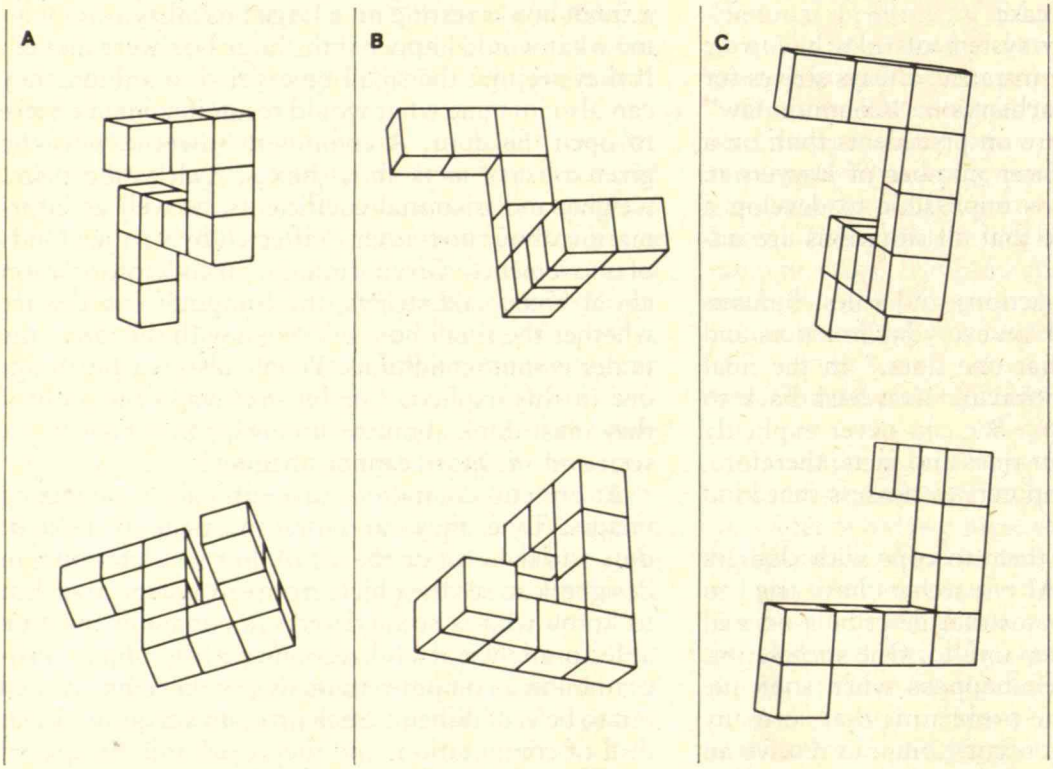
But that is just the beginning of the problem. The computer can make inferences only from lists of facts. It's as if to read a newspaper you had to spell out each word, find its meaning in the dictionary, and diagram every sentence, labeling all the parts of speech. Brains do not seem to decompose either language or images this way, but logic machines have no choice. They must break down images into the objects they contain—and then into descriptions of those objects' features—before drawing any conclusions. However, when a picture is converted into a description, much information is lost. In a family photo, for instance, one can see immediately which people are between, behind, and in front of which others. The programmer must list all these relationships for the computer, or the machine must go through the elaborate process of deducing these relationships each time the photo is used.

Some AI workers look for help from parallel processors, machines that can do many things at once and hence make millions of inferences per second. But this appeal misses the point: that human beings seem to be able to form and compare images in a way that cannot be captured by any number of procedures that operate on descriptions.

Take, for example, face recognition. People can not only form an image of a face, but they can also see the similarity between one face and another. Sometimes the similarity will depend on specific shared features, such as blue eyes and heavy beards. A computer, if it has been programmed to abstract such features from a picture of a face, could recognize this sort of similarity.

However, a computer cannot recognize emotions such as anger in facial expressions, because we know of no way to break down anger into elementary symbols. Therefore, logic machines cannot see the similarity between two faces that are angry. Yet human beings can discern the similarity almost instantly.

Many AI theorists are convinced that human brains unconsciously perform a series of computations to perceive such subtleties. While no evidence for this mechanical model of the brain exists, these theorists take it for granted because it is the way people proceed when they are reflecting consciously.



Psychologist Roger Shepard has shown that people actually use images, not words, to understand and respond to some situations. For instance, when asked to compare two figures (left), people reported that they mentally rotate one of the figures to see if it matches the other.

The figures shown in (A) are identical, as a clockwise turning of this magazine by 80 degrees will prove. The figures in (B) are also identical but those in (C) are not, as no rotation can bring them into congruence.

Like humans, computers can rotate images to check if one image can be superimposed on the other. However, computers do not see these figures as whole images. They have to break them down into lines, angles, and points to compare them.

A computer cannot recognize anger because we know of no way to break down emotion into elementary symbols.

To such theorists, any alternative explanation appears mystical and therefore anti-scientific.

But there is another possibility. The brain, and therefore the mind, could still be explained in terms of something material. But it does not have to be an information-processing machine. Other physical systems can detect similarity without using any descriptions or rules at all. These systems are known as holograms.

Is the Mind Like a Hologram?

An ordinary hologram works by taking a picture of an object using two beams of laser light, one of which is reflected off the object and one of which shines directly onto film. When the two beams meet, they create an interference pattern like that produced by the waves from several pebbles thrown into a pond. The light waves form a specific pattern of light and dark regions. A photographic plate records this interference pattern, thus storing a representation of the object.

In ordinary light, the plate just looks blurry, a uniform silvery gray. But if the right frequency of light is projected onto it, the recorded pattern of light and dark shapes the light into a replica of the object. This replica appears three-dimensional: we can view different sides of it as we change position.

What first attracted neuropsychologists to the hologram was that it really is holistic: any small piece of the blur on the photographic plate contains the whole scene. For example, if you cut one corner off a hologram of a table and shine a laser beam through what remains, you do not see an image of a table with a corner missing. The whole table is still there but with fuzzier edges.

Certain areas of the brain also have this property. When a piece is cut out, a person may lose nothing specific from vision, for example. Instead, that person may see everything less distinctly. Holograms have another mindlike property: they can be used for associative memory. If one uses a single hologram to record two different scenes and then bounces laser light off one of the scenes, an image of the other will appear.

In our view, the most important property of holograms is their ability to detect similarity. For example, if we made a hologram of this page and then made a hologram of one of the letters on the page, say the letter *F*, shining a light through the two holograms would reveal an astonishing effect: a black field with bright spots wherever the letter *F* occurs on the page. Moreover, the brightest spots would indicate the *F*s with the greatest similarity to the *F* we used to make our hologram. Dimmer spots would appear where there are imperfect or slightly rotated versions of the *F*. Thus, a hologram can not only identify objects; it can also recognize similarity between them. Yet it employs no descriptions or rules.

The way a hologram can instantly pick out a specific letter on a page is reminiscent of the way people pick out a familiar face from a crowd. It is possible that we distinguish the familiar face from all the other faces by processing rules about objectively identifiable features. But we would have to examine each face in the crowd, detect its features, and compare them with lists of our acquaintances' features. It is much more plausible that our minds work on some variation of the holistic model. While the brain obviously does not contain lasers or use light beams, some scientists have suggested that neurons could process incoming stimuli using interference patterns like those of a hologram.

However, the human mind seems to have an ability that far transcends current holographic techniques: the remarkable ability to recognize whole meaningful patterns without decomposing them into features. Unlike holography, our mind can sometimes detect faces in a crowd that have expressions unlike any we have previously seen on those faces. We can also pick out familiar faces that have changed dramatically because of the growth of a beard or the ravages of time.

We take no stand on the question of whether the brain functions holographically. We simply want to make clear that the information-processing computer is not the only physical system that can exhibit mindlike properties. Other devices may provide closer analogies to the way the mind actually works.

Given the above considerations, what level of skill can we expect logic machines to reach? Since we can program computers with thousands of rules combining hundreds of thousands of features, the machines can become what might be thought of as an expert novices in any well-structured and well-understood domain. As long as digital computers' ability to recognize images and reason by analogy remains a vague promise, however, they will not be able to approach the way human beings cope with everyday reality.

Holograms may provide a closer analogy to the way the mind actually works.

Despite their failure to capture everyday human understanding in computers, AI scientists have developed programs that seem to reproduce human expertise within a specific, isolated domain. The programs are called expert systems. In their narrow areas, such systems perform with impressive competence.

In his recent book on "fifth-generation" computers, Edward Feigenbaum, a professor at Stanford, spells out the goal of expert systems: "In the kind of intelligent systems envisioned by the designers of the Fifth Generation, speed and processing power will be increased dramatically. But more important, the machines will have reasoning power: they will automatically engineer vast amounts of knowledge to serve whatever purpose human beings propose, from medical diagnosis to product design, from management decisions to education."

The knowledge engineers claim to have discovered that all a machine needs to behave like an expert in these restricted domains are some general rules and lots of very specific knowledge. But can these systems really be expert? If we agree with Feigenbaum that "almost all thinking that professionals do is done by reasoning," and that each expert builds up a "repertory of working rules of thumb," the answer is yes. Given their speed and precision, computers should be as good as or better than people at following rules for deducing conclusions. Therefore, to build an expert system, a programmer need only extract those rules and program them into a computer.

Just How Expert Are Expert Systems?

However, human experts seem to have trouble articulating the principles on which they allegedly act. For example, when Arthur Samuel at IBM decided to write a program for playing checkers in 1947, he tried to elicit "heuristic" rules from checkers masters. But nothing the experts told him allowed him to produce master play. So Samuel supplemented these rules with a program that relies blindly on its memory of past successes to improve its current performance. Basically, the program chooses what moves to make based on rules and a record of all past positions.

This checkers program is one of the best expert systems ever built. But it is no champion. Samuel says the program "is quite capable of beating any amateur player and can give better players a good contest." It did once defeat a state champion, but the champion turned around and defeated the program in six mail games. Nonetheless, Samuel still believes that chess champions rely on heuristic rules. Like Feigenbaum, he simply thinks that the champions are poor at recollecting their compiled rules: "The experts do not know enough about the mental processes involved in playing the game."

INTERNIST-1 is an expert system highly touted for its ability to make diagnoses in internal medicine. Yet according to a recent evaluation of the program published in *The New England Journal of Medicine,* this program misdiagnosed 18 out of a total of 43 cases, while clinicians at Massachusetts General Hospital misdiagnosed 15. Panels of doctors who discussed each case misdiagnosed only 8. (Biopsies, surgery, and post-mortem autopsies were used to establish the correct diagnosis for each case.) The evaluators found that "the experienced clinician is vastly superior to INTERNIST-1, in the ability to consider the relative severity and independence of the different manifestations of disease and to understand the . . . evolution of the disease process." The journal also noted that this type of systematic evaluation was "virtually unique in the field of medical applications of artificial intelligence."

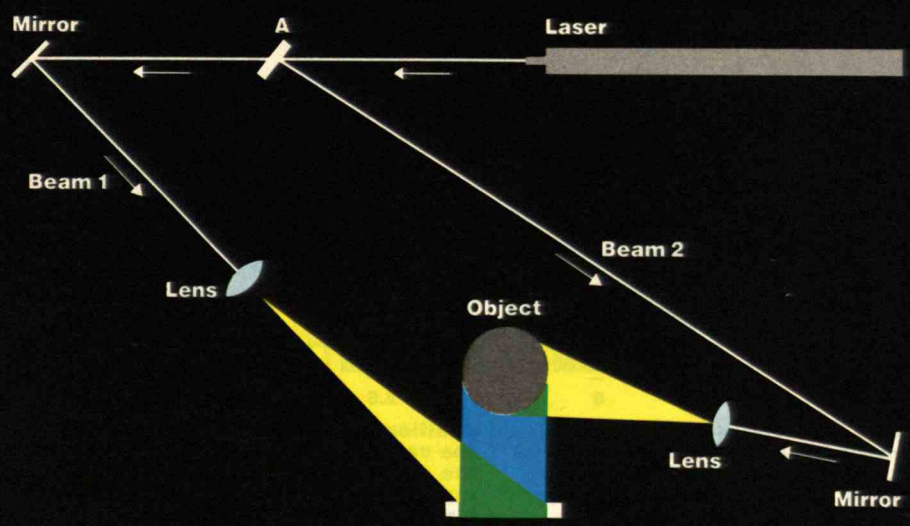
In every area of expertise, the story is the same: the computer can do better than the beginner and can even exhibit useful competence, but it cannot rival the very experts whose facts and supposed rules it is processing with incredible speed and accuracy.

