FUSION

AT THE FRONTIERS OF SCIENCE AND ENERGY

July 1981

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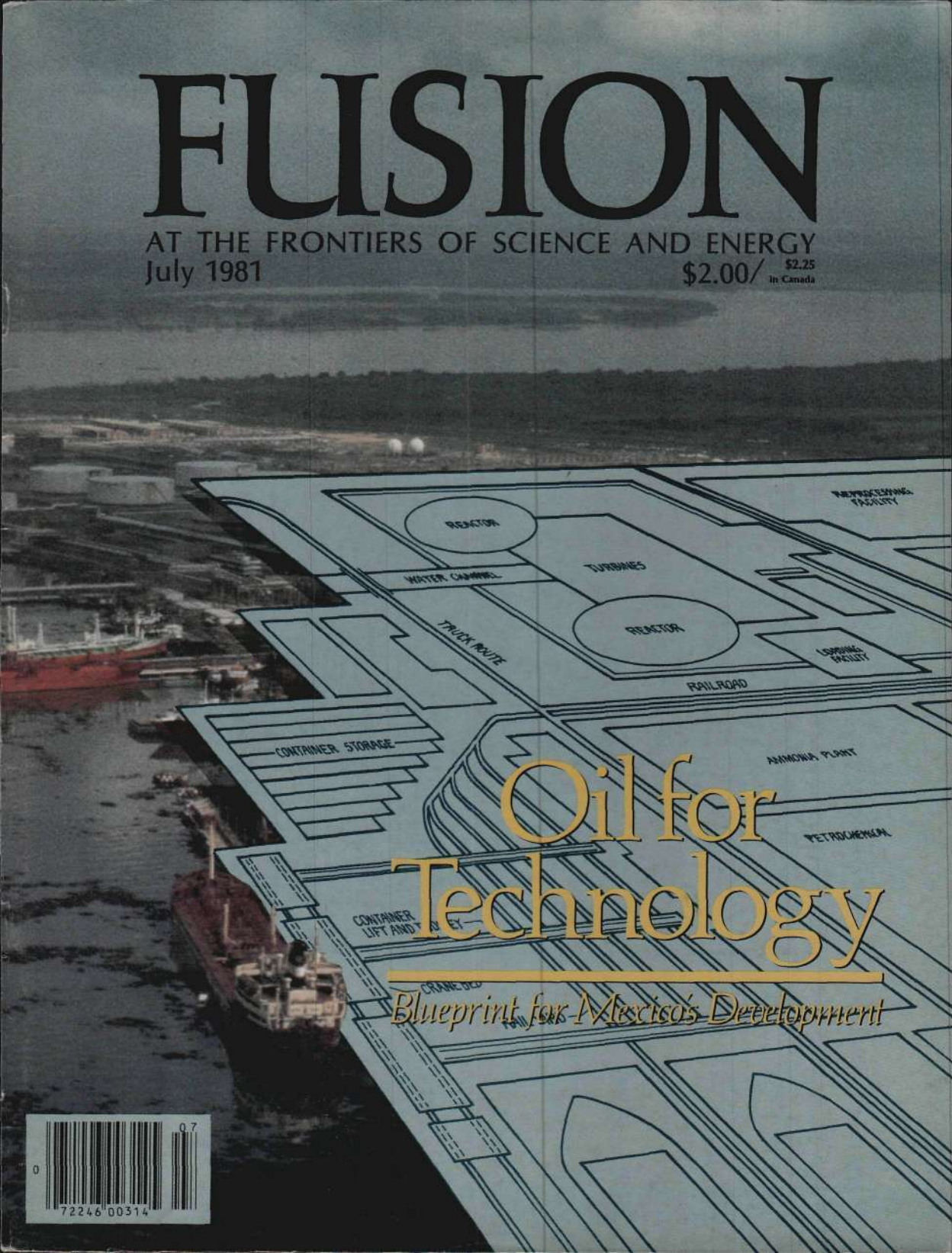

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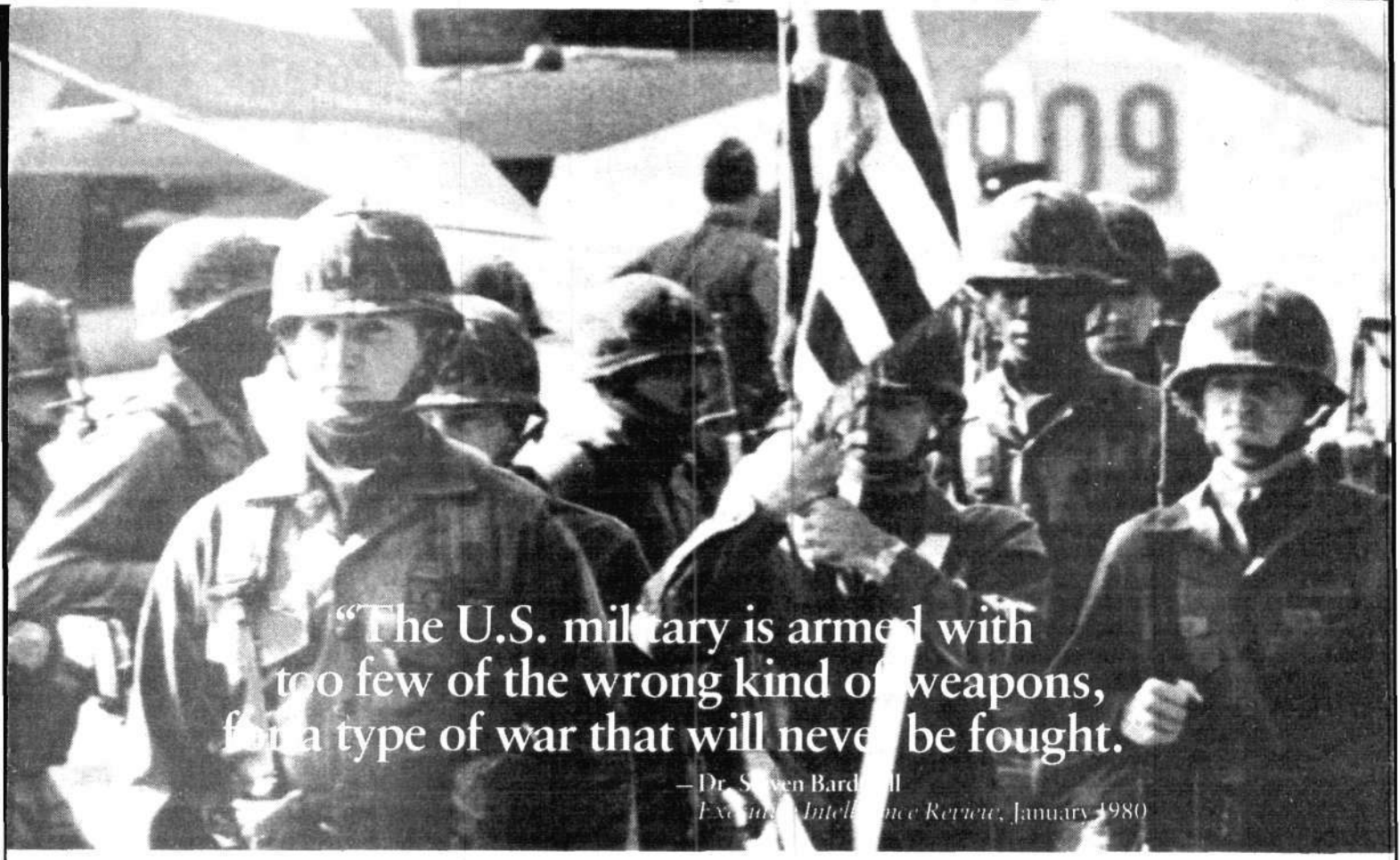

The EIR has warned for over five years that the decline in American industrial, scientific and moral strength would undermine the nation's military capabilities and security. Industrial weakness has led to deficiencies in military hardware, and the decline of scientific research and education has removed from American youth the moral desire to serve and fight for the country.

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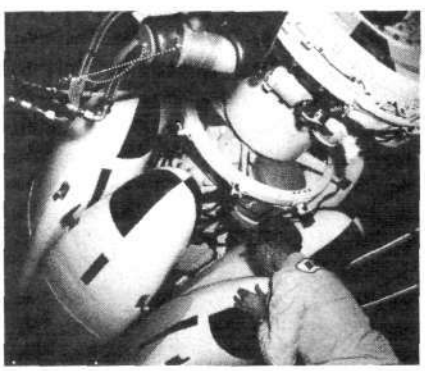
Carlos de Hoyos

High-technology medicine saves lives—and money. Ned Rosinsky, M.D. exposes the fraudulent attacks on kidney dialysis. See page 41.

Features

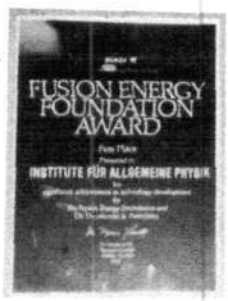


Boeing

Is the U.S. number 2? Our special report on Science and National Security documents how the nation's best defense is a strong science policy. See page 10.

News

Departments



First place in the FEF's Energy Technology Awards went to the Institute fur Allgemeine Physik in Vienna.

From the Editor's Desk

The Space Shuttle Columbia's stunning success has given a lift to U.S. science—and to all of us in the fight to revitalize the nation's science capabilities. The urgency of our winning the science fight is the underlying theme of this issue's special report on Science and National Security. Ironically, as the report demonstrates, the Soviets are using the American System to push the scientific frontier to its limits.

At this writing, the science budget battle is far from over. The Washington section summarizes where things stand and describes the basically incorrect formula the Office of Management and Budget uses to arrive at its verdicts on the so-called cost-effectiveness of R&D. And the national section reveals another motivation behind the budget cutting—OMB head David Stockman's long-time involvement in population control activities.

Some FEF news to note: A special appeal for funds in the editorial (page 6), a report on the FEF annual meeting featuring Ebasco's Leonard Reichle (page 58), and the winners of the first FEF Energy Technology Awards (page 59). Also, we are pleased to inaugurate a column on new technologies and products (page 57), and we invite reader contributions.

Finally, a word about next month's exclusives. Our cover story will report on the ambitious Japanese fusion program that plans to put a commercial prototype reactor on line by 1993, and our special report on the Space Shuttle will include an interview with Captain Robert Crippen.