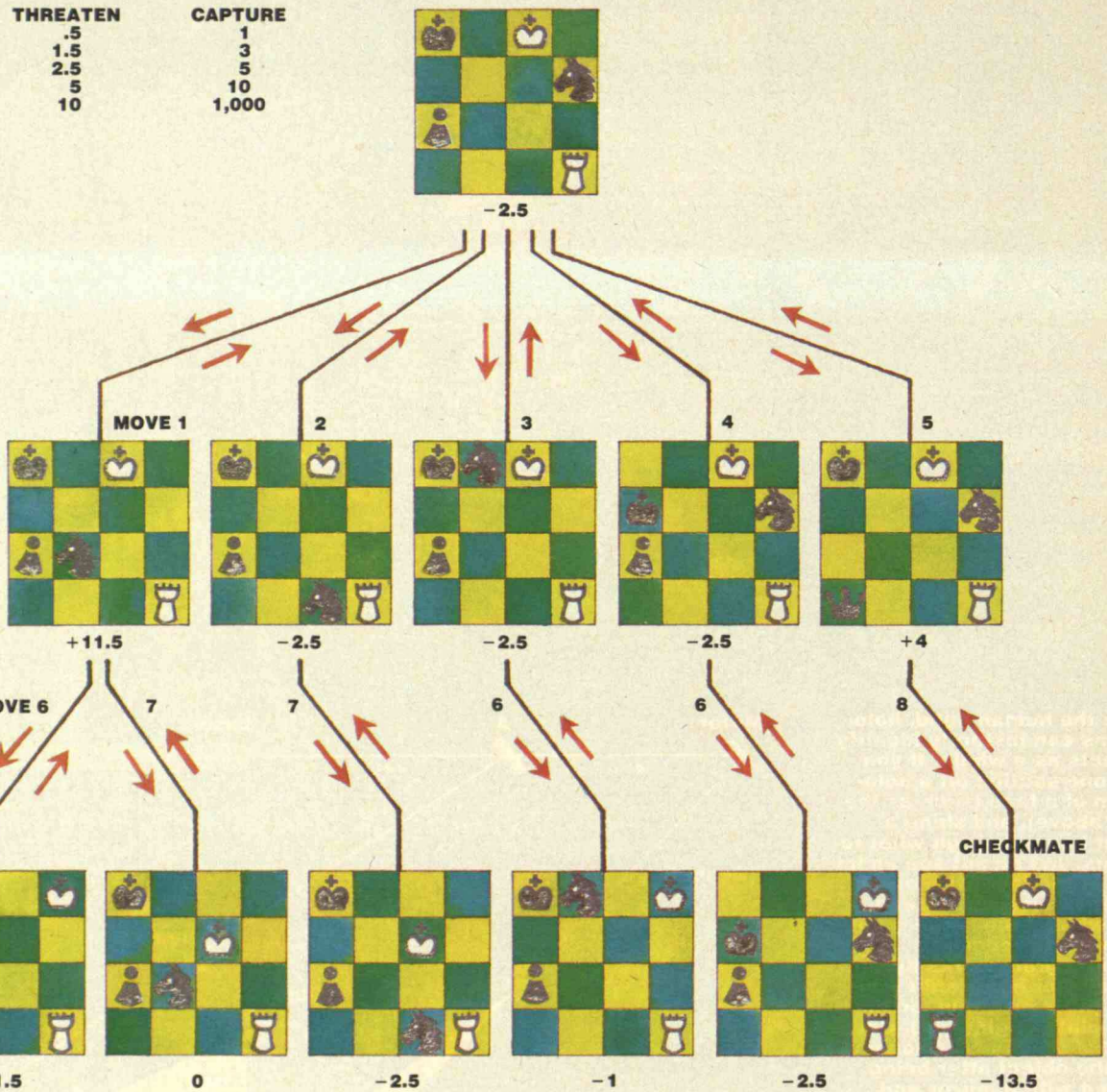
Why? Because the expert is not following any rules! While a beginner makes inferences using rules and facts just like a computer, the expert intuitively sees what to do without applying rules. Experts must regress to the novice level to state the rules they still remember but no longer use. No amount of rules and facts can substitute for the know-how experts have gained from experience in tens of thousands of situations. We predict that in no domain in which people exhibit such holistic understanding can a system based on rules consistently do as well as experts. Are there any exceptions?

At first glance, at least one expert system seems to be as good as human specialists. Digital Equipment Corp. developed R1, now called XCON, to decide how to combine components of VAX computers to meet consumers' needs. However, the program performs as well as humans only because there are so many possible combinations that even experienced technical editors depend on rule-based methods of problem solving and take about 10 minutes

Like the human mind, holograms can instantly identify objects as a whole. If you cut one section off a hologram of a face (such as the one above), and shine a laser beam through what remains, you do not see an image of the face with one section missing. Instead, the whole face is there but with fuzzier edges.

A hologram works by using a laser beam split into two parts by a thin, prism-like plate of glass (A). One part of the beam is bounced off the object after being aimed with a mirror and spread by a lens. The other beam, also aimed with a mirror and spread with a lens, is deflected toward the film plate. When the two beams meet, they form an interference pattern of light and dark, which is recorded on the plate. When another beam of light shines onto the plate, the recorded interference pattern shapes the light into a 3-D replica of the original object.





Like most chess programs, this one is based on heuristic rules, or rules of thumb, that chess champions believe they follow in playing chess. The computer uses these rules to determine its move, as shown in this tree structure of a simplified chess game. The program, playing Black, examines the possible moves and the opponent's countermoves one by one, assigning a score to each position. The score is based on the value of each piece and on the gravity of the threat to it. The program selects the move that leads to the highest score for Black.

One heuristic rule instructs the program to abandon the search for moves when one of White's countermoves leads to a lower score for Black than any countermove already considered. Thus, the program stops examining moves 2, 3, 4, and 5 as soon as it finds that the countermoves lead to positions worth less than 0.

Such programs cannot beat human chess champions consistently, because human experts do not follow explicit rules. They understand what to do intuitively. Rules and facts cannot substitute for the know-how experts gain from long experience.

DRAWING: CYNDY PATRICK

Business managers who rely too heavily on expert systems may discover that the wells of human expertise have gone dry.

to work out even simple cases. It is no surprise, then, that this particular expert system can rival the best specialists.

Chess also seems to be an exception to our rule. Some chess programs, after all, have achieved master ratings by using "brute force." Designed for the world's most powerful computers, they are capable of examining about 10 million possible positions in choosing each move.

However, these programs have an Achilles' heel: they can see only about four moves ahead for each pieces. So fairly good players, even those whose chess rating is somewhat lower than the computers, can win by using long-range strategies such as attacking the king side. When confronted by a player who knows its weakness, the computer is not a master-level player.

In every domain where know-how is required to make a judgment, computers cannot deliver expert performance, and it is highly unlikely that they ever will.

Those who are most acutely aware of the limitations of expert systems are best able to exploit their real capabilities. Sandra Cook, manager of the Financial Expert Systems Program at the consulting firm SRI International, is one of these enlightened practitioners. She cautions prospective clients that expert systems should not be expected to perform as well as human experts, nor should they be seen as simulations of human expert thinking.

Cook lists some reasonable conditions under which expert, or rather "competent," systems can be useful. For instance, such systems should be used for problems that can be satisfactorily solved by human experts at such a high level that somewhat inferior performance is still acceptable. Processing of business credit applications is a good example, because rules can be developed for this task and computers can follow them as well as and sometimes better than inexperienced humans. Of course, there are some exceptions to the rules, but a few mistakes are not disastrous. On the other hand, no one should expect expert systems to make stock-market predictions because human experts themselves cannot always make such predictions accurately.

Expert systems are also inappropriate for use on problems that change as events unfold. Advice from expert systems on how to control a nuclear reactor during a crisis would come too late to be of any use. Only human experts could make judgments quickly enough to influence events.

It is hard to believe some AI enthusiasts' claim that the companies who use expert systems dominate all competition. In fact, a company that relies too heavily on expert systems faces a genuine danger. Junior employees may come to see expertise as a function of the large knowledge bases and masses of rules on which these programs must rely. Such employees will fail to progress beyond the competent level of performance, and business managers may ultimately discover that their wells of true human expertise and wisdom have gone dry.

Computers in the Classroom

Computers pose a similar threat in the classroom. Advertisements warn that a computer deficiency in the educational diet can seriously impair a child's intellectual growth. As a result, frightened parents spend thousands of dollars on home computers and clamor for schools to install them in the classroom. Critics have likened computer salespeople to the encyclopedia peddlers of a generation ago, who contrived to frighten insecure parents into spending hundreds of dollars for books that contributed little to their offsprings' education.

We feel that there is a proper place for computers in education. However, most of today's educational software is inappropriate, snd many teachers now use computers in ways that may eventually produce detrimental results.

Perhaps the least controversial way computers can be used is as tools. Computers can sometimes replace teaching aids ranging from paintbrushes, typewriters, and chalkboards to lab demonstrations. Computer simulations, for instance, allow children to take an active and imaginative role in studying subjects that are difficult to bring into the classroom. Evolution is too slow, nuclear reactions are too fast, factories are too big, and much of chemistry is too dangerous to reproduce realistically. In the future, computer simulations of such events will surely become more common, helping students of all ages in all disciplines to develop their intuition. However, since actual skills can be learned only through experience, it seems only common sense to stick to the world of real objects. For instance, basic electricity should be taught with batteries and bulbs.

Relying too heavily on simulations has its pitfalls. First of all, the social consequences of decisions are

Speech recognition seems to be a skill that resists decomposition into facts and rules.

often missing from simulations. Furthermore, the appeal of simulations could lead disciplines outside the sciences to stress their formal, analytic side at the expense of lessons based on informal, intuitive understanding. For example, political science departments may be tempted to emphasize mathematical models of elections and neglect the study of political philosophies that question the nature of the state and of power. In some economics departments, econometrics—which relies heavily on mathematical models—has already pushed aside study of the valuable lessons of economic history. The truth is that no one can assess the dynamic relationships that underlie election results or economies with anything like the accuracy of the laws of physics. Indeed, every election campaign or economic swing offers vivid reminders of how inaccurate predictions based on simulation models can be.

On balance, however, the use of the computer as a tool is relatively unproblematic. But that is not the case with today's efforts to employ the computer as tutor or tutee. Behind the idea that computers can aid, or even replace, teachers is the belief that teachers' understanding of the subject being taught and their profession consists of knowing facts and rules. In other words, the teacher's job is to convey specific facts and rules to students by drill and practice or by coaching.

Actually, if our minds were like computers, drill and practice would be completely unnecessary. The fact that even brilliant students need to practice when learning subtraction suggests that the human brain does not operate like a computer. Drill is required simply to fix the rule in human memory. Computers, by contrast, remember instantly and perfectly. Math students also have to learn that some features such as the physical size and orientation of numbers are irrelevant while others such as position are crucial. In this case, they must learn to "decontextualize," whereas computers have no context to worry about.

There is nothing wrong with using computers as drill sergeants. As with simulation, the only danger in this use stems from the temptation to overemphasize some skills at the expense of others. Mathematics might degenerate into addition and subtraction, English into spelling and punctuation, and history into dates and places.

AI enthusiasts believe that computers can play an even greater role in teaching. According to a 1984

report by the National Academy of Sciences, "Work in artificial intelligence and the cognitive sciences has set the stage for qualitatively new applications of technology to education."

Such claims should give us pause. Computers will not be first-rate teachers unless researchers can solve four basic problems: how to get machines to talk, to listen, to know, and to coach. "We speak as part of our humanness, instinctively, on the basis of past experience," wrote Patrick Suppes of Stanford University, one of the pioneers in computer-aided instruction, in a 1966 *Scientific American* article. "But to get a computer to talk appropriately, we need an explicit theory of talking."

Unfortunately, there is no such theory, and if our analysis of human intelligence is correct, there never will be. The same holds true for the problem of getting computers to listen. Continuous speech recognition seems to be a skill that resists decomposition into features and rules. What we hear does not always correspond to the features of the sound stream. Depending on the context and our expectations, we hear a stream of sound as "I scream," or "ice cream." We assign the space or pause in one of two places, although there is no pause in the sound stream. One expert came up with a sentence that illustrates the different ways we can hear the same stream of sound: "It isn't easy to wreck a nice

beach." (Try reading that sentence out loud.)

Without the ability to coach, a computer could hardly substitute for an inexperienced teacher, let alone a Socrates. "Even if you can make the computer talk, listen, and adequately handle a large knowledge data base, we still need to develop an explicit theory of learning and instruction," Suppes writes. "In teaching a student, young or old, a given subject matter, a computer-based learning system can record anything the student does. It can know cognitively an enormous amount of information about the student. The problem is how to use this information wisely, skillfully, and efficiently to teach the student. This is something that the very best human tutors do well, even though they do not understand at all how they do it."

While he recognizes how formidable these obstacles are, Suppes persists in the hope that we can program computers to teach. However, in our view, expertise in teaching does not consist of knowing complicated rules for deciding what tips to give students, when to keep silent, when to intervene—although teachers may have learned such rules in graduate school. Rather, expert teachers learn from experience to draw intuitively and spontaneously on the common-sense knowledge and experience they share with their students to provide the tips and examples they need.

Since computers can successfully teach only novice or, at best, competent performance, they will only produce the sort of expert novices many feel our schools already graduate. Computer programs may actually prevent beginning students from passing beyond competent analysis to expertise. Instead of helping to improve education, computer-aided instruction could easily become part of the problem.

In the air force, for instance, instructors teach beginning pilots a rule for how to scan their instruments. However, when psychologists studied the eye movements of the instructors during simulated flight, the results showed that the instructors were not following the rule they were teaching. In fact, as far as the psychologists could determine, the instructors were not following any rules at all.

Now suppose that the instrument-scanning rule goes into a computer program. The computer monitors eye movements to make sure novices are applying the rule correctly. Eventually, the novices are ready, like the instructors, to abandon the rules and respond to whole situations they perceive as similar to others. At this point, there is nothing more for the computer to teach. If it is still used to check eye movements, it would prevent student pilots from making the transition to intuitive proficiency and expertise.

This is no mere bogeyman. Expert systems are already being developed to teach doctors the huge number of rules that programmers have "extracted" from experts in the medical domain. One can only hope that someone has the sense to disconnect doctors from the system as soon they reach the advanced-beginner stage.

Can Children Learn by Programming?

The concept of using computers as tutees also assumes the information-processing model of the mind. Adherents of this view suppose that knowledge consists of using facts and rules, and that therefore students can acquire knowledge in the very act of programming. According to this theory, learning and learning to program are the same thing.

Seymour Papert is the most articulate exponent of this theory. He is taking his LOGO program into Boston schools to show that children will learn to think more rigorously if they teach a literal-minded but patient and agreeable student—the computer. In Papert's view, programming a computer will induce

A few years ago, our computerized warning system interpreted radar reflections from a rising moon as an attack.

children to articulate their own program by naming the features they are selecting from their environment, and by making explicit the procedures they are using to relate these features to events. Says Papert: "I have invented ways to take educational advantage of the opportunities to master the art of *deliberately* thinking like a computer, according, for example, to the stereotype of a computer program that proceeds in a step-by-step, literal, mechanical fashion."

Papert's insistence that human know-how can be analyzed has deep roots in our "rationalistic" Western tradition. We can all probably remember a time in school when we knew something perfectly well but our teacher claimed that we didn't know it because we couldn't explain how we got the answer.

Even Nobel laureates face this sort of problem. Physicist Richard Feynman had trouble getting the scientific community to accept his theories because he could not explain how he got his answers. In his book *Disturbing the Universe,* physicist and colleague Freeman Dyson wrote, "The reason Dick's physics were so hard for the ordinary physicists to grasp was that he did not use equations . . . He had a physical picture of the way things happen, and the picture gave him the solutions directly with a minimum of calculation. It was no wonder that people who spent their lives solving equations were baffled by him. Their minds were analytical; his was pictorial."

While Papert tries to create a learning environment in which learners constantly face new problems and need to discover new rules, Timothy Gallwey, the author of *Inner Tennis,* encourages learners to achieve mastery by avoiding analytic thinking from the very start. He would like to create a learning environment in which there are no problems at all and so there is never any need for analytic reflection.

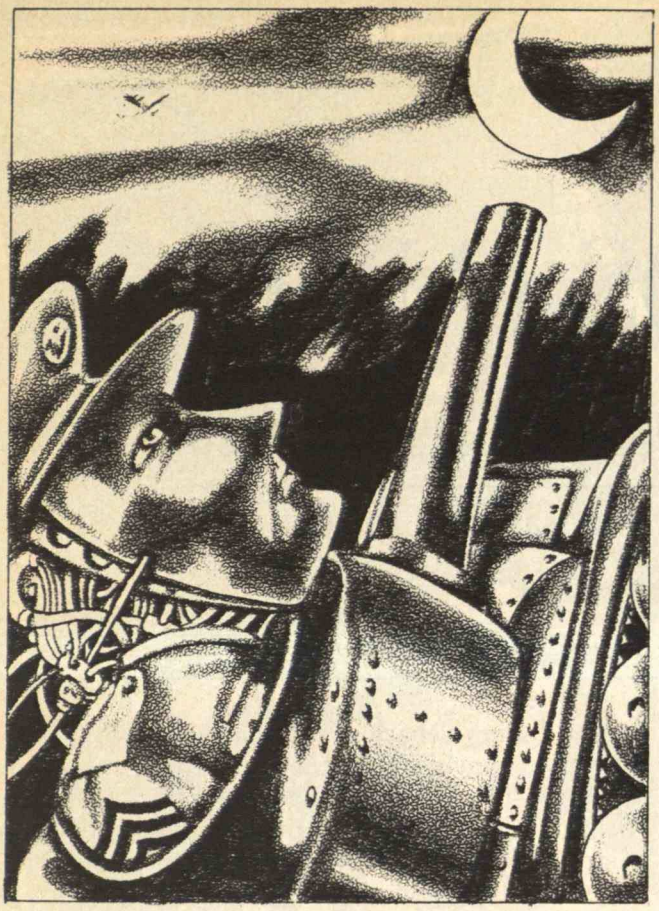
Our view lies in between. At any stage of learning, some problems may require rational, analytic thought. Nonetheless, skill in any domain is measured by the performer's ability to act appropriately in situations that might once have been problems but are no longer problems and so do not require analytic reflection. The risk of Gallwey's method is that it leaves the expert without the tools to solve new problems. But the risk of Papert's approach is far greater: it would leave the learner a perpetual beginner by encouraging dependence on rules and analysis.

AI on the Battlefield

The Department of Defense is pursuing a massive Strategic Computing Plan (SCP) to develop completely automomous land, sea, and air vehicles capable of complex, far-ranging reconnaissance and attack missions. SCP has already spent about $145 million and received approval to spend $150 million in fiscal 1986. To bolster support for this effort, the DOD's Defense Advanced Research Projects Agency (DARPA) points to important advances in AI—expert systems with common sense and systems that can understand natural language. However, no such advances have occurred.

Likewise, computers are no more able today to deal intelligently with "uncertain data" than they were a few years ago when our computerized ballistic-missile warning system interpreted radar reflections from a rising moon as an enemy attack. In a recent report evaluating the SCP, the congressional Office of Technology Assessment cautioned, "Unlike the Manhattan Project or the Manned Moon Landing Mission, which were principally engineering problems, the success of the DARPA program requires basic scientific breakthroughs, neither the timing nor the nature of which can be predicted."

Even if the Defense Department invests billions of dollars in AI, there is almost no likelihood that this



state of affairs will change. Yet once vast sums of money have been spent, there will be a great temptation to install questionable AI-based technologies in a variety of critical areas—from battle management to "data reduction" (figuring out what is really going on given noisy, contradictory data).

Military commanders now respond to a battlefield situation using common sense, experience, and whatever data are available. The frightening prospect of a fully computerized and autonomous defense system is that the expert's ability to use intuition will be replaced by merely competent decision making. In a crisis, competence is just not good enough.

Furthermore, to justify its expenditures to the public, the military may feel compelled to encourage the civilian sector to adopt similar technologies. Full automation of air-traffic control systems and of skilled factory labor are both real possibilities.

Unless illusions concerning AI are dispelled, we are risking a future in which computers make crucial military and civilian decisions that are best left to human judgment. Knowledgeable AI practitioners have learned from bitter experience that the development of fully autonomous war machines is unlikely. We hope that military decision makers or the politicians who fund them will see the light and save U.S. taxpayers' money by terminating this crash program before it is too late.

The Other Side of the Story

At this point the reader may reasonably ask: If computers used as logic machines cannot attain the skill level of expert human beings, and if the "Japanese challenge in fifth-generation systems" is a false gauntlet, then why doesn't the public know that? The answer is that AI researchers have a great deal at stake in making it appear that their science and its engineering offspring—expert systems—are on solid ground. They will do whatever is required to preserve this image.

When public television station KCSM in Silicon Valley wanted to do a program on AI to be aired nationally, Stanford AI expert John McCarthy was happy to take part. So was a representative of IntelliCorp, a company making expert systems that wished to air a promotional film. KCSM also invited one of us, Hubert, to provide a balanced perspective. After much negotiating, an evening was finally agreed upon for taping the discussion.

That evening the producer and technicians were standing by at the studio and Hubert had already arrived in San Mateo when word came that McCarthy would not show up because Hubert was to be on the program. A fourth participant, expert-systems researcher Michael Genesereth of Stanford University, also backed out.

All of us were stunned. Representatives from public TV's NOVA science series and CBS news had already interviewed Hubert about AI, and he had recently appeared on a panel with Minsky, Papert, philosopher John Searle of Berkeley, and McCarthy himself at a meeting sponsored by the New York Academy of Sciences. Why not on KCSM? It seems the "experts" wanted to give the impression that they represented a successful science with marketable products and didn't want to answer any potentially embarrassing questions.

The shock tactic worked. The station's executive producer, Stewart Cheifet, rescheduled the taping with McCarthy as well as the demo from IntelliCorp, and he decided to drop the discussion with Hubert. The viewers were left with the impression that AI is a solid, ongoing science which, like physics, is hard at work solving its quite manageable current problems. The public's chance to hear both sides was lost and the myth of steady progress in AI was maintained. The real story remained to be told, and that is what we have tried to do here. □

SWORDS INTO PLOWSHARES

Converting from Military to Civilian Production

BY SEYMOUR MELMAN

On July 24, 1985, the General Dynamics Corp. announced that it would close its 100-year-old Quincy, Mass., shipyard and lay off 3,600 shipbuilders. The Department of Defense had indicated that it would offer the yard no new contracts, and even the state's influential members of Congress had been unable to persuade the navy to place new orders with the plant. Although the closing had been a distinct possibility for at least two years, neither the company's management nor the union had planned for this outcome. Nor had city, state, and federal officials, who showed the typical panicked response: they decided to form a committee within 30 to 90 days to decide what to do. Such an ad hoc committee would not be able to plan effectively for converting the facility to make ships or other products for the civilian market, as such planning requires one to two years. Predictably, the committee has since decided to look for an outside firm to turn the site into an industrial park of vague composition and proportions. The yard's skilled workers, engineers, and managers will undoubtedly scatter to the winds.

The Quincy debacle is but one incident in the long history of convulsions in the industries that serve the military—this one occurring even in the midst of the Reagan administration's arms buildup. Ford Aerospace laid off 2,500 workers in September 1985 when the Pentagon canceled further production of the notoriously ineffective Sgt. York mobile antiaircraft cannon. Rockwell International dismissed thousands of blue-collar workers and engineers from its Los Angeles plant in the late 1970s when President Carter decided to produce cruise missiles instead of B-1 bombers. And 9,000 workers lost their jobs when the New York Naval Shipyard in Brooklyn shut down in the 1960s.

Most economists downplay the local and regional effects of these events, seeing them as mere bubbles in a big pond. However, the millions of engineers and production workers in the "Quincies" across the United States perceive these outcomes as chilling. They live in constant fear that the Pentagon will terminate their contracts, whether because of a shift in strategy, altered weapons plans, or a slowdown of the arms race.

A national effort to plan for converting military firms to making civilian goods is indispensible for reversing the arms race and stemming the decline of U.S. industry.

ILLUSTRATIONS: STEPHEN ELSTON


HELP SAVE!
The BROOKLYN
NAVY YARD
I WORK IN THE BROOKLYN NAVY YARD
I WORK IN THE BROOKLYN NAVY YARD

Workers, company managements, local communities, and state governments respond by lobbying to save factories, laboratories, and bases that serve the Pentagon, as they have given no thought to economic alternatives. U.S. representatives and senators lobby to secure defense contracts for their districts not because they favor the arms race but because they wish to provide jobs for their constituents. As this process continues, the enormous resources devoted to the military—the capital equipment and production facilities, R&D efforts, managerial abilities, and productive skills—are drained from an already faltering civilian industrial sector. The apparent lack of alternatives to the military economy helps to fuel the arms race and erode the industrial base.

Yet there are alternatives. Facilities can change over from military to civilian work—provided they make detailed plans for this change before a crisis is imminent. Consider how different the situation at Quincy would have been if a committee of managers and workers had made detailed technical, organizational, and economic plans for using the yard's large fabricating shops to make fishing vessels for the outdated New England fishing fleet, other types of civilian ships, metal bridge spans, or industrial equipment. The community would have had some options to choose from instead of facing serious economic hardship.

The United States has more than 150,000 Quincies. The nation must require these firms, laboratories, and bases now serving the military to plan for converting to civilian production. The planning efforts must be local in origin to ensure their success, but they must also be federally mandated to surmount the resistance of top management, which prefers to continue dealing with the military rather than pursue alternative options.

The Military's Drain on Resources

Although the military budget is only 6.5 percent of the gross national product, it siphons off a much larger share of the country's production resources. In 1979, the military received $33 in capital resources, including fixed and working capital, for every $100 of new civilian capital formation. In West Germany that ratio was 20 to 100, and in Japan it was 3.7 to 100. I estimate that the Soviet ratio was 66 to 100. Those numbers show why Japan has been so successful in international competition; it invests far more of its capital in constantly renewing its civilian industrial base. By 1988 I estimate that the U.S. ratio of military to civilian use of capital resources will be about 87 to 100 if the current buildup continues. Moreover, the United States allocates 70 percent of federally funded R&D to military-related efforts. And over a third of U.S. engineers and scientists in some fields, including aerospace and electrical engineering, now work in military-related jobs. This depletion of the civilian sector occurs in all countries with sustained military economies, regardless of their economic and political structures.

Instead of "Japan-bashing"—lambasting the Jap-

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When naval shipyards close, skilled workers disperse and the large fabricating equipment is mothballed. Left: When the yard at Quincy, Mass., closed in July 1985, 3,600 workers lost their jobs. Below: The dry docks of the N.Y. Naval Shipyard stood abandoned and 9,000 people were laid off when the yard shut its doors in 1964 after 165 years of operation. With advance planning, the shipyards could be used to make civilian ships and industrial machinery.

anese for their success—we must face the fact that our investment in new civilian plants and equipment, and our R&D on new production techniques and civilian product designs, are seriously inadequate. As the American Electronics Association has recently stated, "We cannot siphon off a disproportionate share of our skills and technical resources to military application and still stay ahead of Japan in commercial markets."

Indeed, there is a growing awareness in Congress and among the public that the United States cannot have both guns and butter. The huge federal deficit, much of it stemming from the recent increase in the military budget, is creating serious problems for U.S.-based production in both domestic and foreign markets. The international borrowing required to cover the federal deficit drove up the price of the dollar relative to other currencies by 75 percent from 1980 to 1984. Thus, the inflation of the 1970s has been transferred to the master commodity—the dollar—and both high-technology and smokestack firms are suffering, as are farm producers. No one can reduce costs 75 percent to offset the inflated dollar. Planning for converting from military to civilian production is essential if we are to make any serious effort to reverse these effects.

Such planning is also essential to efforts to slow down the arms race. Even members of Congress who would like to cut ineffective or unneeded weapons programs find it difficult to do so because of public pressure to maintain sources of jobs and income. Sen. Alan Cranston (D-Calif.), who attempted to capture the Democratic nomination for president based on his commitment to halting the arms race, voted to approve funds for producing the B-1 bomber, which is largely assembled in California. Sen. Edward Kennedy of Massachusetts, a principal author of the Senate resolution calling for a nuclear freeze, has also voted for military budgets that fuel the U.S. side of the arms race. Of course, the Pentagon is superbly equipped to garner support for its programs among members of Congress. Its liaison group for the House and Senate includes one staffer for every two members of Congress. These lobbyists maintain regular contact with representatives and facilitate attention to military producers in their states. Members of Congress will continue to succumb to these pressures until a national conversion plan frees them from relying on the military budget to deliver jobs and income.

Advance planning for converting military plants to civilian enterprises will also offer alternatives for the military labor force. Few unions—with the notable exception of the International Association of Machinists and Aerospace Workers—have made a sustained effort to promote alternatives to military work. Most professional engineering societies have also been reluctant to address the problems of moving from military to civilian employment. Instead, both unions and professional societies usually devote their resources to gaining the maximum number of Pentagon jobs for their members. Some union leaders and engineers see efforts to find alternatives to military-related employment as biting the hand that feeds them. This sense of threat even led some union leaders at the Quincy shipyard to accuse one member who wanted to plan for converting that facility of being a Soviet sympathizer. They understand that the Pentagon does not look kindly on efforts to curtail its huge concentration of power to allocate money and jobs.

PHOTOS: *BOSTON GLOBE*, UPI/BETTMANN, AP/WIDE WORLD

Problems of Converting to Civilian Production

Today's task of converting from military to civilian production differs greatly from that of moving to a peacetime economy after World War II. Factories that geared up for the war effort could revert to the production equipment, plant layout, product design, organization, and marketing practices they had used before the war. Many previous employees were still around or returning from active duty. Because of these differences, that experience provides little precedent for the difficulties military contractors now face.

A handful of large military contractors did try to use Pentagon-serving facilities to produce civilian goods during the sixties and seventies, but none were successful because the requirements for supplying the two sectors are quite different. Civilian firms, whether competitive or monopolist, strive to minimize production costs to maximize profits. Military-serving firms have no such constraints because the Pentagon determines its payments for weapons and other items through a process of "historical costing." That is, instead of trying to figure out what a new weapon should cost based on different designs and production systems, the Pentagon estimates the costs according to those of previous programs, and adds a percentage as profit. This means that the budget has a built-in escalator, with the military continuing to pay for whatever waste it funded in the past. Moreover, defense contractors have strong incentives to enlarge their costs because that determines both the amount of profit they make and the level of future funding. Contractors also buy production equipment that their counterparts in the civilian sector could not justify, because the Pentagon provides funds for capital investment. Defense Secretary Robert McNamara codified these procedures in the Pentagon's formal regulations during the early 1960s. The widely publicized horror stories about $7,600 coffee makers and $42,000 sets of minor hardware are the normal result of such institutionalized practices.