Marjorie Mazel Hecht

Marjorie Mazel Hecht
Managing Editor

FUSION
AT THE FRONTIERS OF SCIENCE AND ENERGY

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The views of the FEF are stated in the editorials. Opinions expressed in articles are not necessarily those of the FEF directors or advisory board.

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Repealing the Nuclear Nonproliferation Act

Twenty-six years ago the Atoms for Peace program stirred the hopes of the American people that nuclear power would solve the energy problem here and abroad. There was a self-assurance that U.S. science and technology would play a leading role in bringing nuclear energy not only to our European allies but also to the developing sector, to power the transformation of Third World nations into the industrial age. Confidence in man's ability to use the atom to forge progress was so widespread that even the mainstream *Life* magazine could editorialize Aug. 22, 1955 that the real frontier was fusion, not fission, and while the advanced sector might move right ahead to this more energy-efficient source of power, the developing nations might have to make do for a few decades with fission. At the time, the United States planned to build 330 reactors by 1980, and 3,600 reactors worldwide by the year 2000.

Today, in 1981, Atoms for Peace has been turned on its head. The 1950s vision of President Eisenhower, India's Homi Bhabha, and scores of other world leaders and scientists has been twisted into its opposite. Nowadays, in the media and in the population—both among those who know better and the ignorant—nuclear power equals war, nuclear reactors mean "proliferation."

This inversion of a noble American dream can best be understood by looking at the purveyors of nonproliferation—the disarmament lobby. With a few notable exceptions, nonproliferation advocates of various political stripes follow their founder, Bertrand Russell, in being antinuclear and antigrowth. They are also likely to be part of that minority (championed recently by liberal press like the *New York Times*) that sneers at the Space Shuttle: "It's too costly," and "What good is it?"

The Question of Peace

Of course, peace, like motherhood and apple pie, is unassailable. But peace, according to the nonproliferation litany, is a strange animal. To get peace, the nonproliferationists claim, we must get rid of nuclear weapons. In the process,

however, they scrap fission, the only energy source that can provide power on a scale great enough and cheap enough to raise three-quarters of the world's population from starvation and misery. Peace, for the disarmament lobby, has become a moralistic cover for supporting the policies of deindustrialization, zero growth, and "appropriate technology."

As Edward Teller succinctly put it, you can "outlaw the cause of war or the means of war." We agree with Teller: The cause of war is the scarcity of nuclear power plants, and this situation must be turned around if we are to have peace.

Unfortunately, the antinuclear Malthusian outlook is written into the U.S. law—as the Nuclear Nonproliferation Act of 1978, known as the Percy-Glenn Act, which amended the Atoms for Peace legislation of 1954.

There are many peace-seeking Americans who will object to such a black-and-white classification as unjust. We need safeguards, they protest, against the misuse of nuclear power by extremists and "outlaw" nations. For this reason, they have backed the morass of regulatory proscriptions in Percy-Glenn.

The answer to such supporters of nonproliferation is quite simple. Extremists who intend to develop nuclear weaponry will do so regardless of this U.S. law and regardless of their own nation's civilian nuclear capabilities. And they will do it, of necessity, with the complicity of some government that already has a nuclear weapons capability. The same is true of any terrorist group.

Legislating Environmentalism

Given this fact, there is no way to view the purpose of the Percy-Glenn Act except as legislation designed to prevent the U.S. export of nuclear power reactors, in particular, to the Third World. The act spells this out unambiguously. For example, Section 2 (d):

> It is the policy of the United States to . . . aid foreign nations in identifying and adapting appropriate technologies for energy production, including solar and unconventional technologies, and, in particular, to identify alternative options to nuclear power in aiding such nations to meet their energy needs, consistent with the economic and material resources of those nations and environmental protection.

Furthermore, the maze of regulations established under Percy-Glenn and their congressional interpretation in the last two years have not so much stopped the "proliferation" of nuclear plants worldwide as they have stopped the United States from exporting nuclear technology. Economically, this has been a disaster. While the Nonproliferation Act has tied up the U.S. nuclear industry with regulatory rope, eleven other governments are strongly supporting their nations' nuclear exports and are bidding on the construction of new plants. It's estimated that the United States has lost $9 billion in nuclear export trade during this period. In terms of jobs, each export order lost meant the loss of 60,000 man-years of employment for U.S. workers.

As for the future, the International Nuclear Fuel Cycle Evaluation survey indicates that in the next six years, 73 to 96 plants could be ordered throughout the world. In this issue, our cover story demonstrates how the FEF plan to industrialize Mexico would easily up this estimate by another dozen plants.

The political issue involved in the repeal of Percy-Glenn is fundamental. There can be no economic growth without the development of fission—and fusion—and there can be no world peace without an aggressive nuclear export program to ensure that the rest of the world is brought into the 21st century with 21st century technology.

The Space Shuttle Columbia awed the nation, not only with the beauty and majesty of man once again reaching out to civilize space, but also with its reaffirmation of man's ability to *know* and command the universe through science. Columbia, as designed, landed on a dime; nuclear power, as designed, can produce power safely.

Continued on page 6

Fusion Propulsion: The History of The Concept

To the Editor:

For the record, publication is requested in your letters column of the following comment relating to Dr. Friedwardt Winterberg's article "Colonizing Space with Fusion Propulsion" [*Fusion,* April 1981]:

The need for fusion propulsion for meaningful interplanetary operations has been well recognized for a long time. Some 18 years back, this writer analyzed extensively nuclear pulse missions through the solar system for NASA. A model of lunar industrialization—using nuclear pulse freighters in geolunar space and nuclear underground detonation procedures for a broad variety of purposes, not only mining—was developed by this writer in the late 1960s, presented at the 23rd International Astronautical Congress in 1972, and published in *Acta Astronautica,* Vol. 1, pp. 585-622, 1974, a scientific journal of the International Academy of Astronautics.

In the subsequent years, the writer received a lot of flak for his proposal (I guess I should call it now the "Winterberg proposal") for his advocacy of nuclear underground detonation processes on the Moon and other accessible bodies by self-appointed extraterrestrial environmentalists and Sun worshippers to whom the only legitimate energy source in space is solar radiation. Incidentally, shallower detonations are more practical and cost-effective, and their application does not involve unnecessary temperature problems (at least 600°C at the depth indicated in Winterberg's Figure 3). They can be used to stoke atomic underground ovens to reduce metals while extracting important volatile elements, found only at the surface, from lunar sand. I am looking

Continued on page 6

Editorials

Continued from page 5

The real danger to the nation is the proliferation of ignorance— a citizenry living in ignorance of science that accepts depopulation and deindustrialization because it fears progress. Let's repeal the Percy-Glenn Act and get back to the policy of civilization inherent in the Atoms for Peace program.

Science in Danger

As *Fusion* goes to press, we face an emergency for science in America— and for *Fusion* magazine. *Fusion*'s last two issues, which alerted 300,000 Americans to take action against the grave dangers of the Reagan administration budget cuts in the nation's science programs, made it into circulation only barely. Some of the worst science budget cuts have been those the Fusion Energy Foundation has been forced to make in its own operations this spring.

The FEF has had an operating deficit of more than $100,000 since we launched *The Young Scientist* magazine and intensified our campaign to educate the American people—particularly youth—to join the "Apollo Program" for fusion power mandated by the Magnetic Fusion Energy Engineering Act of 1980.

In February, the passage of this fusion legislation, a fundamental victory for American science, itself came under attack by those trying to force the new Reagan administration to accept the same philosophy of zero growth and scarcity that the nation had repudiated last Nov. 4. The FEF then launched a national *science alert*, which included printing 75,000 statements, dossiers, and copies of congressional testimony and mailing out 30,000 of the *science alert* statements.

This alert is still on in full. But it is only through the loans and generous special contributions of a small number of our readers and members that this issue of *Fusion* has reached you. We have made emergency requests to private foundations for funds to continue publishing *The Young Scientist*, and *Fusion* itself is still in serious danger.

A total national commitment to the discovery and realization of basic advances in science—the Apollo Program model—is the only basis for saving this nation from a decline to third-rate-power status. Here's what must be done:

- All the cuts in basic science must be restored, the 1980 McCormack fusion legislation must be fully implemented, the space program restored to its 1960s level of achievement, and the national science laboratories saved from the layoffs ordered in their irreplaceable scientific staff. This is the message of the FEF *science alert* announced to our 15,000 members March 1. Support it.
- All 120 nuclear reactors built or under construction in the United States must be put on line fast, or several of the nation's power grids will begin to collapse as early as next year. This is the message of the FEF's March 21 national campaign dossier on "how to lower electricity rates with nuclear power" and our continuing efforts to reopen the undamaged Three Mile Island Unit 1 reactor.
- Science education in the United States must be revived from its devastated condition and made the leading edge in classrooms—elementary schools, secondary schools, union training and apprentice programs, and so on. For both teachers and students, we have to re-create the excitement of science that characterized the peak NASA years. This means establishing *The Young Scientist* as a staple in American classrooms and launching a national series of FEF conferences on science and education this spring and summer.

The key to U.S. economic recovery is restoring the nation's commitment and excellence in science. The most powerful tool we have for that purpose is *Fusion* magazine, and *Fusion* needs your help now.

Letters

Continued from page 5

forward to seeing these concepts discovered in the future.

Krafft A. Ehricke
President
Space Global Co.
LaJolla, Calif.

The Author Replies

My article was adapted from a public lecture I had given. I saw some of the drawings and captions only after they were published. For example, one drawing about laser initiated thermonuclear microexplosions for propulsion was adapted from a paper by Wood et al. Also, because the article was taken from a taped public lecture rather than a manuscript, I did not make references to any literature, as I would have done in a scientific paper.

My first paper proposing magnetically confined thermonuclear plasmas for rocket propulsion was published in *Astronautica Acta* in 1958. This paper was submitted to *Astronautica Acta* prior to the public release of similar ideas in the 2nd United Nations Conference on the Peaceful Uses of Nuclear Energy in 1958.

The idea of propelling a rocket with a chain of nuclear explosions was proposed around 1945 by Everett and Ulam of Los Alamos. However, I believe the idea to propel a rocket by a chain of thermonuclear microexplosions in general, and the use of a superconductive magnetic reflector in particular, was first proposed in papers I had published. Furthermore, the propulsion idea was first presented at a meeting in 1967 as a report of the International Centre for Theoretical Physics in Trieste (published in *Astronautik* in 1968 and in *Physical Review* in 1968). The idea of the magnetic reflector was first presented in the summer of 1969 at the Enrico Fermi School in Italy and published in the proceedings by Academic Press in 1971. My first paper proposing charged particle beams for thermonuclear microexplosion ignition was published in 1963.