Defense contractors also do not produce goods that are as reliable as those that firms in the civilian market make. Civilian firms must typically make products with a 1 percent or lower failure rate to stay in business. In contrast, the F-15, the most advanced U.S. fighter plane, averages 55 percent availability—the air force can count on only half of the planes to operate at any given time. No civilian transit system could afford to keep half its vehicles in maintenance. Aegis, the navy's anti-aircraft system deployed on destroyers, costs more than $1.1 billion per unit, yet the navy expects it to be available only 42 percent of the time, and its software functions an average of just two and a half hours between failures. Needless to say, only firms that have a guaranteed market for their products could afford to deliver such unreliable goods. The military's system of "concurrency" contributes to this unreliability. Pentagon regulations allow contractors to go directly from the design stage to production without testing and refining their products.

The engineering staffs of military contractors function much differently from their counterparts in the civilian sector. A manager of a civilian electronics firm describes these differences: "We have had a number of design engineers come and go who had their training in the aerospace business . . . men with brilliant minds, outstanding recommendations, and very fine schooling. Without exception they all flunked out of our company because they had never really thought about designing a consumer product.

"In aerospace you are given something to build, with a set of specifications, and that's it. If it costs you $5,000 or $50,000 you build to those specifications. . . . In consumer industry the design engineer has to be constantly weighing, making decisions that

In the 1970s, Boeing-Vertol, makers of military helicopters, produced electric-powered subway cars. The cars were a failure because the firm assumed that it could adopt the same design and production techniques it used to make products for the military. Many components proved to be overly complicated, and the cars had not been adequately tested. Mass transit could provide a market for firms that wish to convert to making civilian goods, provided they retrain their workers and adopt more efficient production techniques.

affect the value of the product and may in the end affect the overall appearance of the product and its functions. . . . You have to be prepared to have the end product be somewhat different from what you had intended." These problems begin in our colleges, which do not train engineers to do "value engineering"—they usually train them to be indifferent to cost.

Because of these contrasts, military contractors that have attempted to use people and facilities to produce civilian goods without advance conversion planning have typically met with disastrous results. The effort of Boeing-Vertol, makers of military helicopters, to produce electric-powered trolleys and subway cars during the 1970s was one such failure. The company mistakenly assumed that its designers and assemblers could function as "systems engineers," easily combining components produced by subcontractors in England, Germany, and Japan. The company also followed the military practice of dispensing with thorough prototype testing: engineers took the cars straight from the drawing board into production. Naturally, when the cars were put into actual use, mainly by the Massachusetts Bay Transportation Authority (MBTA), they broke down often.

The trucks and wheels at the center of the trolleys persistently derailed. The cars' main mechanical components were not arranged for ease of maintenance. The circuitry controlling the propulsion system proved to be unreliable. Cooling motors and fans for traction motors burned out rapidly. Main gearboxes leaked lubricant, and no one seemed able to devise a solution. Many components proved to be overly complicated—engineeers had to reduce the number of parts in the doors by half after they repeatedly failed to work. Users had trouble obtaining spare parts from foreign suppliers, and they had no way to predict how many spares they would need since the products had not been tested. Boeing-Vertol repair workers and engineers had to take up residence at the MBTA's maintenance shops. After several lawsuits, the company went back to producing military helicopters.

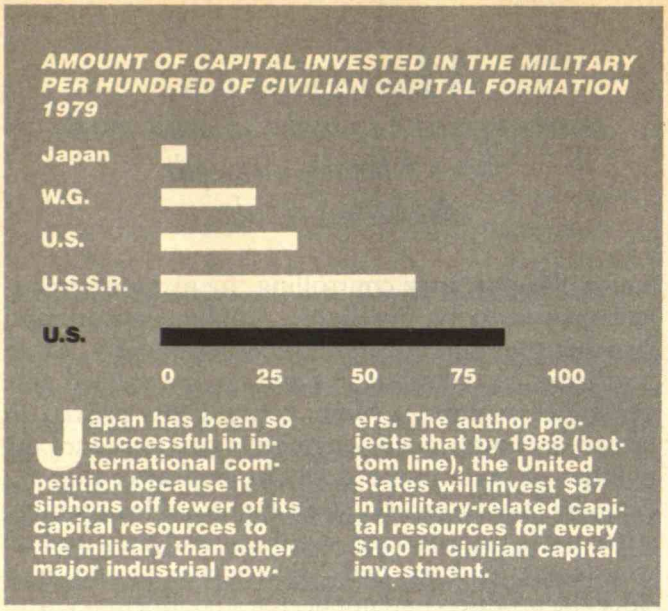
Military firms that have attempted to make civilian goods have typically met with disastrous results.

Attempts by the Rohr Corp.—makers of engine nacelles, or enclosures, for the aerospace industry—to produce cars for San Francisco's BART mass-transit system met with a similar fate. Both Boeing-Vertol and Rohr merely attempted to diversify their product lines without retraining their managers, engineers, and production workers to perform the procedures that are essential for making civilian products.

The experiences related by the marketing manager of a major aerospace contractor during the mid-sixties illustrate similar problems. The manager's firm decided to try to sell to civilian doctors an electrocardiograph machine developed for use on U.S. astronauts. Three representatives of the firm called on a leading cardiologist to show him the machine, which was encased in a sturdy, military-type container. The cardiologist was impressed, but he asked whether the AMA had approved the machine for general use. The industry men were taken aback, and asked what the American Management Association had to do with this sort of thing. They were unaware of the American Medical Association and the fact that it might have some say in evaluating new medical devices.

The doctor then asked what sort of liability insurance the firm was prepared to offer. This really surprised the management men, who did not know that they could be held responsible if something went wrong with a patient who was linked to the machine. Finally, when the men told the doctor the machine would cost $6,000, he told them that was ten times the price of electrocardiographs already on the market. The company decided to abandon the idea of selling its product to the medical community.

PHOTO: BOEING



Japan has been so successful in international competition because it siphons off fewer of its capital resources to the military than other major industrial powers. The author projects that by 1988 (bottom line), the United States will invest $87 in military-related capital resources for every $100 in civilian capital investment.

A few groups have attempted to draw up comprehensive plans to convert plants serving the military to civilian production. However, company managers have been reluctant to embrace these ideas. For example, during the early sixties, when the New York Naval Shipyard was threatened with closing, graduate students in Columbia University's Department of Industrial Engineering and Operations Research devised a set of alternatives under my direction. This work led to a blueprint for turning the shipyard into a modern, profitable shipbuilding plant, which I sent to Mayor Wagner, his Economic Development Committee, union officials, bankers, members of Congress, and federal officials. Few of these people even bothered to read the proposal. Instead, they devoted their efforts to the "Save the Shipyard" committee, which conducted the usual lobbying and public-relations campaigns in a desperate attempt to attract new military contracts. The navy ordered the yard shut in 1964. Not until 1967 did the U.S. Commerce Department commission researchers at Fordham University and a consulting firm to prepare a plan for redeveloping the shipyard. The consultants proposed offering production, storage, and office space to firms in varied industries. However, by the time the report came out, the yard had been closed for four years and the labor force had dispersed. The area remains poorly used today.

In the 1970s engineers and production workers at the North London plant of England's Lucas Aerospace Co. devised perhaps the best-known blueprint for converting from military to civilian production. When cutbacks in defense budgets threatened employees' jobs, these workers prepared detailed plans for making an array of civilian products, including gas heat pumps, windmills, and portable dialysis machines. The plans included an analysis of how to finance such ventures and of potential markets. These efforts attracted widespread publicity and sparked an intense national debate and interest from other unions. Yet the company's top management refused even to discuss the proposals, and fired the engineers who led the effort. The firm did have to reduce its operations significantly.

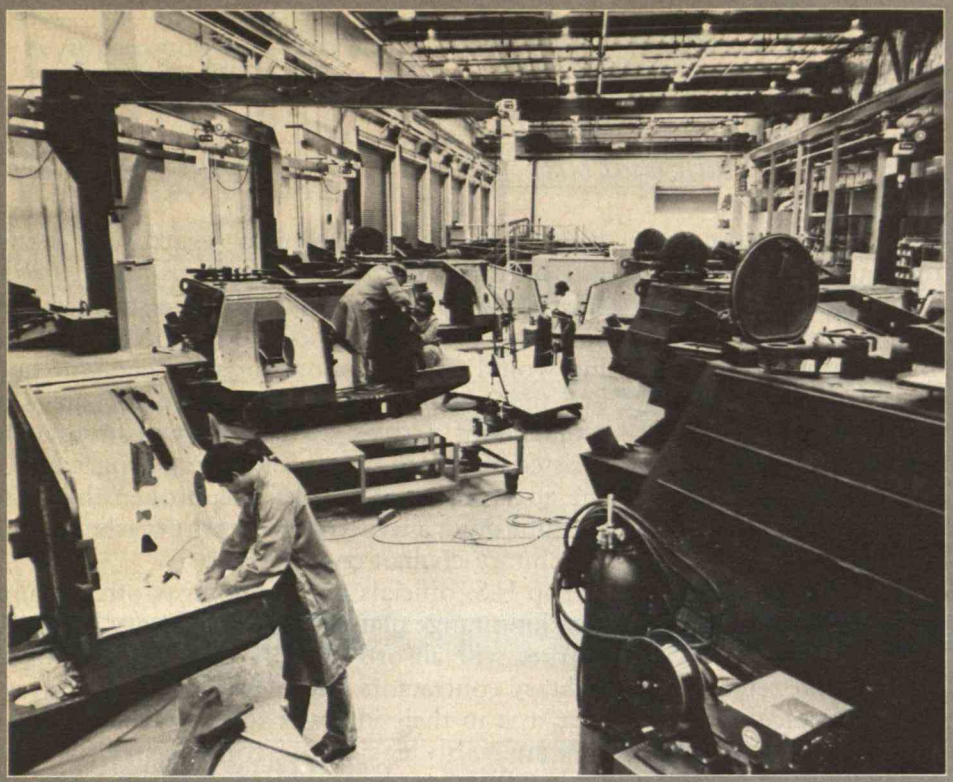
This experience highlights the fact that top managers of defense contractors prefer to deal with the military, which guarantees a market for their products, rather than compete in the civilian market. Managers also fear that efforts to make long-range conversion plans will alienate them from the military. Of course, many firms seek to cushion the risks of working exclusively for the military by acquiring divisions that produce civilian goods. However, most managers view efforts to actually convert military plants with utmost skepticism and feel threatened by employee initiatives.

Setting Up a National Strategy

To surmount these barriers, Congress must adopt legislation requiring every factory, laboratory, and base that serves the Pentagon to draw up long-range plans for converting to civilian work. Separating the issue of conversion from ideological disputes about whether a nuclear arms race can be won or how to end it would, in turn, allow Congress to devise a military budget according to actual defense needs. Managers, engineers, and union leaders would no longer have to be afraid of appearing to criticize the very source of their jobs and income.

Each facility must have the responsibility for devising its own conversion plans, as only local employees and managers understand their unique circumstances and can choose which products to pursue. Even review of these plans by a central federal agency would be impractical and prohibitively expensive. Ten years ago, Lloyd J. Dumas, professor of political economy at the University of Texas, estimated that a staff of more than 14,000 people with a yearly budget greater than $500 million would be required to review all conversion plans. Centralized development of conversion plans would be even more cumbersome and costly.

A facility of any size would need at least two years to prepare a detailed technical, organizational, and financial conversion plan. Setting up teams composed half of managers and half of employees would



Even in the midst of a military buildup, strategies change and weapons programs are eliminated. Ford Aerospace recently had to lay off 2,500 workers when the notoriously ineffective Sgt. York anti-aircraft cannon was cut from the budget. Teams composed of workers and managers could plan to convert their facility to making goods for the civilian market, such as machine tools and equipment for repairing the nation's infrastructure.

guarantee a serious effort, as all whose futures were directly affected would be involved.

The committee's choice of which products to make would be crucial. However, the range of industries that could provide a market is broad. Conversion committees could begin their search by looking to the goods that the United States now imports. For example, Canadian, German, and Japanese manufacturers supply the electric-powered trolleys and subway cars used in the United States, an obvious market for military contractors. Foreign firms also supply 45 percent of all U.S. machine tools, including computer-controlled tools—another obvious market. The array of materials and equipment required to repair the nation's crumbling infrastructure, including the 45 percent of all highway bridges that are no longer considered safe, is another major market. And of course, firms could also develop completely new products.

To define potential markets for firms wishing to convert to civilian production, a national conversion committee should require federal agencies to determine the capital-investment needs for the activities under their jurisdiction. The committee could also invite state and local governments to determine their long-term needs. In 1979 the U.S. Commerce Department put the value of "fixed reproducible tangible wealth"—which includes all business, government, and household structures and capital equipment, minus military and consumer durables—at $5.7 trillion. I estimate that more than two-thirds of this equipment is at least 10 years old. Therefore, bringing the nation's production facilities and infrastructure up to a first-class standard would cost $3.8 trillion and require 14 million workers each year for at least 20 years. Since about 8 million workers are unemployed and 6 million more serve the military economy, we would achieve full employment by redirecting our resources toward modernizing our industrial base.

Devising a way to make equipment of all classes at prices competitive in the world market is one key to successful conversion. That will not be easy—but it is possible. Contrary to popular belief, high U.S. wages are not the primary obstacle. Although U.S. workers were among the world's best paid from 1865 to 1965, in 1980 they ranked ninth. Yet only now do U.S. managers cite wages as a major factor in making it difficult to compete. The Swiss, whose workers are among the highest paid of all, produce top-of-the-line precision instruments such as electron microscopes and advanced machine tools. The challenge is to channel our resources, including technical talent and capital investment, into production that generates wealth for our society, instead of siphoning off an ever larger bite to the military.

Managers and engineers, as well as some production workers, will have to be retrained. Public universities could set up one-year training programs to help in this effort. Many white-collar workers will

PHOTOS: FORD AEROSPACE

We could achieve full employment by redirecting resources toward modernizing our industrial base.

have to be transferred to other industries and communities, since no civilian firm could survive with the overhead typical of military contractors. In 1978, when I visited the Rockwell plant outside Los Angeles that was building the B-1 bomber, the staff included 5,000 production workers, 5,000 engineers, and 4,000 administrators. Because these people have served the military at society's request, the public should provide relocation allowances and generous income guarantees during the changeover period—say, two years' salary up to a limit of $40,000 a year. State employment agencies could coordinate efforts to help them find alternative employment.

Facilities would have to regroup the remaining staff to avoid the inefficient practices typical of military-serving firms. Introducing new employees with experience in producing civilian goods would also be essential to the success of any converting enterprise.

Firms could be required to put 1.25 percent of their military contracts into a special fund administered by the Treasury for retraining, income support, and other conversion operations. Some facilities might not be able to convert to civilian production because their equipment is too specialized or their location impractical. And there would be no guarantee that firms that did convert would be successful. However, the fact that the people who have the most at stake would draw up the conversion plans would maximize the chances for success.

The top management of a company could decide not to adopt the conversion plan even if a facility were threatened with shutdown. However, the plant's workers and the larger community could pressure managers to pursue the alternatives because everyone would know that a comprehensive plan existed. Outside investors and even the employees themselves could also consider taking over the plant with assistance from state and local economic development agencies. Local governments could even use their power of eminent domain to take over a facility rather than allowing a firm to mothball the plant indefinitely.

Garnering Political Support

Every U.S. president from John Kennedy to Ronald Reagan has opposed legislation promoting plans for economic conversion. They have taken their cue from Pentagon officials, who regard such planning as a blueprint for diminishing their power. It is true that any plans that allow individual firms and U.S. society to reduce their dependence on military funding would erode support for the Pentagon budget and the arms race. Because of such pressures, governments of nations with military economies have resisted efforts to set up conversion programs. Only the government of Sweden has broken this pattern by publishing a two-volume report on the feasibility of military-civilian conversion.

Top U.S. officials and economists often maintain that long-range planning is unnecessary because the market will absorb laid-off workers, and because military contractors will plan for conversion whenever it is in their interests to do so. However, it is incomparably easier for contractors to operate within the cost-maximizing framework of the Pentagon than to compete in the open market, so we cannot count on them to make an effort to convert. Of course, the market's "unseen hand" might eventually help revitalize the U.S. economy. Meanwhile, however, the millions of people directly and indirectly involved in military production would face serious hardship. The justified fear of widespread layoffs generates massive political opposition to cutbacks in the military budget, delaying such changes indefinitely. With a national framework for converting from military to civilian production, prospects for peace could be viewed as an invaluable opportunity rather than a severe penalty.

Some observers maintain that conversion planning is unnecessary because governments could award civilian contracts—say, for repairing the infrastructure—to military firms, much as the Pentagon now awards contracts. However, this is a certain road to failure because these firms are not prepared to switch directly to producing civilian goods, and because this type of no-bid contracting would only encourage the wasteful practices endemic today.

For all these reasons, national legislation that mandates comprehensive conversion planning is essential. Rep. Ted Weiss (D-N.Y.) proposed such legislation in 1985—H.R. 229. Despite opposition from the military and its contractors, the time may be ripe for bringing such a bill to national attention. The public is increasingly aware of the high social and economic costs of escalating military budgets, and a coalition of peace groups, professional societies, businesspeople, unions, religious groups, and minority

THE TRADE-OFFS OF INVESTING IN MILITARY VERSUS CIVILIAN RESOURCES

Seven percent of the military outlays from fiscal 1981 to 1986	$100 billion	The cost of rehabilitating the U.S. steel industry so that it is again the most efficient in the world
The navy's F-18 fighter program	$34 billion	The cost of upgrading America's machine-tool stock to bring it to the average age of Japan's
Cost overruns, to 1981, on the navy's Trident and the air force's F-16 programs	$33 billion	The cost of rehabilitating one out of five U.S. bridges
The cost overrun, to 1981, on the army's heavy-tank (XM-1) program	$13 billion	The shortfall of capital needed to maintain the water supplies of 150 cities for the next 20 years
The cruise-missile program	$11 billion	The cost of bringing the annual rate of investment in public works to the 1965 level
The cost overrun, to 1981, on the navy's Aegis-cruiser program	$8.4 billion	The cost of a comprehensive R&D effort to produce cars that get 80 to 100 miles per gallon
The cost overrun, to 1981, on navy FFG-7 frigates	$5 billion	The minimum added annual investment needed to prevent U.S. water pollution from exceeding present standards
The cost of excessive, nonstandard service equipment for military aircraft	$300 million	President Reagan's fiscal 1981 and 1982 reduction in capital grants for mass transit
One F-15A airplane	$29 million	The cost of training 200 engineers to design and produce electric trolleys in the United States

and women's organizations can be counted on to throw their support behind the bill.

Some proponents of this legislation want to combine military-civilian conversion with overall efforts to revitalize U.S. industry. However, military contractors face a series of unique tasks: they must make the major decision of which civilian goods to produce, retrain managers and engineers, bring off the large-scale relocation of excess engineers and technicians, and complete a major redesign of their production facilities. In contrast, industries that are candidates for revitalization face the central problems of upgrading their capital supply and their engineering and managerial competence. The U.S. steel industry, for example, has a market; it must figure out a way to modernize and improve the efficiency of its production to better serve that market. Thus, while military-to-civilian conversion is necessary to renew our industrial base, the administration of these two efforts should be kept separate.

More and more Americans are doubting the conventional wisdom that the military is the best source of jobs and prosperity, and that U.S. economic resources and resilience are unlimited. The severe decline in our industrial base may provide the impetus for establishing a national framework to convert to a peacetime economy.

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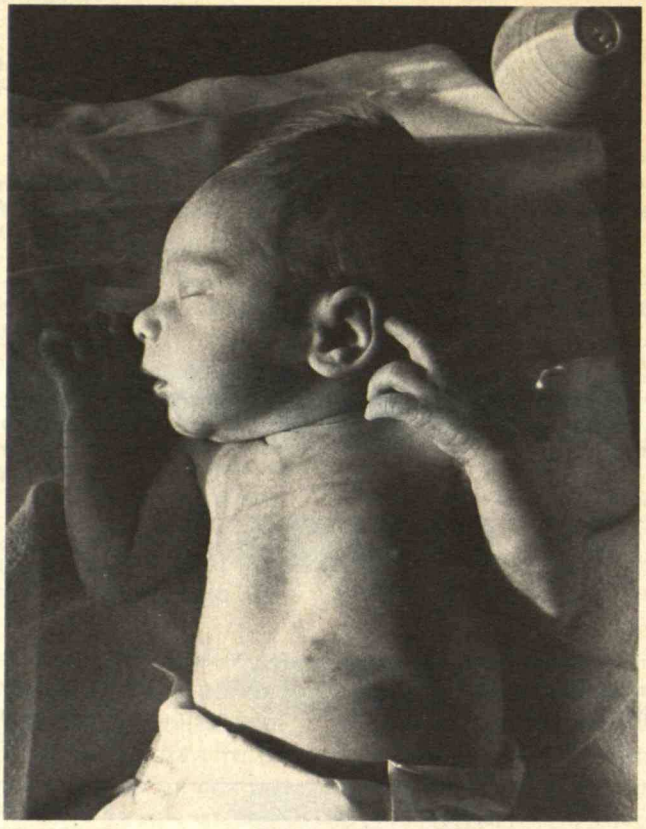
Babies with severe jaundice must now undergo complete blood transfusions that have dangerous side effects. Enzyme technology may offer a safer solution.



Using Enzymes to Treat Newborn Jaundice

Every year in the United States, about 6,000 to 10,000 babies are threatened with brain damage and other disorders because their blood contains high levels of a toxic waste product called bilirubin. To treat this severe jaundice, hospitals must replace the infants' blood with adult blood—a complete transfusion that can have dangerous side effects. Now scientists think they have a safer solution: use an enzyme to break down the bilirubin into its less harmful components.

Bilirubin is a toxic by-product formed when red blood cells die and the spleen fragments them for disposal. The body transports the bilirubin by-product to the liver, where it becomes part of the bile and is eventually excreted. Because red cells in the blood of newborns have a shorter life than adult red cells, an infant produces twice as much bilirubin for its size as an adult. A baby's immature liver also processes the toxic substance much more slowly. As a result, large amounts of bilirubin often build up in the blood of newborns.

One in five babies has so much bilirubin that the toxin's yellow color stains the skin and the baby becomes jaundiced, even though he or she is otherwise healthy. Fortunately for most of these babies, a few days of phototherapy—exposure to a blue light—converts the bilirubin to a less toxic substance, and the jaundice disappears.

However, a smaller number of newborns—approximately 1 out of 20—has a bilirubin level so high that phototherapy cannot control it, and the toxin threatens to damage the central nervous system. If not corrected, this condition can cause mental retardation, cerebral palsy, deafness, seizures, and even death. For these babies, blood transfusions have so far been the only effective treatment. However, the donor blood may carry life-threatening diseases or cause abnormalities. Specialists in newborn medicine have long sought another treatment, and three years ago pediatrician Arthur Lavin, researcher Cynthia Sung, and M.I.T. Professor Alexander Klibanov joined forces with M.I.T. Professor Robert Langer to find one.

The Power of an Enzyme

Langer had already developed a technique for using an enzyme to remove heparin—an anticoagulant acid—from blood. Large amounts of heparin must be added to blood as it passes through a heart-lung machine to avert the coagulation and clotting that often occur. However, when the heparin is carried back to a patient who's just had heart surgery, its anticoagulation effect can cause severe hemorrhaging. The enzyme technology that Langer and his colleagues developed "keeps the heparin in the machine where you want it but doesn't let it go back to the patient where it could cause harm," Langer says.

The technique for removing bilirubin works much the same way. An enzyme—isolated from a fungus—uses oxygen to convert bilirubin into much less harmful components. The enzymes are treated in a standard blood filter so they cannot enter a patient's bloodstream.

In recent experiments with both animal and human blood, the enzymes broke down more than 90 percent of the bilirubin in a single pass through the filter; the process removed 50 to 60 percent of the toxin from the blood supply in 30 minutes. This is enough to bring bilirubin levels down to a range safe for newborns.

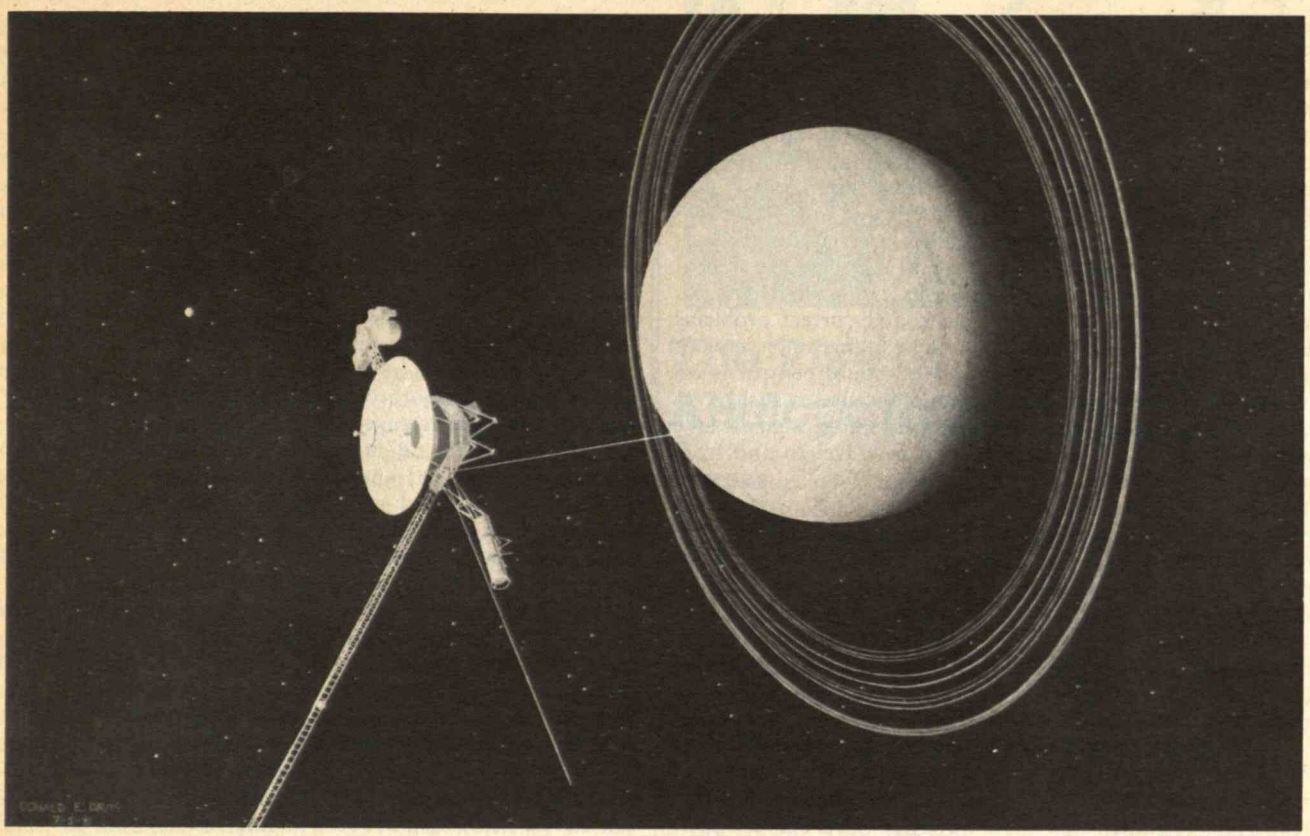
Clinical trials with newborn babies have not yet been completed, and some physicians remain cautious about its therapeutic value. "Although the concept is simple, carrying it out may not be so simple," notes Dr. Elizabeth Brown, director of neonatology at Boston City Hospital. Since clotting can occur whenever the blood goes through a filter, she says, the enzyme system will also require heparin as an anticoagulant. And so both bilirubin and heparin would have to be cleared from the newborn's blood.

However, Brown adds, "If these problems can be overcome, an enzyme filter should be a big advance over the transfusion treatment. Because the side effects of donated whole-blood transfusions are worrisome even in adults, being able to filter and reuse the patient's own blood is a very exciting concept." Indeed, bilirubin and heparin are only two of many toxins that enzymes may be able to cleanse from the blood. "There is a long list, including poisons youngsters eat, that might be cleared this way," Brown says.

—Suzanne Wymelenberg □

PHOTO: DAVID WITBECK

Artist's rendition shows *Voyager 2* two hours before its closest approach to Uranus on January 24, 1986. The craft has already spent nearly nine years in space.