I believe that Dr. Ehricke first proposed the idea of using nuclear explosives for planetary mining. My concept, however, goes beyond the simple idea of just using nuclear ex-

plosives for mining or tunneling. My idea, explained in the text of the article, is to use nuclear explosives to crush the rocks into small particles for the reduction of the pressure gradient in very deep mines where ordinary mining technologies fail. The problem in deep mining is the very large rock pressure which, combined with the large pressure gradient from the mine shaft into the solid rock, leads to very large forces by which rock chips can be explosively released from the wall. A mine shaft made into rock previously *crushed* by an underground nuclear explosion eliminates this problem because here the pressure gradient is reduced by the large shield of crushed rocks. Only the recognition of this fact leads to the conclusion that a mine shaft could be put through the *center* of the Moon, where the pressure is approximately 10^5 atmospheres.

I should add that Krafft Ehricke, one of the greatest spaceflight scientists, pioneered many important ideas. For example, he pioneered the hydrogen-oxygen rocket, without which the Apollo mission would have not been possible. He is also the first one who extensively published about space colonies long before O'Neill and, in my opinion, in a much more scientific way. He is furthermore the author of a monumental work on space flight. I feel indebted to his work, and I regret that the publication of my popular lecture on fusion propulsion for space flight has led to this misunderstanding.

Dr. Friedwardt Winterberg
Desert Research Institute
Reno, Nevada

In Appreciation

To the Editor:

Enclosed is $40, $20 for a subscription to *Fusion* and $20 to help get this country back on the right track (get rid of the Jane Fonda types). My concerns are primarily with energy and agriculture.

Neal Wilson
Lincoln, Nebr.

To the Editor:

Your publication is the first to instill in me optimism for the future . . . I have never looked forward to the next issue of any publication as much as *Fusion*. I am a high school physics teacher and find the magazine an exceptional resource for fact and philosophy. . . .

Robert Hymer
Ypsilanti, Mich.

The Lightning Rod

My dear friends,

The tremendous excursion of Columbia filled me with hope. And not least because, after a hiatus of some years, Americans are once again afforded the opportunity to view this planet Earth from a vantage point where the great gulf that divides its inhabitants can be seen from proper perspective.

This awful chasm has little to do with the division of oceans or the Moats of Empire that consume so much of our attention. It is better expressed as the great difference between the angle of a man's head when it is tilted toward the stars, and the head of a man so bowed and dispirited that it sinks to a fixed contemplation of the mud on his boots.

We should congratulate ourselves on the general enthusiasm engendered by the launching of Columbia; we ought to be proud we are proud. Unfortunately, there are some spirits the Space Shuttle has proved unable to lift into orbit.

Prior to the launch, and even afterwards, more than a few gentlemen were observed on television screens arguing that "The cost is too great." The coverage provided by certain daily journals of news and opinion greatly resembled an accounting manual. So obviously inimical were the intentions of some persons that, when the first attempted launch of Columbia was prevented by the appearance of a "computer bug," my wife joked that 10 environmentalist groups would immediately file suit to defend the bug.

Not a few of the loudest nay-sayers dared to make their objections in the name of science. Pointing to their beloved "iron law" of fixed resources, they cried that the funds expended on the voyage could have been better applied on any number of more worthy scientific projects. One poor fellow, beside himself with fury as he witnessed the national joy, complained bitterly that no one had the right to get excited over what was after all, a mere space truck.

Others contented themselves by demanding with a repetitive whine, "What good is it?" and were similarly unpleased with any answers provided.

I was reminded again of my first "launch," in 1783, if memory serves me. An intrepid Frenchman had determined to send aloft two men in a balloon; I watched their ascent from the Champs de Mars through a little telescope as I was too ill on that occasion to leave my carriage. The astronauts reached the dizzying height of 2,000 feet. As I exclaimed at this marvelous sight, someone accosted me to demand, "Yes, but what good is it?"

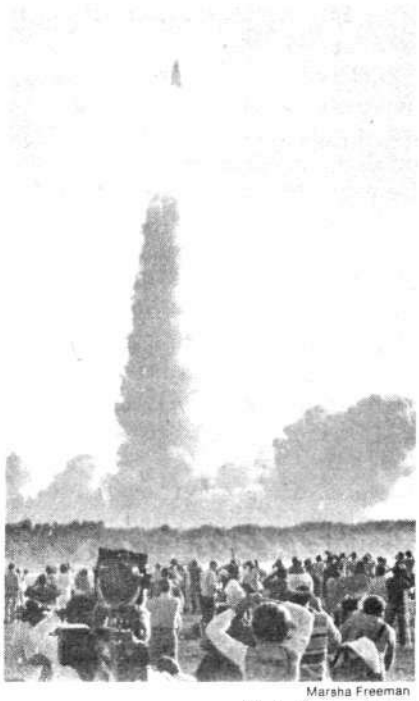
I could think of no better reply than a question of my own. 'What good," I asked, "is a newborn baby?"

One of our former astronauts seemed to me to have the right idea when he suggested that Columbia's flight was proof that our civilization is moving into space. We are indeed in the process of creating a new Atlantis, whose dimensions, although as yet unknown, must be shaped in accordance with the principles of our Creator. We are eternally creating new knowledge, new resources; what else is the business of man?

As for the unhappy souls obsessed with their denial of that infinite power, we serve them best if we act in their interest by endeavoring to raise up their eyes without lowering our own.

Yr. obt. svt.

News Briefs



Marsha Freeman

Hail Columbia!

ALL HAIL COLUMBIA: SPACE SHUTTLE RELAUNCHES U.S. INTO SPACE

The successful voyage of the Space Shuttle Columbia April 12-14 awakened the spirit of the American population and provided the basis for reinvigorating the U.S. space program. "This project opens our way to the stars," Commander John Young told the cheering crowd at Edwards Airforce Base in California.

Reflecting on the mission's importance, Gene Cernan, the Apollo astronaut, told an ABC-TV audience that the real payoff of the NASA program is its importance to America's youth. "If this shuttle project can interest just one in ten of America's youth to go into some worthwhile activity, to think of the future, and to study to be scientists and engineers, then to save that one young person in ten is worth every dollar we spend on the shuttle program." The cost is small, he continued, "when you think of the money our youth are encouraged to spend on drugs every year."

The next issue of *Fusion* will feature on-the-spot coverage of the shuttle mission by *Fusion* editor Marsha Freeman, including an exclusive interview with Capt. Robert Crippen, a *Fusion* reader.

FEF ENDORSES SPACEWEEK EVENTS

At a members meeting in Houston April 12, just hours after the successful launch of the Space Shuttle, the Fusion Energy Foundation announced its endorsement of the nationwide Spaceweek events planned for the week ending July 20, the anniversary of the Apollo Moon landing. Spaceweek is a coalition effort led by NASA and prospace groups around the country whose aim is to reestablish the U.S. presence in space. The theme of the Spaceweek events, to be held in New York, Houston, Los Angeles, San Francisco, and other cities, will be "Space: America's New Wealth." The events are designed to educate the public, media, and national leaders about the scientific and economic benefits of a revitalized space program. "The United States is heading down the road to technical stagnation and economic starvation," said Spaceweek president Troy Welsh in a release on the upcoming events. "A strong space program can resupply our country with energy and minerals, boost our productivity, heighten our security, and give American products a selling edge in the world markets."

The FEF's contribution to Spaceweek will be to draft and circulate a "McCormack Bill for NASA," spelling out the tremendous potential of the space program in the 1980s and the budget NASA needs to carry this program out.

The Bornemann evidence.

SLANDER OF FEF AIMED AGAINST U.S. NUCLEAR REVIVAL

The Fusion Energy Foundation has been alerted by supporters that the Edison Electric Institute passed on to its member utilities Feb. 5 a packet of materials slandering the FEF and Lyndon H. LaRouche, Jr., one of the organization's founders and a newly elected board member. The package includes a letter to Edison Electric Institute vice president H. Jack Young from Elihu Bergman, head of Americans for Energy Independence, repeating the defamatory statements against the FEF and LaRouche circulated by the B'nai B'rith's Anti-Defamation League—statements that are the subject of a libel suit. Independent investigations by *Fusion* reader Richard Bornemann of the Oregon Voice of Energy revealed that a willful libel of the FEF is involved, whose intention is to eliminate a leading pronuclear, grass roots force in America and derail the fight to revive the U.S. nuclear power industry. On April 12 the FEF mailed out to utility executives and other figures in the energy policy field the FEF's reply to the slander, along with a revealing interview by Bornemann of Americans for Energy Independence head Bergman. The FEF statement pins a deliberate campaign of "disinformation and corruption" on Bergman, who claims that the FEF is only seeking a stronger U.S. nuclear industry and U.S. economy so that LaRouche and the (long dissolved) U.S.

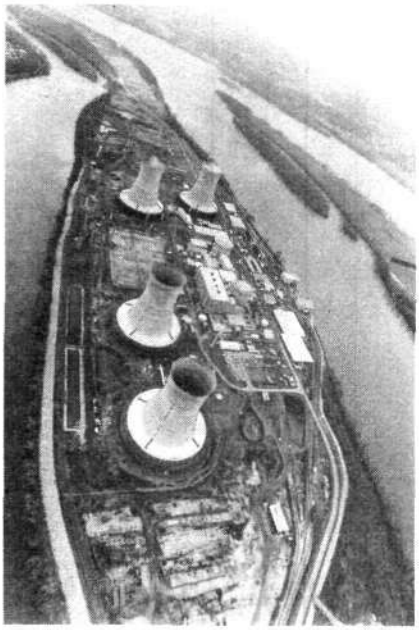
Labor Party can take them over! The statement calls on the nation's utility executives to join the FEF's campaign to pressure the Nuclear Regulatory Commission to license and reopen America's nuclear plants and "stop the disruption of the fight for nuclear energy before it is too late."

The FEF statement and the evidence uncovered by Richard Bornemann will be published in the next issue of *Fusion*.

NRC REJECTS GPU'S REQUEST TO START UP TMI 1

The Nuclear Regulatory Commission ruled against a request from General Public Utilities Co. for a license to start up the undamaged Unit 1 reactor at Three Mile Island, in a unanimous decision March 23. Late last year GPU president Herman Dieckamp had requested that the NRC allow the utility to ready Unit 1 for startup while the public hearings held by the Atomic Safety and Licensing Board in Harrisburg, Pa. wind to a close. Dieckamp argued that whereas every other Babcock and Wilcox reactor that was shut down for modifications after the incident at TMI's Unit 2 has long since been restarted, Unit 1 has been unjustifiably penalized simply because it is sited next to Unit 2, also owned by GPU. All the requisite modifications have been made at Unit 1, and the reactor had an excellent four-year operating record up to March 1979.