Veteran Voyager Viewing Uranus

As you read these words, we are about to receive the first close-up views of the third largest planet in the solar system. *Voyager 2*, a 1,800-pound space probe that has already added substantially to our knowledge of the solar system, is closing in on Uranus.

The results are almost certain to contain surprises. We know that Uranus, the eighth most distant planet from the Sun, is surrounded by at least nine rings. We also know that five moons orbit outside the rings. The rings are very narrow and dark, perhaps composed of the dark organic material found in meteorites. The five known moons are smaller than our Moon, but they reflect more of the light they receive from the Sun. Surface ices may cover some of them, and some dark material may overlay the ice.

Uranus is the only planet tipped completely on its side. We will be looking at a south pole that faces the sun, and with its surrounding rings Uranus may look very much like a bull's-eye.

The giant outer planets (Jupiter, Saturn, Uranus, and Neptune) have masses from 14.5 to 317.9 times that of Earth. As a result, they have retained more materials of the early solar nebula than the smaller and more familiar inner planets. They may be the Rosetta stone that helps us understand what processes shaped the solar system and our own Earth.

Voyagers 1 and *2* are a bold break in planetary exploration, like their predecessors, *Pioneers 10* and *11*, which flew past Jupiter and Saturn. These four spacecraft are the first to explore beyond the inner solar system, and so they have faced much more complex problems. The distances are great: Jupiter, the nearest of the outer planets, is ten times farther from Earth than Venus or Mars. The sun is too far away to provide adequate energy, so spacecraft must carry their own power plants. There are long delays in communications to and from Earth, so spacecraft activities must not depend on detailed minute-by-minute instructions. And the spacecraft must move at higher speeds than present-day launch vehicles can attain. Otherwise, their transit time will exceed the lifetime of their equipment. Fortunately, the technology exists to overcome these obstacles.

The two *Voyagers*, like the two *Pioneers* before them, carry their power and heat sources with them. *Voyager 2* has three major radioisotope-powered generators and a number of smaller radioisotope heaters.

A gravity-assist technique overcomes the problem of inadequate speed. For example, the trajectory of *Voyager 2* allowed it to pick up speed from the gravities of both Jupiter and Saturn as it passed those planets. It was as if the space probe were snapped out of a slingshot. In the same way,

PHOTO: NASA

the gravity of Uranus will bend *Voyager 2*'s trajectory and increase the probe's speed by almost 1.2 miles per second. This will give it an additional boost toward its encounter with Neptune on August 14, 1989.

Because the Voyagers were intended to reach only Jupiter, their planned lifetimes were just four years long. However, thanks to conservative design, high reliability, and extensive redundancy in almost every subsystem, *Voyagers 1* and *2* still function after eight years in space, and *Voyager 2* can make its multiplanet "grand tour." Astronomer David Morrison, a member of the Imaging Team for Voyager, has said the two spacecraft are "among the most autonomous, sophisticated robots ever sent to explore other worlds."

The dominant feature of *Voyager 2* is an extremely efficient communications antenna 12 feet in diameter—at the time of launch, the largest flown on any planetary mission. Electro-optical devices behind a slot in the antenna dish send signals to an onboard computer. On the basis of these signals, the computer issues commands to align the antenna with Earth, creating a highly efficient Earth-to-spacecraft radio channel. Meanwhile, a star tracker aligns *Voyager* with Canopus, a brilliant star of southern skies.

In addition, the computer controls the stabilization and orientation of the spacecraft by issuing commands to fire thrusters fueled with pressurized hydrazine. Four of the thrusters correct the trajectory of *Voyager 2*, and the other twelve stabilize the orientation of the spacecraft.

Besides the computer-assisted antenna, *Voyager 2* also has two more interconnected subsystems for control. The second is an accurate clock that issues commands to the other subsystems at the appropriate times. The third controls the 11 science instruments.

All three control subsystems have built-in redundancy, all can be reprogrammed in flight, and all can locate and correct problems without human intervention. This on-board control is essential because at such great distances radio signals take hours to travel to and from Earth.

Redundancy Proved

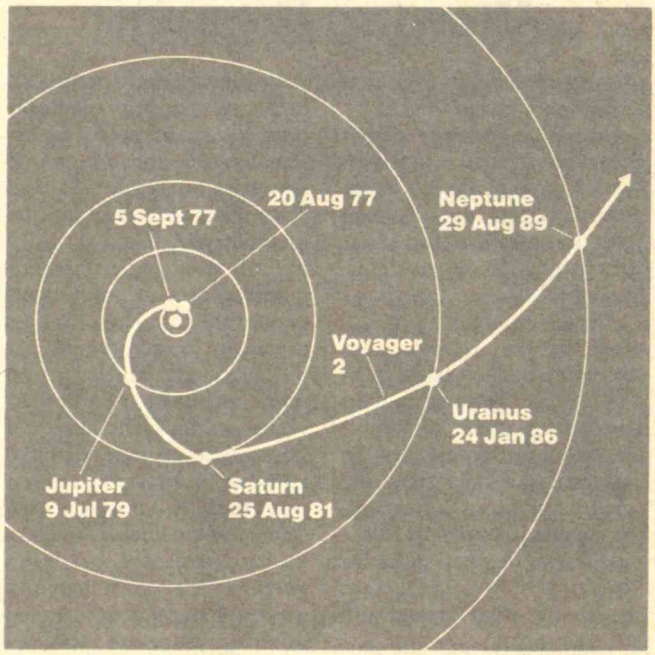
The value of *Voyager 2*'s life-sustaining independence became apparent less than eight months after launch, when the primary radio receiver failed. First, having received no commands from Earth for seven days, the subsystem concerned switched to a backup receiver as programmed. However, the backup receiver had a fault, too: it imprecisely tracked the changing frequency of command signals from Earth. So, after a 12-hour programmed wait, the subsystem switched back to the primary radio receiver. This receiver, which had recovered, worked for about 30 minutes before an apparent power surge caused the circuit-breakers to open. Once more, after seven days of silence, the backup receiver went into operation, but this time flight controllers at the Jet Propulsion Laboratory were prepared. They compensated for the receiver's difficulties, re-established communications, and ever since have controlled *Voyager 2* despite its partial deafness.

At the start of the mission in 1977, each of the three radioisotope generators on *Voyager 2* was producing an average of 159.2 watts of electricity. By the time *Voyager 2* flies past Uranus, the three will have deteriorated somewhat, but together they will still be generating about 400 watts, more than enough for the scientific instruments aboard. In the eight years since launch, the generators will have produced a total of more than 30,000 kilowatt-hours of energy—enough to power over 50 houses for a month.

Most of the 232 pounds of instruments are clustered on a science boom. On the end of this boom is a scan platform that can rotate about two axes to point precisely at targets of interest. Attached to the scan platform are four kinds of remote-sensing instruments—ultraviolet and infrared spectrometers, a radiometer, a photopolarimeter, and two television cameras.

The infrared spectrometer will record data on the chemical compounds in the planet's atmosphere, and indicate variations of atmospheric temperature and pressure. Similarly, the ultraviolet spectrometer will provide information on chemical reactions in the planet's upper atmosphere, including those due to electrons and ions from space.

The photopolarimeter will



Voyager 2 has successfully encountered Jupiter and Saturn. But Uranus has never been approached by any human-made object, and surprises are certain. The planet is known to have five moons, and _Voyager 2_ will pass within 18,000 miles of one. However, M.I.T. scientists have found a gravitational anomaly in one of Uranus' rings that is best explained by a sixth moon. There is also curiosity about Uranus' gravity, which according to some evidence is very small, to other evidence very large.

DIAGRAMS: OMNIGRAPHICS

measure the brightness and polarization of sunlight reflected from Uranus, revealing details of the planet's surface. Two radio receivers will measure radio emissions and the oscillations of plasmas near the spacecraft, yielding data about the atmosphere and solar environment. To measure the Uranian magnetic field, there are two pairs of magnetometers, located on a 43-foot boom to isolate them from the spacecraft's own magnetic fields. Finally, a television tube will capture images of Uranus, which will be digitized for transmission to Earth.

As *Voyager 2* passes behind Uranus, the nature of communications will change. First, the planet's atmosphere will dim the spacecraft's radio signal, and then the planet itself will extinguish it. Later, when the craft reappears, the signal will gradually return. Studying the signal's changes will enable scientists to profile the variations in temperature and pressure at different heights of Uranus' atmosphere. This data, combined with information on the speed of *Voyager 2*'s flight past Uranus, will show the gravitational effects—and hence the masses—of Uranus and its satellites.

On January 24, 1986, in its closest encounter, *Voyager 2* will be 66,540 miles from Uranus. At this distance, the planet will appear over 50 times the size of our Moon as we see it from Earth. The planet will be half in sunlight and about as bright as the Moon. The probe will take 250 to 300 pictures during this encounter.

Then *Voyager 2* will snap leftward toward Neptune, which it will reach in August 1989. But the spacecraft's career will not end there, either. With careful rationing of propellant and power, *Voyager 2* should be able to send us signals until 2019, some 42 years after launch—not bad for a spacecraft that started out with a planned four-year lifetime.—*Gary L. Bennett* □

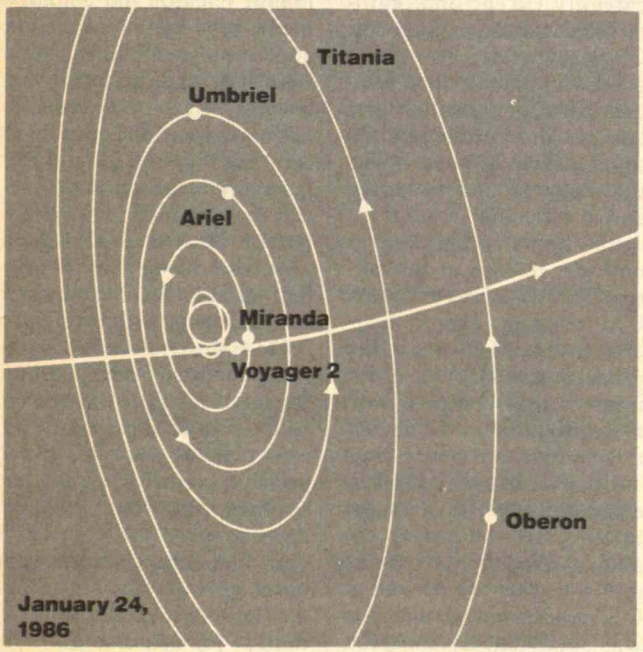
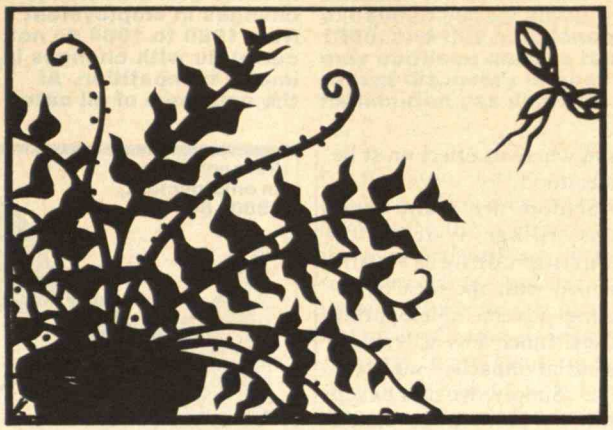


ILLUSTRATION: ELIZABETH SLOTE



The Rise of Allelopathy

Why does crabgrass succeed so well in suburban lawns? Because its roots release a toxin that prevents other grasses from invading its territory. Dead crabgrass releases the same toxin, repelling intruders even during the dormant season.

Why do weeds grow so fast and trees so slowly in areas where timber has been cut? Because many weed and fern species produce chemicals that interfere with tree growth.

These phenomena are in the realm of allelopathy—the science of allelochemicals, a class of biologically active products that plants themselves manufacture. Allelochemicals affect the plants' environment, usually protecting against threats from insects, fungi, or other plants.

Examples are legion, explanations still few. Dead leaves of cranberry bushes contain an allelochemical that slows the growth of competing plants. Lantana shoots and roots contain chemicals that deter milkweed, corn, wheat, and soybean. Many plants produce insecticidal compounds, and some even make systems of compounds that interact synergistically. Some plants produce allelochemicals that thwart grazing animals. Scientists have traced a significant reduction of broad-leafed weeds to residues from previously planted small grains, but there is also evidence that no-till farming results in accumulations of allelochemicals, inhibiting subsequent crops.

Once observed, such antipathies among plant, insect, and fungus communities should easily lead to new herbicides, insecticides, and fungicides. But it is not so simple. After two decades of research, natural, plant-specific controls are yet to emerge. The chemistry of plants and their pests is complex, and isolating the biologically active fractions responsible for allelochemical action is slow and painstaking. Indeed, a symposium on allelochemistry at the 1985 fall meeting of the American Chemical Society (ACS) attracted some 85 papers from throughout the world.

Professor Alan R. Putnam of Michigan State University guesses that no more than 25 percent of the allelochemicals produced by higher plants and microbes are yet identified. Furthermore, said Putnam, "I'm aware of no case where a single chemical has been unequivocally proven to explain the entire situation." After isolating each suspected compound, allelochemists have to follow it through the plant that creates it, the soil that may chemically alter it, and finally into a new orga-

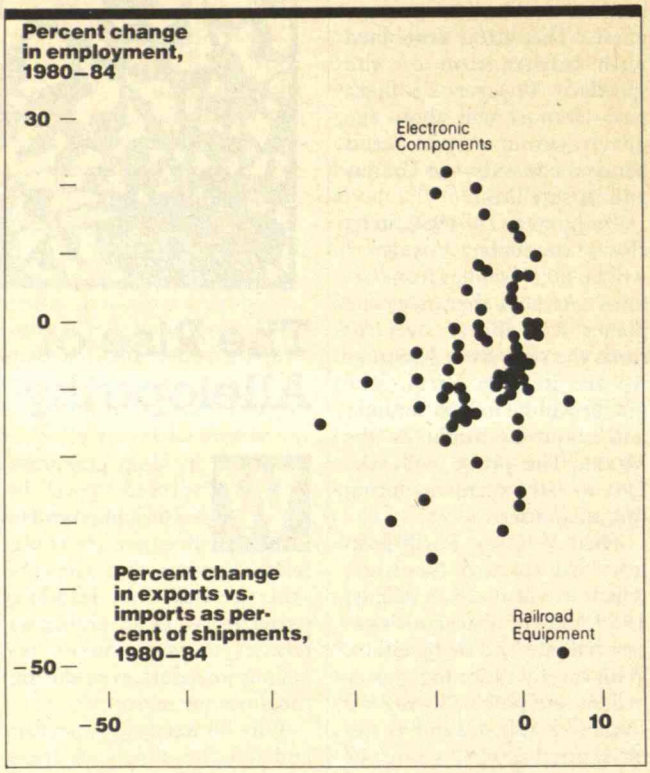
nism, where its effect must be understood.