The unanimous decision by the four NRC commissioners means that GPU will not be able to restart Unit 1 until late October at the earliest. In the meantime, GPU's customers will continue to pay $14 million a month extra for electricity to cover the cost of replacement fuel.



General Public Utilities

TMI 1: The NRC ruled to keep it closed until the hearings on TMI 2 are over.

FEF OFFICIALS BREAKFAST WITH INTERIOR SECRETARY WATT

FEF director of research Uwe Parpart and Dr. Steven Bardwell, editor-in-chief of *Fusion*, had a breakfast meeting in early April with Secretary of the Interior James Watt. A main topic of conversation was the policy debate over strategic resources. To the widely held view of mineral resources as finite and dwindling, Parpart and Bardwell counterposed the notion of resources as infinite, because they are defined by an advancing technological base. As an example of how advanced technology totally redefines what is considered a "natural" resource, Parpart and Bardwell discussed at length the potential of the fusion torch, to the great interest of Secretary Watt and his advisors. The secretary had, in fact, recently testified before various Senate subcommittees against a proposal to inventory the nation's strategic resources, noting that in the past such inventories had understated the supply of minerals later recovered through new mining techniques.

JAPAN RESUMES ITS NUCLEAR PROGRAM

The power development coordination council of Japan, which is chaired by Prime Minister Zenko Suzuki, decided March 26 to authorize the construction of three new domestic nuclear power plants. These are the first nuclear projects to be licensed in Japan since the U.S. Three Mile Island incident, and they signal the resumption of Japan's aggressive nuclear program. The reactors, which will be constructed by domestic manufacturers, are of the light-water type and will have a combined output of nearly 3 gigawatts of power. They are scheduled for completion in 1989 and 1990.

LOUSEWORT LAURELS TO ELIZABETH DODSON GRAY

This month's Lousewort Laurels award goes to Elizabeth Dodson Gray, the vice-chairman of the U.S. Association for the Club of Rome, who informed a reporter this spring that she intends to initiate a campaign to defend the rights of stupid people. "Our technological-partriarchal society has a deep bias in favor of intellectuals and against stupid people," she said. "This needs to be reversed."

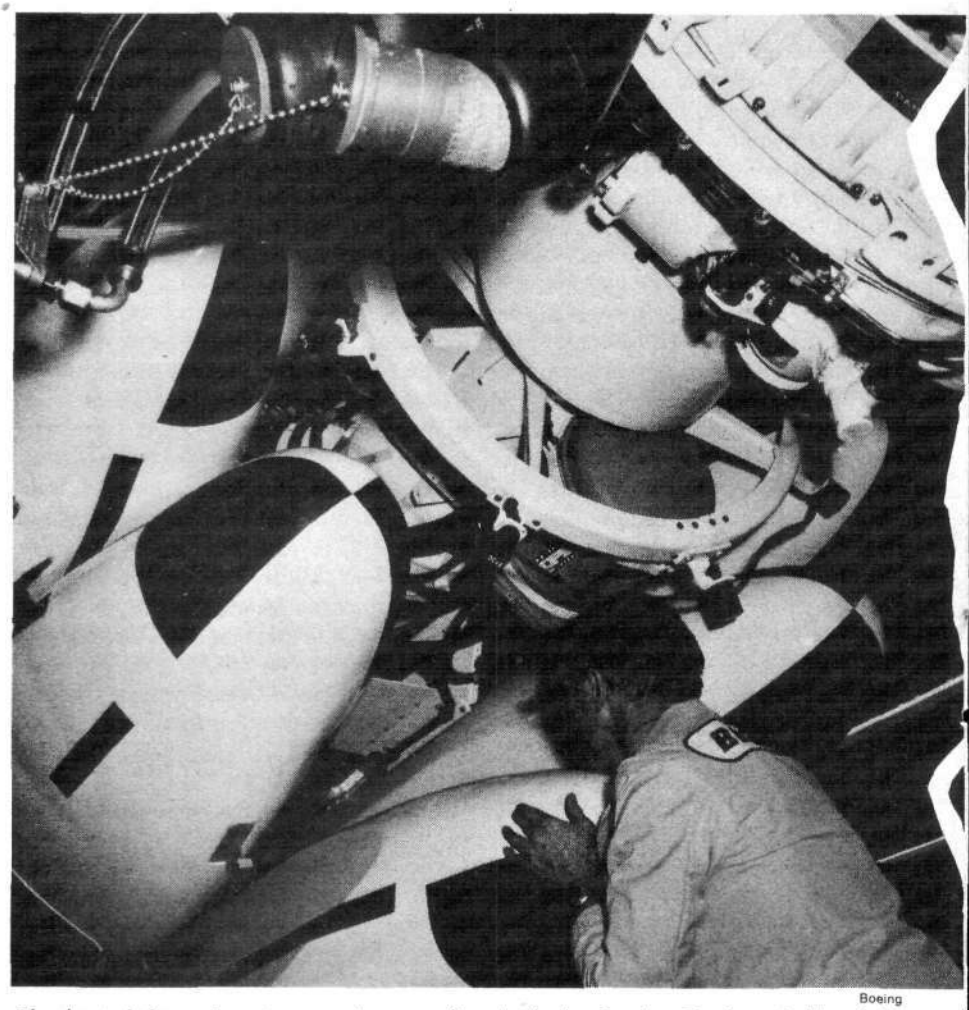
Dodson Gray was among the 55 members of the American affiliate of the international Club of Rome who met secretly in Chevy Chase, Md. April 14-15 to map out a new round of assaults on the American commitment to progress.

Science and National Security: Is the U.S. Number 2 in Both?

Inside This Section

This special report reviews U.S. and Soviet scientific and technological capabilities and their spinoff, military preparedness. *Fusion* editor-in-chief Steven Bardwell introduces the subject in "Science Policy: Soviets Advance with American System," comparing the thinking behind U.S. and Soviet science policies.

"How the U.S. and the Soviets Measure Up" contrasts U.S. and Soviet capabilities in areas with critical implications for defense: space exploration, manpower and education, and basic industrial indicators. In " 'In-Width' Military Expansion: An Incompetent Approach to National Defense," *Executive Intelligence Review* economics editor David Goldman reports on an econometric study of the impact of the Weinberger-Stockman defense budgets. Finally, excerpts from recent remarks by Soviet Academy of Sciences president A.P. Aleksandrov and retired Air Force general Alton Slay give a vivid picture of the Soviet commitment to upgrading its civilian power industry, which is the basis for advanced defense spinoffs, and the erosion of the U.S. defense capability, which has resulted from general economic decline.



Boeing

The best defense is a strong science policy. Left, the Boeing Cruise missile; right,

Science Policy:

Soviets Advance with American System

There is a deep and disturbing irony in the comparison presented in this special report between Soviet and American science policies: At the same time that the Soviet Union has stepped up its pursuit of a nuclear future based on rapid economic growth, influential circles in the United States have formulated a science policy coherent with a deliberate phaseout of the older, "sunset" industries—our basic industrial infrastructure—a static technology base, and a policy of negative population growth. This set of policies, adopted in the name of national security, has put the country on a path that guarantees that we will be forced to fight a war over scarce resources—a war that we will lose because we will not have the new technologies and industrial infrastructure required to expand the nation's resource base and technological capacities.

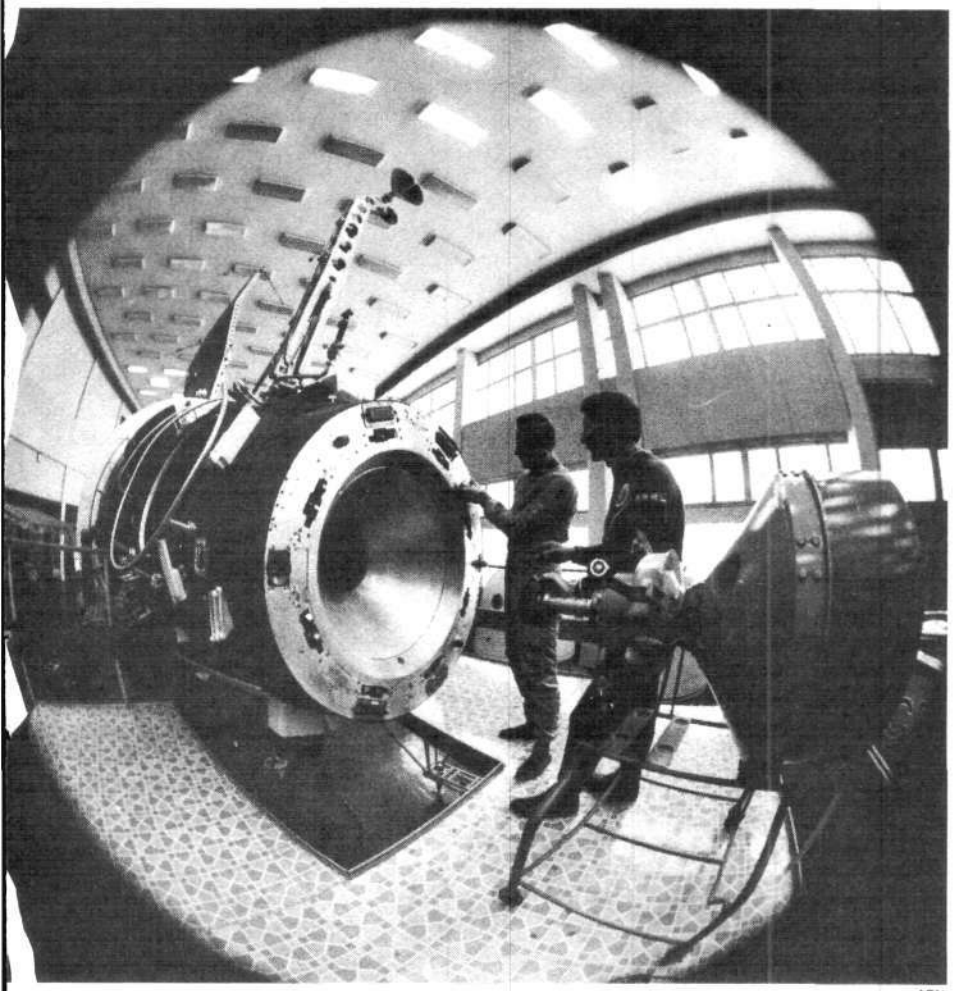
The alternative to this situation is obvious. A policy of aggressive scientific research and technological progress is the primary requirement for a strong military defense. Such a policy would ensure our ability to maintain a strong defense capability and, more important, to foster economic development internationally, thus obviating the primary causes of international instability. James Schlesinger, former secretary of defense and energy, made one of the first statements of the Malthusian view in his 1960 book, *The Political Economy of National Security:*

"Economics is the science of choices in a world of limited resources. The same dualism that underlies economics underlies the nature and condition of man. For anything you have missed, you have gained something else; and for anything you gain, you lose something. We have gone around the world spreading the 'gospel of plenty' raising the level of expectations. In the nature of things, these rising expectations can never be satisifed. Despite the modification of the original Malthusian dogma over the years, the danger remains that excessive growth of population will wipe out the gains of economic progress. It is unwise to overstate the importance of economic growth per se.

"We must in our strategic policy return to the days before the Industrial Revolution. Prepare to fight limited wars. Higher Soviet industrial development rates than attained in our production will have very little strategic significance. The industrial mobilization base is only one of several gauges of power. A strategic menace may be based upon a rather modest economic structure. We must build our military force on the exact opposite of the industrial potential notion."

This is the perspective that underlies the defense budgets proposed in March by Defense Secretary Caspar Weinberger and the cutbacks in fusion development funding and gutting of basic research and education in Office of Management and Budget Director David Stockman's overall budget. It is the same policy perspective that motivated the *Global 2000 Report* prepared by the State Department and Council on Environmental Quality under the Carter administration, the report advocating retrenchment in population growth and economic growth globally.

The logic of this position is terrifyingly simple. Since resources are fi-



APN

Soviet cosmonauts examine the docking bay of the orbital space station Salyut.

nite, its proponents argue, then the Earth is already overpopulated. Given that there is only a fixed and indeed shrinking supply of resources, we must cut back our consumption and plan for increasingly hard times.

They go further: It is either our country or our enemies who will control the allocation and consumption of the last remaining resources. Thus, our national interest is defined by our ability not only to protect our present share of resources, but to control global resource wealth. It is either "us" or "them" in the end.

The inescapable conclusion of this Malthusian view is that world war is inevitable and that national survival depends on winning a war over a shrinking supply of vital raw materials.

The implications of this view, which contradicts a million years of human history, are frightening. Not only does this view degrade man to the level of an armed predatory animal and imply the near-term extinction of the human species, but the corollary science and military policy guarantees that we will lose that war if we face an enemy who does not subscribe to the same Malthusian viewpoint.

The Soviet Union has accurately stated many times that resources are not finite, that new technologies create new resources, and that there is no limit to man's potential. Soviet science and military policy is based on this truly American outlook. The Soviet Union is investing in research and development in those areas of high-density energy—nuclear fission, fusion, and laser technologies—that are not accidentally both the frontiers of science and the most critical areas military research.

The contrast between this and U.S. policy was underlined by outgoing undersecretary of defense for research and engineering William Perry in a statement to Congress Jan. 20, 1980:

"The Soviet Union now has about twice as great an effort as we have in military research and development creating a growing risk of technological surprise. . . . The Soviets have applied their investment program to their research and development base, devoting an increasing share of their total defense expenditures to improving their military technology in an attempt to negate our technological lead."

A Progrowth Adversary

In other words, we are faced with a potential adversary nation that does not believe that economic shrinkage is necessary or desirable, that is aggressively expanding its resource base through exploration and the development of new technologies, and that is applying the most advanced scientific ideas to its military.

What do the Malthusian savants have to say about this? General Maxwell Taylor assures us that we need fight only local wars. Former National Security Council director Zbigniew Brzezinski believes that the "aura of power" is often sufficient to deter one's enemies. Stockman's budget office tells us it has not thought about that yet.

The alternative path for the United States is clear: We must have a broad-based science program that will serve as the foundation for reinvigorating our industry and educational institutions, as well as the military. Without these civilian spinoffs, military preparedness is impossible. As General Alton Slay noted in recent testimony before Congress, "It is a gross contradiction to think that we can maintain our position as a first-rate military power with a second-rate industrial base. It has never been done in the history of the modern world."

In economic terms, the resurrection of the U.S. economy can only be accomplished by a directed effort at the development and implementation of new industrial technologies. A properly conceived national budget, especially its military component, must stress an aggressive, innovative R&D policy as the centerpiece of a program for national industrial development. There are four essential components to such a program:

- *Advanced energy production.* Nuclear technologies must be funded at an accelerating rate. Advanced fossil fuel technologies like magnetohydrodynamics must be funded (the Stockman budget for fiscal 1982 cuts the funding for MHD from $60.5 million to zero). Thermonuclear fusion development must be put on a crash program of the sort mandated by the 96th Congress's passage of the McCormack bill (Stockman's fiscal 1982 budget cuts $65 million from the legally required budget of $525 million for fusion research).
- *Space research.* The NASA program for putting a man on the Moon resulted in a tremendous boost to the economy. New technologies, hundreds of thousands of new engineers, and a national commitment to scientific progress powered the whole U.S. economy through the 1960s. The Stockman budget makes severe cuts in the NASA budget, which have affected the Space Shuttle and will result in cancellation of all planetary exploration projects, closing the Jet Propulsion Laboratory, and delay or cancellation of a multitude of earth-imaging and meteorological programs.
- *Science education.* The most critical component is manpower development. Without scientific and engineering know-how, economic health is impossible. The longest lead-time item in any bill of materials is the skilled manpower required. The Stockman budget cuts the funding for science education from $112 million to $12 million!
- *A military R&D commitment.* One of the most effective ways to direct a program of national reindustrialization is with a well-conceived, imaginative military R&D policy. Space research, high-energy physics, and plasma technologies are all required for successful military research and receive task orientation from such research. The essential point is that an expanding, vigorous economy, a large and healthy industrial base, and a strong military are inseparable.

Perhaps the final irony is that there does exist a faction in the Soviet Union that is promoting zero growth and a low-technology future. This faction has endorsed the *Global 2000 Report,* and it frequently praises the antinuclear demonstrations in the United States as evidence of "progressive forces." There is just one small, additional point. The Soviet zero growth faction proposes these policies for the United States alone!

How the U.S. and the Soviets Measure Up

SPACE
Satellite Launches

Year	U.S.	Soviet Union
1976	27	99
1977	23	98
1978	33	88
1979	16	87
1980	12	89
Total to 1980	799	1,339

Manhours in Space

Year	U.S.	Soviet Union
Total to 1980	22,503*	46,893

EDUCATION
Compulsory Mathematics and Science Curriculum, Primary and Secondary Schools

U.S.	Soviet Union
Elementary mathematics*	3 years arithmetic
	2 years arithmetic combined with algebra
	5 years algebra
	10 years geometry 5 years intuitive geometry, 3 semirigorous plane geometry, 2 years semirigorous solid geometry
	2 years calculus
1 year physics**	5 years physics
1 year chemistry**	4 years chemistry
1 year biology**	5 ½ years biology
	1 year astronomy
	5 years geography
	3 years mechanical drawing
	10 years workshop training

SCIENTISTS AND ENGINEERS ENGAGED IN R&D
(in thousands)

Year	U.S.	Soviet Union	
		Low est.	High est.
1970	546.5	733.3	806.9
1971	526.4	804.2	881.8
1972	518.5	862.5	950.1
1973	517.5	966.7	1,072.1
1974	525.4	995.8	1,108.0
1975	534.8	1,061.2	1,187.6
1976	549.9	1,113.7	1,254.5
1977	571.1	1,147.8	1,299.1
1978	595.0	NA	

INDUSTRY

	Electric power production (billion kilowatt-hours)		Petroleum production (billion barrels)	
Year	U.S.	Soviet Union	U.S.	Soviet Union
1976	2,038	1,111	2,968	3,848
1977	2,124	1,150	3,009	4,046
1978	2,206	1,202	3,178	4,238
1979	2,248	1,239	3,121	4,342
1980	2,286	1,295	3,135	4,468

	Steel (million tons)		Cement (million tons)		Industrial productivity*	
Year	U.S.	Soviet Union	U.S.	Soviet Union	U.S.	Soviet Union
1976	128	160	70	137	104.5	103.3
1977	125	162	75	140	102.4	104.1
1978	137	166	80	140	100.9	103.6
1979	136	164	79	136	101.0	102.4
1980	112	163	NA	138	99.5	102.6

Space
*The United States had none between 1975 and 1980.
Source: NASA

Education
*In the United States, beyond elementary mathematics, there are no compulsory subjects in the science of mathematics; enrollment in mathematics subjects in grades 9 through 12 for the 1976-77 academic year was as follows (in thousands of students out of a total enrollment of 15.7 million): general mathematics (grades 9-12): 609; elementary algebra: 2,563; geometry: 1,900; advanced algebra: 1,317; advanced senior algebra: 225; trigonometry: 460; probability and statistics: 39; computer math: 153; calculus: 105.

**Few students who are not heading for college receive even one year of each of these sciences.
Source: "The Wirszup Report," Izaak Wirszup, professor of mathematics, University of Chicago, Dec. 1979.

Scientists and Engineers Engaged in R&D
Source: *Science Indicators*

Industry
*Productivity in industrial manufacturing as a proportion of the year before.

'In-Width' Military Expansion

An Incompetent Approach To National Defense

The Fusion Energy Foundation used the LaRouche-Riemann econometric model to test the assumptions underlying the defense budgets released by Defense Secretary Caspar Weinberger March 4, and found that these assumptions will lead the United States toward economic and strategic disaster.

The new defense budget for fiscal year 1981 is projected by the Reagan administration at $178.6 billion, $7.4 billion above the request levels in the Carter budget, and that of 1982 is projected at an appropriation level of $222.8 billion, an additional $26.4 billion above the Carter request. These funding increases were portrayed by both the Reagan administration and the press as plans for a major military buildup.

However, the Weinberger strategy relies on an "in-width" expansion of existing technology, within the context of drastic cutbacks in all forms of federal government support for research and development and scientific education, and as such it presents insuperable economic problems. Without an "in-depth" development of precisely those areas of the science budget that are being cut—which would lay the basis for a surge in productivity throughout the economy, as well as generate advanced military applications—the proposed in-width buildup is economically impossible. It will be inflationary and, as the model run demonstrated, will lead to a plummeting of the economy's reinvestable surplus.