"Seldom are plant rotations, tillage systems, or planting configurations planned with the idea of reducing adverse allelopathic effects, much less to exploit beneficial impacts," said Putnam. "Simply, we don't even know the best way to design our home vegetable gardens."

But allelochemists are confident that their work will soon produce results for farms and gardens. Horace G. Cutler of the U.S. Department of Agriculture's Richard B. Russell Center in Atlanta told the ACS he believes all active allelochemicals will turn out to be biodegradable. The brightest hope is for allelochemicals that will act as natural insecticides and herbicides, substituting for today's long-lived chemicals.

A few simple examples were reported to the ACS. Applied to a Michigan apple orchard in early spring, herbicides from sorghum and sudangrass reduced weed biomass by more than 85 percent. Also, two compounds in the Bolivian wild potato have been identified with its excellent resistance to common insect pests of the cultivated American potato. Dirk A. Ave and his Cornell University collegues are now working to build these compounds into U.S. potato varieties.

Looking farther into the future, Basil A. Burke of ARCO's Plant Cell Research Institute told the ACS he foresees genetic technologies that will enable plants to produce a wide range of allelochemicals. His vision: "The selected plant, formerly helpless in its own behalf, will now, through genetic engineering, build its own chemical factories and summon an arsenal of allelochemicals in its own defense."—*John Mattill* □



In most U.S. industries, changes in employment from 1980 to 1984 do not correlate with changes in import competition. At the extremes of all categories studied by Norman S. Fieleke of the Federal Reserve Bank of Boston, employment growth was highest in electronic components and job losses highest in railroad equipment. But the trade balance worsened in electronic components, while it improved greatly in railroad equipment.

Stronger Than We Know

For those who lament the "de-industrialization of America" under the pressure of foreign competition, some good news from Norman S. Fieleke, vice-president and economist at the Federal Reserve Bank of Boston: "U.S. goods-producing industries have borne up well under the onslaught of foreign competition," he writes in the *New England Economic Review*. "It is clearly premature to lament the downfall of American industry."

Analyzing the foreign competition in 76 major U.S. commodity categories, Fieleke finds that the U.S. trade balance—imports versus exports—did indeed worsen between 1980 and 1984 in every category except one—military and miscellaneous goods. Capital goods; consumer goods; and automotive vehicles, parts, and engines were hardest hit. The largest absolute deficits were in industrial supplies and materials, and in consumer goods.

But there's another important way to look at this picture, he says. Lots of major U.S. industries export "sizeable fractions" of what they produce, and the value of the imports that compete with these products on the domestic market is often very low.

Of all the categories Fieleke examined, steam engines and turbines had the largest surplus of exports over imports in 1984, when 31 percent of U.S. production in this field was exported. By contrast, imports accounted for only 7 percent of all shipments in that year. Aircraft parts, ordnance, shipbuilding and tanks, and complete aircraft were close behind, and several chemical and machinery industries were also near the top of the list, with exports topping imports by at least 10 percentage points.

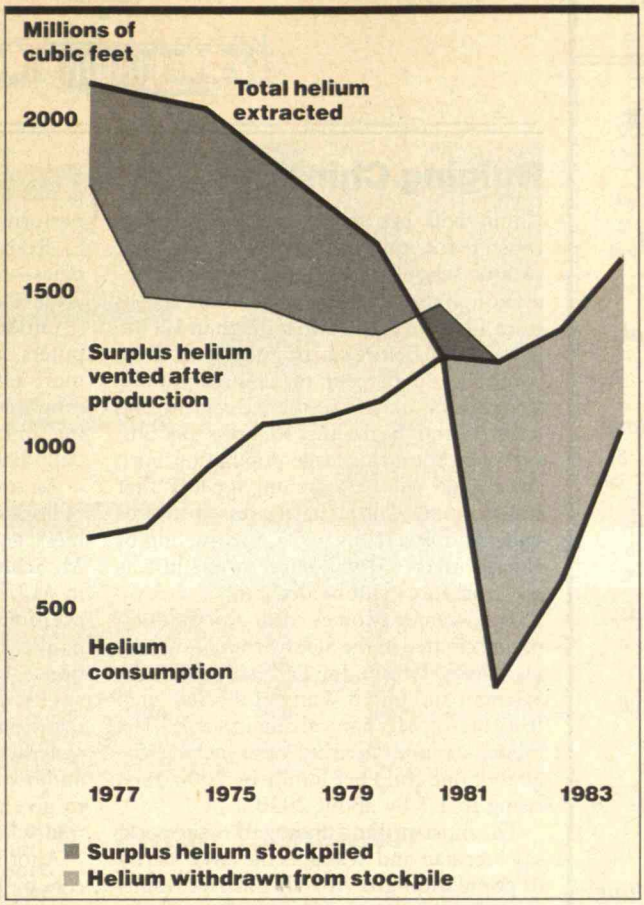
At the other end of the scale, a category called kitchen articles and pottery turned in the most dismal performance of all, with shipments that were less than the value of competing imports and exports that were only 10 percent of shipments. Leather products were a close second, followed by radio and television sets.

Summarizing the data, Fieleke finds that 1984 exports were equal to or greater than competing imports for 32 out of 73 categories. And the median category shows competing imports exceeding the industry's exports by only 0.5 percent of total shipments.

Furthermore, there is no correlation between export-import balance and employment, says Fieleke. Output and employment have often risen even while imports rose, he finds, because U.S. demand has outstripped the growth of imports. Indeed, Fieleke's basic argument rests on the fact that production of goods in the United States has grown so strongly in the first half of this decade, far exceeding the growth of GNP.

De-industrialization as a result of foreign competition "is more nearly a matter of myth than of substance," he says. "While the U.S. competitive position would be stronger if the dollar had not appreciated so much in recent years, American industry has borne up well thus far in the face of heightened competition."—*John Mattill* □

The Short and the Long of Helium



Demand for helium has exceeded supply since 1980, and this imbalance may continue despite the recent discovery of new helium-rich gas deposits.

Remember the "helium crisis" of the sixties, when the federal government began to capture and stockpile the precious helium vented from natural gas processors?

A classic government boondoggle, the *Detroit News* concluded last summer.

Potentially "one of our government's most successful activities," said Arthur Francis of Union Carbide Corp.'s Linde Division at the American Chemical Society's annual meeting last fall.

Why this sudden divergence of views?

The basic facts about helium conservation remain unchanged in the 25 years since the U.S. Bureau of Mines was authorized to capture and stockpile this uniquely useful gas. Helium is light in weight and chemically inert—fireproof and harmless. It is useful for these characteristics and, especially, for its very low boiling point. While water goes from liquid to gas at 100°C, helium does so at the remarkably low temperature of −269°C—just four degrees above absolute zero. At liquid-helium temperatures, molecular motions slow and many materials become "superconductors," losing their resistance to the flow of electricity. Because of these properties, helium is a much-needed refrigerant, a vital ingredient of many prospective energy technologies. It is also important in space and medical technology and essential in the manufacture of optical fibers and in the operation of communications networks.

Helium is most abundant as an impurity in natural gas. When gas containing helium is burned, the helium disperses into the atmosphere. Helium can be readily separated from the gas before combustion, but the lower the helium concentration, the higher the cost of doing so. Thus, if we run out of helium-rich natural gas, we run out of low-cost helium.

From Surplus to Shortage

In its first decade, the government's program produced 43.5 million cubic feet of stockpiled helium. But demand (about 7.5 million cubic feet) was lower than expected. This meant that the financial burdens were greater than expected, since the helium program was operating on borrowed funds to be repaid through sales.

Responding to this experience, the government stopped buying helium for conservation in 1973. As surpluses developed, private owners shut down two of the country's five helium recovery operations and eventually persuaded the government to permit private storage in the government facility. Since then, helium demand has grown significantly because of helium's high-technology applications. Helium production increased almost apace with demand until 1981, when growing demand began to exceed supply. Then, the stockpile began to do just what it was supposed to do: cushion the country against shortages of this unique material.

By the end of 1984, the government's investment in the helium stockpile was about $25 per thousand cubic feet—roughly the price private firms were paying for helium from natural gas producers. However, the total investment the architects of the plan had foreseen in the seventies was far less. But not to worry, Francis told the American Chemical Society. As long as the value of the stockpiled helium is greater than the program's expense, the project is in the black, having provided a vital stockpiling function at little or no long-term capital cost.

Why last summer's headlines, then? A deep deposit of helium-rich gas discovered last year in Wyoming turns out to contain enough helium to meet the growing needs of the whole world into the twenty-first century. Hence the idea that the stockpile is suddenly obsolete. A prospective helium glut may keep the program from ever recovering its costs.

Not at all, says Francis. Helium consumption will continue to rise as high technology becomes a larger part of our economy. Demand for helium may triple between now and the year 2000, he says. Meanwhile, production from the new Wyoming field may turn out to be economically marginal, since its natural gas is rich not only in helium but also in carbon dioxide, for which there is little or no market.

Francis' best guess is that for the rest of the twentieth century, about half of the helium available in the United States will be used and half wasted. By contrast, 65 percent was wasted in the 1960-80 period. The growing demand will let the U.S. helium program repay its debt. And the stockpile will continue to act not only as a vital reserve but "as a giant flywheel smoothing the ebb and surge of helium production."—*John Mattill* □

DIAGRAMS: OMNIGRAPHICS

Bulging China

China will be on an economic roller-coaster for the next half-century, first seeking schooling and then jobs for a population bulge that will take the census from 1 billion in 1980 to more than 1.2 billion in 2020 before starting a gradual drop.

Nearly 40 percent of China's population today is under the age of 20, crowding schools and beginning to press on universities. Soon this large population born since 1965 will be searching for jobs that the economy will be hard-pressed to provide. And finally, by 2025, the fraction of elderly (over 65) will start to rise just as the workforce will be declining.

This scenario comes from a population model created in the Sloan School's System Dynamics Group by Professor John D. Sterman and Qifan Wang of the Shanghai Institute of Mechanical Engineering. The model assumes fertility approaching the goal of one child per family by 2000, then rising to 1.7 by about 2020.

The most striking finding of their work, say Sterman and Wang, is the large inertia in population growth. This inertia results from the numbers of children born in the sixties and seventies, and from rapidly increasing life expectancy, up from 35 years in 1948 to more than 68 years today. □

Interweaving Art and Technology

M.I.T.'s new Wiesner Building, whose dedication drew national attention late last fall, is an adventure in intellectual diplomacy: Can people with such diverse psyches as television engineers, cinematographers, art curators, and artificial intelligence experts find collegiality in a five-story building where their paths will cross daily? And what miracles can flow from such an unconventional coupling?

Though answers may be elusive for a decade or more, there is no lack of interest at the Institute. The building is a literal translation of the passion of Jerome B. Wiesner, president emeritus of M.I.T., that computers are the driving force of a revolution in humankind's relation to technology, and that this new relationship can be enriched by an active association between technology and the arts.

Three programs find space in the I.M. Pei-designed building:

□ Art galleries that are unique in an institute of technology in the United States, and a Council for the Arts that makes grants to nurture the visual, graphic, and performing arts in the M.I.T. community.

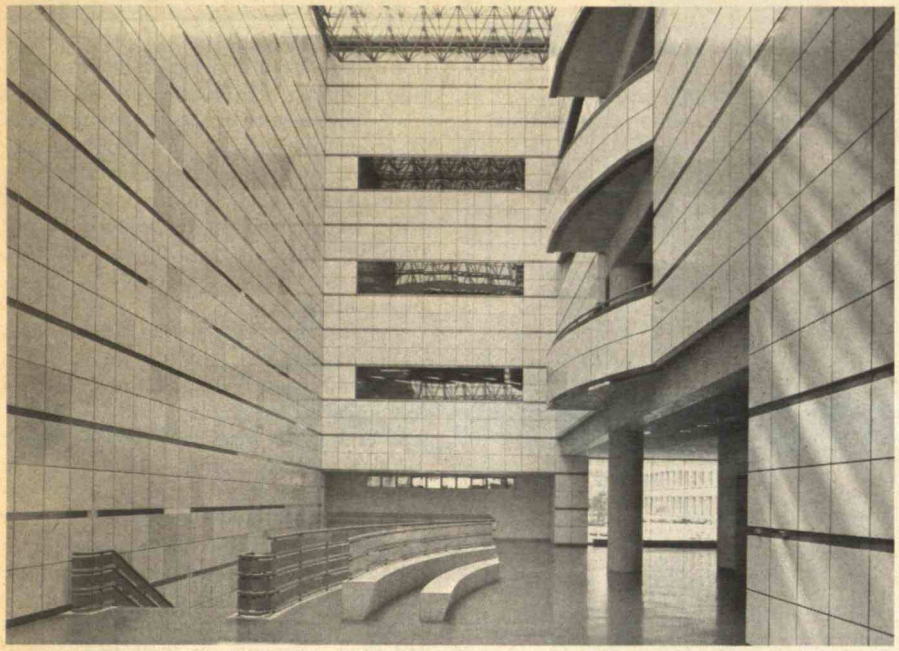
□ Research on communications technologies—television, motion pictures, holograms, and graphic arts.

□ Studies on the interface between computers and people, to make computers more effective and accessible and people more responsive to them in music, teaching and learning, management, and even daily life.

An example of the third program is "Phoneslave," a telephone answering and message system conceived by Christopher M. Schmandt, principal research scientist in M.I.T.'s Media Lab. This system uses ever-increasing knowledge of its user's habits and interests—as well as instructions—to answer telephones, take messages, and even make calls to draw information from databases. The next generation is "Desktop," a more complete audio/video environment that will be able to give an appropriate answer when it is told who is asking a question.

Another example is "Newspeek," a concept by Professor Andrew B. Lippman for a "personal" newspaper. Working overnight, your computer will tap the vast databases that are now available—news from the wire services and newspapers, the day's television broadcasts, financial data, transportation schedules, photographs. In the morning, it will present to you at the breakfast table a digest of all this into a *U.S. News*-like "front page" on which the stories are tailored to your interests and needs. For more information about a story, you need simply touch the section of the sensitive screen where it is being displayed. How does "Newspeek" know what to put on its front page? You will have given it a list of your interests, and it will draw on its own experience—what you have asked about in the past.