Defense Spending and the Economy

Defense expenditures represent an economic overhead expense. Investment in industrial capacity for defense purposes may enhance the productive sector of the economy, but the output from that capacity is a pure tax on the productive resources of the rest of the economy.

UPI

Weinberger: A buildup "in width."

The questions the FEF used the LaRouche-Riemann model to answer are:

(1) What amount of *physical product* (plant and equipment, raw materials, consumer goods) must be invested in military-related sectors of the economy to produce a significant increase in defense procurement?

(2) How *productive* are the military-related and nonmilitary-related sectors of the economy now, and how productive can they be under the conditions prescribed by OMB Director Stockman and Weinberger?

(3) Can the economy afford to lose this margin of its output from the stream of civilian production?

(4) Would such a program succeed?

The FEF econometric simulation showed that a concerted mobilization of resources for defense procurement using existing technologies would fail to reverse the declining growth capability of the U.S. economy, and by the end of the four-year program, it would produce a new economic downturn.

The assumptions were based on the stated policies of both Defense Secretary Weinberger and OMB Director Stockman. The model was programmed to reflect the economy's existing technology base; unlimited budgetary and credit largesse for a procurement program enhanced by $20 billion 1976 dollars; and a mix of defense procurement from different industrial sectors based on the most recent available input-output data for the U.S. economy. It was further assumed that the program begins immediately, and that Federal Reserve monetary policy and OMB fiscal policy do not create additional economic disruptions in excess of the present still-severe recession.

These assumptions give Stockman and Weinberger the benefit of the doubt in all cases. The last assumption of an otherwise stable economic environment, conducive to defense production, contravenes available evidence that the economy is headed deeper into recession.

The result of the simulation is summarized in the accompanying computer-generated graphs:

Figure 1 shows the behavior of total economic surplus (value-added in physical terms). Over 1980, surplus fell from an annual rate of $553 billion 1976 constant dollars to an annual rate of $495 billion, in response to the Federal Reserve's stringent credit policy. Under the simulated procurement program, surplus rises to an annual rate of $523 billion, recouping about half of its previous losses.

The increase in output occurs for the simple reason that those industrial sectors that produce for the military are, by and large, the most technologically advanced, and hence the most productive. So a shift in resources toward military producers results in higher output and average productivity for the economy as a whole. But this is a one-shot affair. If the product of the military sectors remains outside the flow of production, as all defense goods do, the net tax on the total economy will ulti-

mately drag the total economy down.

Figures 2, 3, and 4 show the volume of required inputs for the total economy; respectively, labor (tangible consumption goods), capital investment, and raw and intermediate materials.

The final group of graphs shows the continued deterioration of the economy:

Figure 5 shows the value for productivity. Because of the changed mix of economic activity, the effective productivity rate for the total economy is slightly higher.

Figure 6 shows the volume of economic "free energy," the amount of reinvestable surplus. Immediately upon initiation of the military buildup, this category recovers slightly, out of the negative range it reached during 1980, but not nearly back to levels registered as of 1978. During 1982 and 1983, it begins to fall.

Figure 7, the rate of gross surplus (surplus divided by all tangible input costs), remains below even recession levels, an unacceptably poor rate of economic functioning. This is the result of sharply escalating real input costs, particularly on the raw materials side. A defense buildup would force the U.S. economy to crank up its old, energy-inefficient, technologically backward processing industries to full capacity. The inefficiency of this basic industry would force down the crucial rate of gross surplus, a measure of "total factor productivity."

Figure 8, the "free energy ratio," or potential growth rate, is the most important in the series. It measures reinvestable surplus (gross surplus minus overhead costs) divided by total input costs. As the graph shows, the economy's rate of growth—after rising from a negative rate during 1979-1980—falls continuously through the period of the military buildup, to virtually zero (1.5 percent per year) at the end of the final year.

In summary, a substantial buildup in width would ruin the economy's future capacity to grow, and produce a crisis in the physical economy through underinvestment in the civilian economy by the end of the present administration.

Figure 1
GROSS SURPLUS OF U.S. ECONOMY
(billions of 1976 dollars)

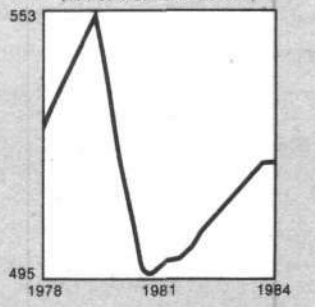


Figure 2
CONSUMPTION OF PRODUCTIVE WORKFORCE
(billions of 1976 dollars)

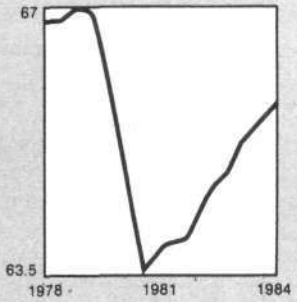


Figure 3
AGGREGATE NET CAPITAL INVESTMENT
(billions of 1976 dollars)

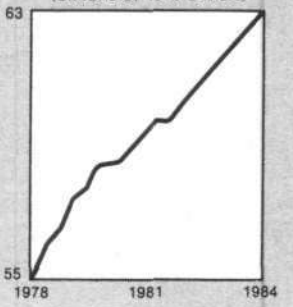


Figure 4
RAW MATERIALS AND SEMIFINISHED GOODS INPUT
(billions of 1976 dollars)

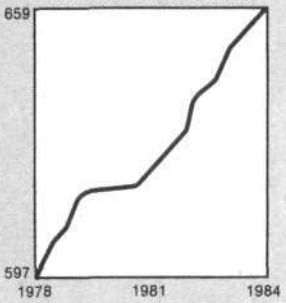


Figure 5
RATIO OF SURPLUS TO CONSUMPTION OF PRODUCTIVE WORKFORCE

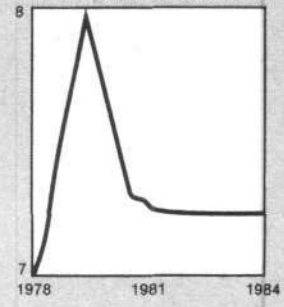


Figure 6
REINVESTABLE SURPLUS OF U.S. ECONOMY
(billions of 1976 dollars)

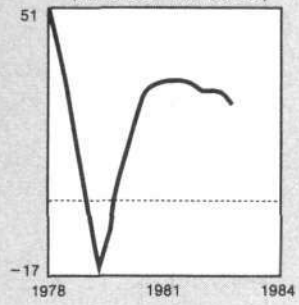


Figure 7
RATIO OF SURPLUS TO TOTAL CAPITAL AND LABOR INPUTS

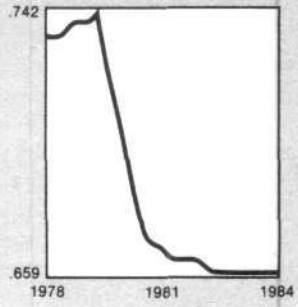
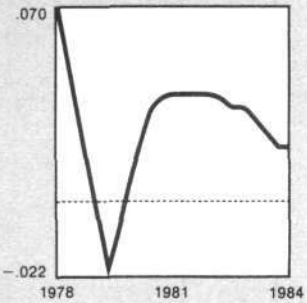


Figure 8
RATIO OF REINVESTABLE SURPLUS TO TOTAL CAPITAL AND LABOR INPUTS



A. P. Aleksandrov:

No Limits to Soviet Energy Growth

In an article called "Energy Prospects" carried in the Soviet daily Izvestia *on Feb. 21, physicist A. P. Aleksandrov outlined the shifting Soviet energy structure for the rest of the century. Aleksandrov is president of the Soviet Academy of Sciences and a member of the party Central Committee of the Communist Party of the Soviet Union. The following excerpts from his article were translated by the Foreign Broadcast Information Service.*

The very complex task of supplying our huge, rapidly developing national economy with energy must be resolved reliably and with a long-term view. It is not possible to resolve this task by traditional methods—that is, by increasing the extraction of oil, gas, and coal. It is necessary to substantially change the structure of their consumption and to make wide use of nontraditional energy resources. . . .

The limited nature of reserves of oil in large-scale deposits now being exploited and the tendency for the cost of this oil to increase make it necessary, in examining long-term prospects for the power industry, to change its structure in such a way as to substantially increase the relative proportion of coal in the fuel and energy balance, to approximately maintain the proportion of natural gas, to substantially reduce the proportion of oil for fuel and in the late 20th century to go over to using oil mainly as a feedstock material for the chemical and microbiological industries.

The entire shortfall in the fuel and energy balance must be covered . . . by substantially extending the proportion of nuclear power, using thermal neutron and fast breeder reactors and, in the future, thermonuclear power. . . .

In many cases, however, the direct utilization of coal or nuclear power is impossible or unsuitable, as in aviation, for instance. In these cases it is necessary to obtain suitable secondary energy sources. Let us take a look at how this can be done.

Nuclear Heating

It is easiest of all to resolve the task of obtaining low potential heat for heat supply in cities. In today's reactors at nuclear power stations, the primary energy released by the chain-reaction of splitting atomic nuclei is converted into heat for heating the fuel elements containing the fissionable uranium. This heat is transferred by the water in the primary system, which is pumped through the reactor and either yields steam directly—the steam then goes to the turbogenerator—or, in a steam generator, heats the water in the secondary system, which provides the steam sent to the turbogenerator.

It is possible to separate off some of the steam with suitable parameters from the turbine and channel it into heat exchange units in the heat supply network. This is the principle of the nuclear thermal power station (ATET), which generates both heat and electricity.

It is possible in general to channel hot water from the primary system not into the turbogenerator, but into a heat exchanger in an intermediate system. The hot water in the intermediate system is pumped through the heat exchangers of the heat supply network. This is the principle of nuclear heat supply station (AST). . . .

In view of the fact that approximately 50 percent more primary energy sources are utilized in producing low potential heat than in producing electricity, this sphere of application of nuclear power will be of very great significance as regards savings in the next 10 years. Thus the utilization of ASTs and ATETs fully solves the problem of ousting petroleum products from the sphere of production of low potential heat. . . .

Let us move on to the utilization of energy sources in metallurgy and the chemicals industry. It is difficult and disadvantageous to use atomic power stations (AES) as flexible capacities. The larger capital expenditures on them compared with conventional power stations and the small fuel component in the cost of electricity mean that it is economically expedient to use them on a permanent, "base" load system. Moreover, intermittent load systems inevitably reduce the reliable life of AES because of metal fatigue phenomena under an intermittent load. . . .