A third example comes from music. As performers, computers are mechanical: they play the same piece exactly the same way every time. Human musicians don't: their music is varied in tempo and style with their mood and with the performance. Computers programmed by M.I.T.'s Professor Barry Vercoe are now adapting to their human partners. First it was a flutist, whose finger movements were monitored by the accompanying computer so the flute could set the pace. Then it was a violinist, whose computer accompaniment was activated by the vi-



The collaboration of artists and engineers inside M.I.T.'s new Wiesner Building was presaged by the partnership of artists Scott Burton and Kenneth Nolan with architect I.M. Pei on details of the atrium.

olin's acoustic signal. Now Vercoe is taking the acoustical monitor one step further: in a series of rehearsals, his computer gradually adapts itself to the musician's timing and emphasis, becoming a true accompanist.

The point in all these examples is that computers can be programmed to do again without explicit instructions what they have once been told to do—to look for news stories about tennis, for example, after that topic has been specified from a larger file. Such adaptive programs seem to give computers the power to learn, says Vercoe. They seem of their own volition to change their behavior in response to their user's interests or style.

Used in this way, computers seem a little like children, says Vercoe. "Teaching" them is in many ways analogous to teaching our children.

Furthermore, Wiesner is convinced that these efforts to make computers more "human-like" will also yield new insights into human evolution and learning—a "new scientific discipline," Wiesner says, "in cognitive processes. . . . We are retracing nature's evolution of information and control systems."—*John Mattill* □

Small Transistor

X-ray lithography has been used to create what is believed the smallest transistor ever made of silicon—and possibly any other semiconductor material.

Working with Professors Henry I. Smith and Dimitri A. Antoniadis in the Research Laboratory of Electronics, Stephen Chou, a physics student from Beijing, has made transistors with channel lengths as short as 600 Angstroms—about two millionths of an inch. Transistors in current commercial practice are 20 times larger. Reduced size will permit faster operation. □

Skier's Thumb

The thumb has suddenly become, second to the knee, the most vulnerable part of a skier's anatomy.

The information comes from Waterville Valley, N.H., where the ski patrol has collected a data series on skiers and their injuries since 1966. Ski enthusiast Laurence R. Young, professor of aeronautics and astronautics at M.I.T., has been analyzing that data for nearly as long.

He has noted that overall injury rates on the slopes have been stable for the last decade—averaging about 3.5 injuries per thousand skiers. However, the nature of those injuries has changed. Knee accidents are the nemesis of intermediates, novices,

Continued on page 80

PHOTO: STEVE ROSENTHAL

REPORTER

CONTINUED FROM PAGE 79

and beginners at Waterville Valley. But among advanced and expert skiers there, thumb injuries are now the most common of all. Indeed, statistics show that although the ankle/lower-leg area was once the second-most likely site for injuries among skiers in general, the thumb has displaced it for that dubious honor. Skier's thumb often accompanies head or face injuries. Most such accidents occur on hard snow, during forward falls.

The finding, says Young, brings into question the role of ski poles in accidents, and he calls for a review of how poles and pole grips are designed.

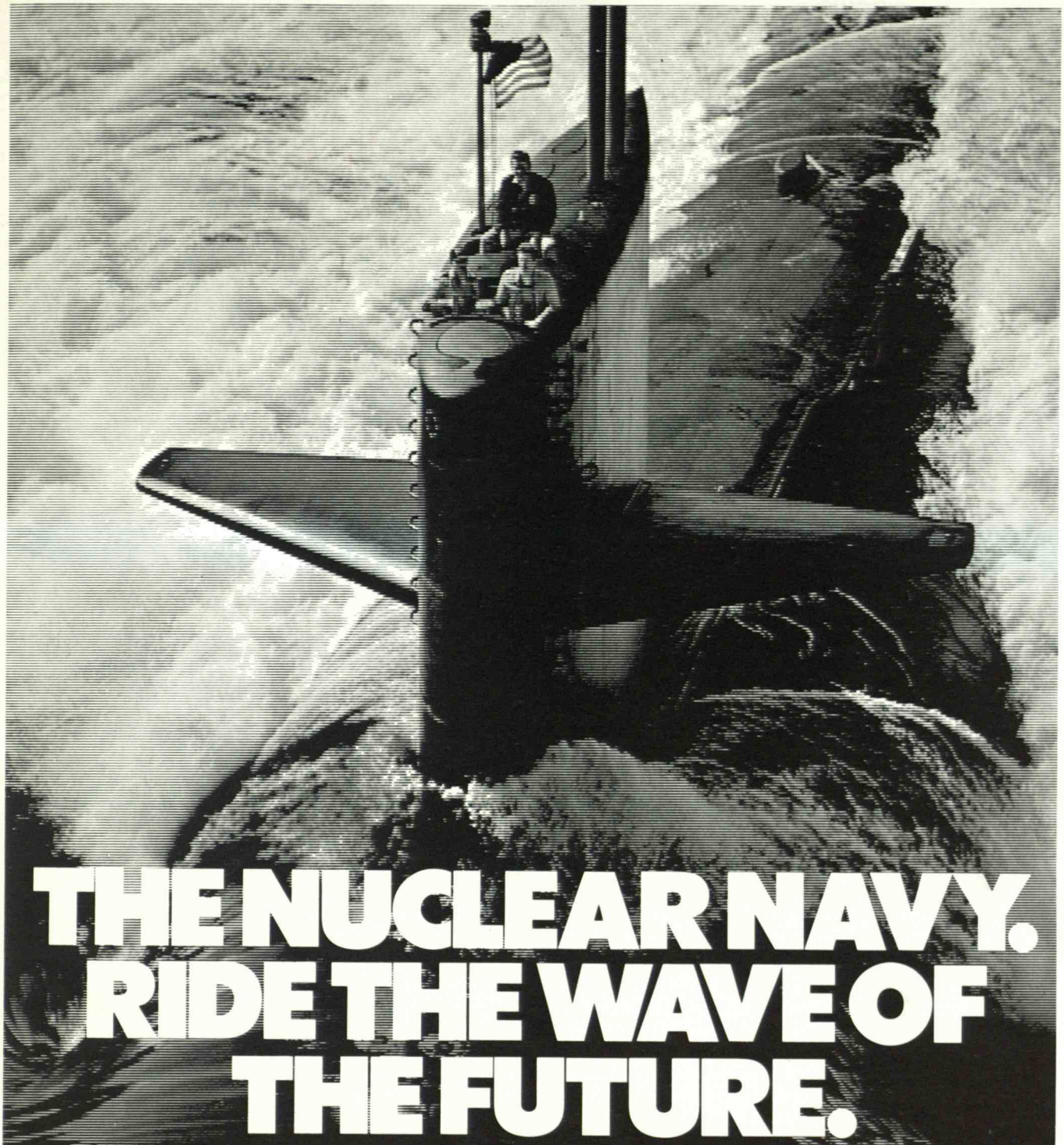
Overall injury rates at Waterville Valley correlate with the number of skiers on the slopes. In 1981-82, the rate was 2.52 injuries per thousand skiers per day on weekdays, 3.95 on weekends, and 4.43 on holidays. Also, younger skiers are more likely than older ones to sustain serious injuries. Three percent of injured skiers had their accidents on their first day of skiing in the season, and 30 percent had skied fewer than 30 days in the season prior to their injuries. Finally, fatigue contributes to accidents: injuries peak between 2 and 3 P.M., though the density of skiers at Waterville Valley peaks between 11 A.M. and 2 P.M. □

Joy in Mathematics

Professor Michael Sipser of M.I.T. recalls for the *Washington Post* the first time he experienced mathematical beauty: "I was very young, . . . and I remember my father folded down the flaps of a cardboard box so that each was holding down the next. And I remember . . . being amazed, it was so perfect . . . my first experience of joy in abstract thought." □

AI Seminar, Other Courses

A two-and-a-half-day state-of-the-art seminar on artificial intelligence is slated for January 21-23 at M.I.T. For further information: M.I.T. Seminar Office, (617) 253-7406. And several four-month advanced study programs are scheduled to start on February 3: biotechnology, manufacturing automation and control, systems reliability, and communications technology and policy. For further information: Center for Advanced Engineering Study, (617) 253-6128. □



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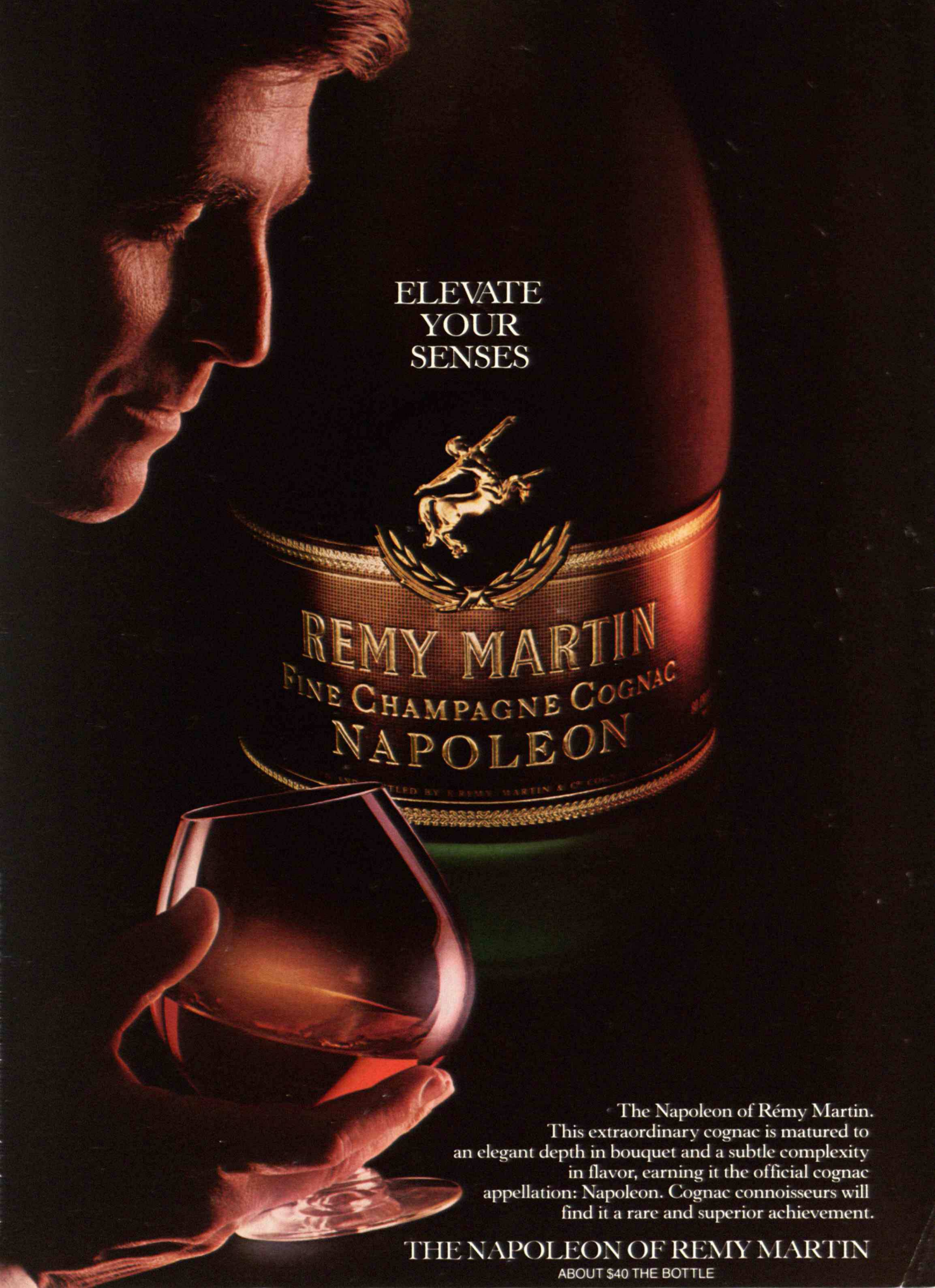

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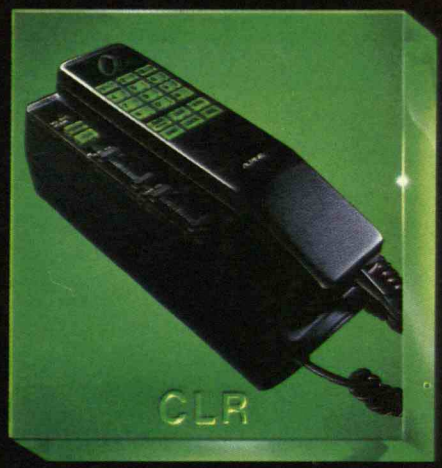

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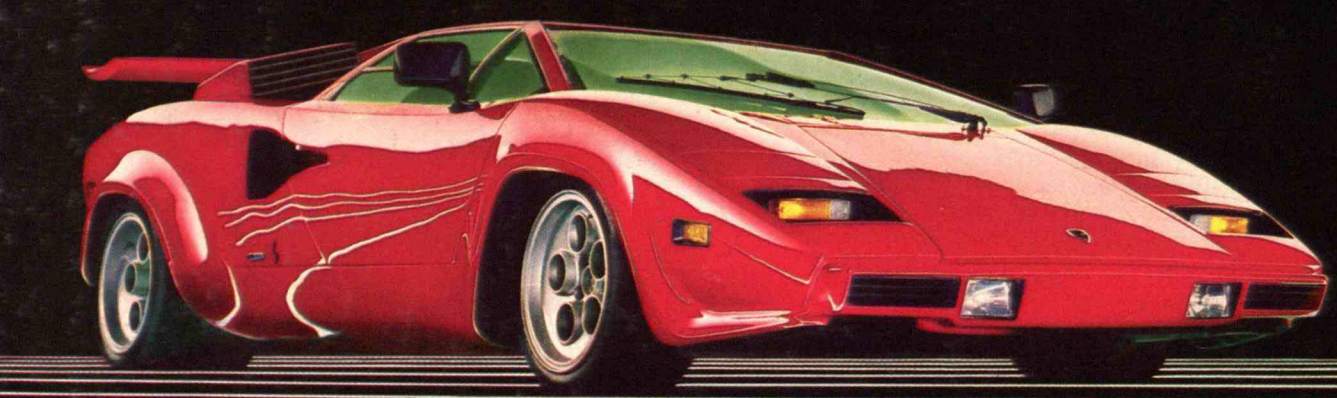

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