There is only one way to avoid such restrictions—the use of some kind of

Gen. Alton Slay:

'Sick Industry' = 'Sick Defense'

This assessment of the U.S. defense posture is excerpted from a speech by Gen. Alton A. Slay, Commander of Air Force Systems Command, on Sept. 22, 1980 before the American Mining Congress in San Francisco, California.

I have chosen . . . an unpleasant theme—whose importance eclipses any other I could think about. I'm going to suggest to you this morning that our position in the international pecking order of military, technical, industrial, and economic power is slipping badly. I'm going to suggest to you that we are no longer the "Arsenal of Democracy," as President Roosevelt correctly tagged us 40 years ago. I'm going to suggest to you, in fact, that unless things take a turn for the better over the next several years, we may not even be able to correctly tag ourselves as the Arsenal of the United States. . . .

At the time of the Cuban missile crisis, we had an overpowering edge over the Soviets. That strategic power edge has vanished. . . . The Air Force had almost 350 major squadrons, with 850,000 military people, operating

low-inertia energy storage system, for instance, the use of hydraulic accumulators or the production of some kind of energy source or end product. For instance, the production of hydrogen on the downward curve of the graph of the load of an energy system, by channeling surplus energy from an AES into the production of hydrogen from water, constitutes a possible form of storage. This hydrogen, burned in a gas turbine, can be used to cover peak loads. It can be used in metallurgy for heating and as a reducing agent for oxide ores. It can also be used in obtaining ammonia or in other chemical production techniques, or finally, in the power-engineering processing of coal in order to obtain synthetic hydrocarbons. . . .

The reasoning can be applied to the use of nuclear power to phase petroleum products and natural gas out from metallurgy and the chemical industry. By using electrochemical and plasma technologies and by utilizing selective methods of excitation of the necessary energy levels in molecules and atoms, it is possible to combine several chemical processes with the use of nuclear power. This potential will be extended when high-temperature reactors, which are now at the development stage, come into use.

Thus, we can see that the use of coal and nuclear power, taking into account the possibility of producing secondary energy sources, can cover all spheres of consumption of primary energy sources. . . . It is, of course, clear that such a restructuring will take a long time—approximately 30 years. Will traditional energy resources be enough over that time for the rate of growth in the power industry which our country needs? And, moreover, is it possible to create a structure for the nuclear power industry that will enable it to be used virtually indefinitely from the viewpoint of resources and environmental pollution. . . .

With oil-saving measures and more

Continued on page 62

16,000 first-line aircraft, from nearly 250 installations worldwide. Today, we have just 250 major squadrons, not 350; we have just 550,000 military people, not 850; operating 7,000 aircraft, not 16,000; from 134 major installations, not 250; and not nearly so worldwide. About the same degree of decline can be measured in other services. In 1970, for example, our total armed forces strength stood at around 3½ million. Today, that fraction is about 2 million—a decline of almost 40 percent in almost a decade.

During the 1970s, Soviet spending on things related to military research and development, military weapon system acquisition, and military facilities, exceeded that which the United States spent by $240 billion.

The total number of Soviet scientists and engineers engaged in all types of research and development activities is now approaching the 1 million mark, the largest research and development manpower pool in the world. . . . Last year, the Soviets graduated just under 300,000 engineers. We graduated 50,000 and that was a banner year for us. We have never graduated more than 52,000 engineers in any one year. The Soviets have three times as many engineers engaged in military research. . . .

If you believe that one U.S. engineer is the equivalent of three Soviet engineers (which I don't believe), how long will that 3 to 1 ratio last, with them graduating six times the number of engineers each year than we do? How long do you think it will be before that ratio is 5 or 6 to 1?

You can forget that old tale of poorly built, ineffective Soviet military equipment. If that tale was ever true, it certainly is not true now, nor was it true when the equipment they have in the field today was manufactured. They have highly sophisticated, reliable, and effective weapons and don't let anyone try to tell you anything different. I also want to put away the myth that the Soviets are bumblers when it comes to production. They are efficient producers and their factories are modern and well equipped. They are far outproducing us in every aspect of military production:

They produce about 20 armored vehicles for every one we field; the ratio of artillery tubes built is also 10 to 1 in their favor; they build over twice as many fighters, and three times as many helicopters as we do; they field 18 surface-to-air missiles for every 1 we field; they build twice as many submarines and twice as many naval surface combatant ships as we do.

No, there's no solace to be had for us on either the R&D or production parts of the military equation. The Soviets are now, and have been for 20 years, on a concerted R&D acquisition offensive. They've had a constant forward thrust—a constant acceleration—that's given them the momentum we lack. . . .

But that's an average. Last year, we had a negative growth rate of eight-tenths of 1 percent. . . .

Moving up to the next industrial echelon, we find another capacity problem: There are only three remaining U.S. suppliers of large forgings, the kind we need for aircraft landing gear and engine components. . . .

The shrinking industrial base, coupled with increasing demand . . . worldwide for scarce materials, and products made from these materials has resulted in greatly lengthened lead times and escalated costs. . . .

But I'm afraid that our near-term capability to surge—to do something to get hardware in the field quickly—is miniscule and that the long-term prospects aren't as grand as some people obviously think they are. For example, we recently appraised our surge capability for F-15 and F-16 fighters. We found that during the next 18 months, under surge conditions, and using all of the authority and clout we could muster, we could not receive any additional F-15 or F-16 aircraft beyond those currently contracted for.

One thing that we can do is to stir the pot. . . . I've been doing that as often as I can, since a sick industry equates, in my mind, to a sick defense posture.

FMIT Decision Will Affect Fusion Course

The Fusion Materials Irradiation Test Facility (FMIT) under construction at Hanford Engineering Design Laboratory in Richland, Wash. may be phased out if the administration's budget cuts are accepted by Congress. The FMIT is the only major facility planned worldwide to test future materials for fusion reactors under simulated fusion conditions. Its successful operation will have a crucial impact on designing commercial fusion plants, since costly materials failures can be foreseen and thus avoided.

The McCormack fusion bill, the Magnetic Fusion Energy Engineering Act of 1980, directs the Department of Energy to begin engineering development of the technology needed in order to achieve a demonstation fusion electric power plant by the year 2000. How the FMIT fits into this technology was summed up in the Buchsbaum Report to the DOE June 24, 1980, as follows: "Thus a good start has been made on the development of the various technologies which will be needed in the engineering of fusion."

Now, in line with the science budget cuts of Office of Management and Budget director David Stockman, the DOE has requested a phaseout of the FMIT, with a $14 million rescission of funds for fiscal year 1981 from the total of $31.5 million, leaving just enough for an orderly shutdown. For fiscal year 1982, the DOE request for the FMIT is $0.

Although no action has yet been taken by Congress on requested budget rescissions, on March 30 the Energy Research and Production Subcommittee of the House Committee on Science and Technology restored $14.7 million to the fiscal year 1982 budget to allow the FMIT to continue construction. It is now up to Congress to decide on the fate of the FMIT.

The FMIT is intended to resolve the most difficult technological problem confronted in designing economic fusion power plants—perfecting materials that can withstand the high-energy neutron bombardment inside a fusion reactor chamber. The FMIT facility will consist of a materials test building and a linear accelerator (built by Los Alamos National Scientific Laboratory) that generates a 30-MV beam of deuterium ions. The deuterium ion beam is to be directed onto a target of liquid lithium. The resulting nuclear reactions will then generate high-energy neutrons of 14 MeV.

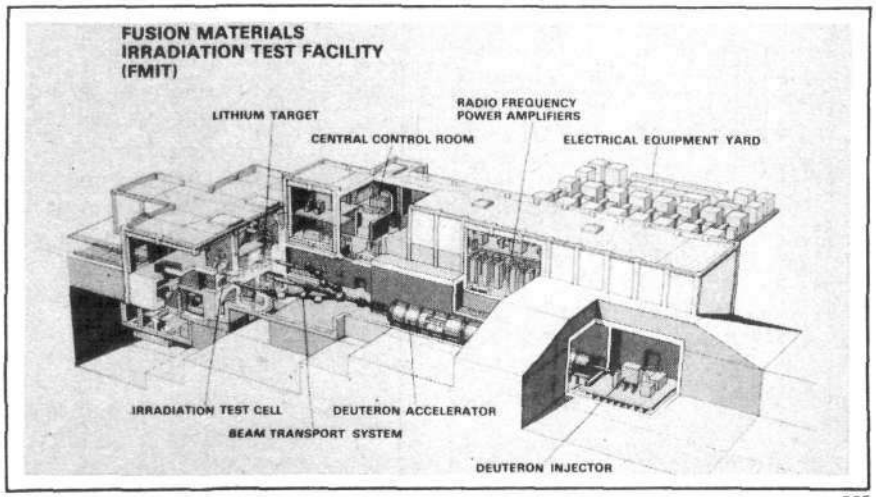
These 14-MeV neutrons will be equivalent to those produced by the deuterium-tritium fusion reaction in a fusion reactor, which are the main product and can cause major damage to the reactor's walls over long periods of operating time.

The FMIT neutron flux will be close to the 10^{15}-neutrons/cm^2-sec flux of a commercial fusion reactor. It can thus be determined how various materials and alloys exposed to this neutron flux in the FMIT over extended periods of time will stand up to the conditions in an actual reactor.

Eliminating unfeasible materials candidates and learning the potential working lifetimes of materials selected for a fusion reactor will greatly enhance future construction of an actual fusion power plant, since costly mistakes at that time can be avoided. The safety and economics of operating a fusion reactor will depend greatly on choosing metals, alloys, and other materials that can retain adequate strength, ductility, and dimensional stability in the severe, high-temperature neutron-irradiation environment of a fusion reactor.

The FMIT was originally scheduled for completion in 1982, with a total budget of $75 million, but funding delays under the Carter administration, when combined with the escalating inflation of recent years, have led to an approximate doubling of the estimated total budget. The real dollar cost, however, has remained virtually identical to the estimated funding for the project, and all of the technical problems encountered are being overcome on schedule.

Both the Japanese and European fusion research communities have expressed concern that the FMIT may not be completed, because its investigations of materials for fusion reactors will benefit fusion research worldwide.



DOE

The main features of the FMIT facility are shown above in an artist's sketch. A linear accelerator will direct a deuterium ion beam onto a lithium target, producing high-energy neutrons like those expected in fusion reactors.

Livermore X-Ray Laser: Beam Weapon Breakthrough

"The X-ray laser system has the potential of tipping the battle in favor of the defense for the first time in the history of nuclear warfare," commented one Pentagon official in the Feb. 23 issue of *Aviation Week & Space Technology*. The article by Clarence A. Robinson, Jr., reported that Lawrence Livermore National Laboratory has achieved a major breakthrough in antimissile beam-weapon technology with the experimental demonstration of an X-ray laser system.

In fact, it is reported that Dr. Edward Teller, the "father" of the U.S. fusion effort, has stated in Washington meetings that the X-ray laser is the most significant strategic development since the H-bomb. Although this claim may be slightly exaggerated with respect to the near-term impact of the X-ray laser as an anti-ICBM weapon, the tremendous strategic potential of such a system underscores the essential role of advanced plasma physics and fusion research in securing a credible national defense capability.

How It Works

X-ray lasers are quite complex and interesting on the theoretical level because their operation requires a close matching between the dynamics of energy-dense plasmas and atomic physics. The Livermore tests for the X-ray laser consisted of irradiating a thin rod made of a heavy element, 3 to 8 feet long, with the soft X-ray output of a very small nuclear bomb. This leads to 500,000 joules of X-rays directed along the rod's axis. The X-ray laser pulse is reported by *Aviation Week* to be only several billionths of a second long—that is, the power output of this laser is several hundred trillion watts.

It is well known that a few thousand joules of X-rays per square centimeter at these power levels would destroy or critically disable any warhead target in space. One small nuclear device could be used to pump up to 50 laser rods simultaneously. Then, each of the rods could be pointed at a separate target, the entire assembly constituting a small anti-ICBM satellite.

One space shuttle payload could suffice to place enough of these X-ray laser satellites into orbit around the Earth to protect the United States against the Soviet Union's complete arsenal of ground- and submarine-based ICBMs.

Remaining Questions

Defense analysts from numerous government agencies and laboratories agree that the X-ray laser has a great potential if it can be developed into a practical system. The major questions that remain involve taking the system from the present stage of scientific demonstration to that of a reliable hardware in the space environment and perfecting the aiming and tracking of potential targets.

It is unclear at this point if the X-ray laser described by *Aviation Week* is a true "laser." The X-rays are certainly of a single wavelength and generated by a stimulated emission process, but they may not be phase coherent.

However, such true X-ray lasers have been hypothesized. Fusion scientist Dr. Friedwardt Winterberg, at Nevada's Desert Research Center, submitted a proposal for a similar system to the Department of Energy more than four years ago, which could generate a coherent beam like that of a true laser.

The X-ray laser system is by no means limited to military applications. The short wavelength and high energy density of the electromagnetic photons that it emits make it potentially one of the most powerful scientific and diagnostic tools of the 20th century.

The short wavelength means that the beam has great penetrating power through matter and can be propagated over long distances without losing intensity through diffraction. For weapons applications, the rapid deposition of the X-ray photons onto the target would be almost 100 percent efficient and lead to the generation of a highly destructive shock wave.

As a scientific instrument, the X-ray laser would provide the means for taking pictures with a spatial resolution as small as an atom and a temporal scale of less than one-billionth of a second. This would have revolutionary implications for microbiology, chemistry, and materials science.

Europeans Prepare to Expand Fusion Effort

The top management of the European Community's fusion program are preparing studies that will demonstrate the need to immediately enlarge the European fusion effort, according to U.S. government sources. Despite budget cuts in the West German fusion program and changes in the management of the British effort, there are plans to upgrade the JET (Joint European Torus), currently under construction at Culham Laboratory in Great Britain.

The initial European Community fusion study, completed in January, is quite favorable and notes the continuing worldwide progress in fusion research. The European Fusion Review Panel will report the findings of its more detailed review to the EEC before July 1981.

Frascati Tokamak Results Confirmed

U.S. Department of Energy sources have confirmed that the Italian Frascati FT tokamak has obtained density-confinement time products greater than 30 trillion nuclei-seconds per cubic centimeter (that is, on the order of 10^{13}; 10^{14} is the Lawson criterion for a working fusion reactor). The experimental success of the Italian high-density, high-magnetic-field compact device surpasses the old record held by the Alcator, a similar machine at

the Massachusetts Institute of Technology. It is projected that density-confinement time products of 100 trillion are needed for commercial fusion reactors.

A fuller report on the Frascati FT tokamak appeared in the June *Fusion*.

U.S., Japan Hold Fusion Seminar

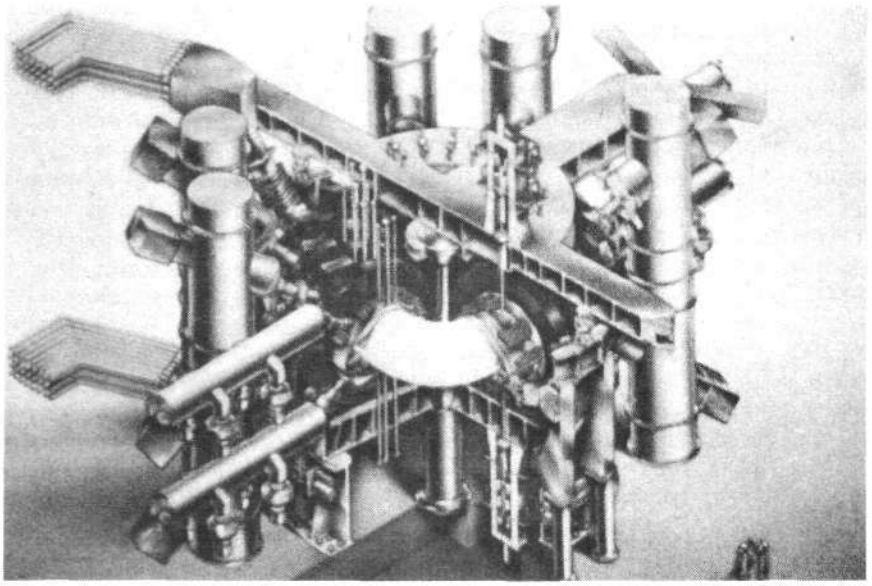
Scientists from the Japanese fusion research program held a joint seminar with U.S. researchers at the Los Alamos National Scientific Laboratory in New Mexico in the last week of March. The main topic of discussion was the reversed-field toroidal z-pinch magnetic bottle, whose recent experimental successes in both Japan and the United States have generated new interest in this approach to fusion.

The Los Alamos ZT-40, for example, recently overcame the impurities problem and demonstrated a stable magnetic field-reversed configuration with quiescent periods of plasma stability lasting several milliseconds. This and other reversed-field experiments should lead directly to new reactor designs, enhance the understanding of the mainline tokamak approach, and open the door to entirely new fusion-confinement systems.

Fukuda Calls for Increased Cooperation

In his meetings with President Reagan on March 20, former prime minister of Japan Takeo Fukuda stressed the need for increased cooperation between Japan and the United States in developing fusion power before the year 2000. As prime minister in 1978, Fukuda proposed providing as much as $1 billion in Japanese funding to accelerate the U.S. fusion effort. This would also help balance the U.S.-Japan trade deficit. Fukuda's proposal was curtailed by James Schlesinger, the U.S. secretary of energy at the time, who insisted that energy cooperation include Japanese funding for renewable energy sources such as synthetic fuels.

Although some important cooperative programs were set up in fusion as a result of the Fukuda initiative, the overall effect of the Schlesinger counterproposal was to dissipate the funding for fusion.



Japan Atomic Energy Research Institute

Artist's conception of the JT-60. Started in 1978, the tokamak is scheduled for completion in 1985. The Japan Atomic Energy Research Institute laid out the JT-60 program in 1975 with the objective of achieving fusion plasma breakeven.

Congress Reworking Reagan Budget Request

Both houses of Congress are now marking up the budget for the Department of Energy, the National Science Foundation, and the National Aeronautics and Space Administration in an effort to restore the most vital programs that were cut by the Reagan administration. Although the Senate has voted to stay within the budget guidelines requested by the administration, it is unlikely that the specific science program cuts will remain.

Overall, the Reagan energy, science, and education budgets were a severe disappointment to the scientific, technical, and high-technology industrial constituencies. The antinuclear, zero-growth Carter administration had submitted a fiscal year 1982 budget that, at worst, kept most programs going and, at best, in the case of fusion, gave the program a hefty and much-needed increase. Yet, the avowedly progrowth Reagan administration has proposed cutting back—or cutting out entirely—programs that would allow the economy to go forward.

Marsha Freeman

Working to reinstate the science budget cuts: above at congressional hearings, Rep. John Meyers (left) and Rep. Tom Bevill (right); inset, Rep. Marilyn Bouquard and Sen. Harrison Schmitt.

Fight Over Fusion

In its mark-up session March 25, the Subcommittee on Energy Research and Production of the authorizing House Committee on Science and Technology, chaired by Marilyn Bouquard (D-Tenn.), voted to add $14.7 million to the administration's $460 million fusion request. Although the increase will help reinstate two programs that had been completely eliminated, it will not help to get underway the new engineering development work that is mandated in the 1980 fusion legislation.

The administration's $460 million fusion request had eliminated the Fusion Materials Irradiation Test (FMIT) facility at the Hanford Engineering Development Laboratory in Washington state, although the facility will be needed to develop new materials for future fusion reactors. In addition, the $30 million ISX-C tokamak device scheduled to be built at the Oak Ridge National Laboratory had been written out of the budget. The ISX series of machines tests for impurities in fusion devices.

Bouquard's subcommittee has added $14.7 million for the FMIT project and $6.5 million for the ISX-C. To do this, the House subcommittee made a $1.5 million cut in the operating budget for the fusion mirror program and cut the $5 million that had been included in the Reagan budget for fusion materials development to compensate for the elimination of the FMIT.

Sources in the fusion program indicate that the $1.5 million cut in the mirror program will come out of the Elmo Bumpy Torus program, which is also at Oak Ridge.

The DOE fusion office was hoping to begin a mirror program at the Massachusetts Institute of Technology, in addition to beginning serious design work on the next-step Fusion Engineering Device and the Center for Fusion Engineering, both of which are mandated in the Magnet Fusion Energy Engineering Act of 1980. However, at a budget level of $474.7 million, this activity will be minimal next year. The fusion law had provided for a budget of $525 million in fiscal year 1982.

Sources in Congress concur that unless the President himself decides to move forward with the fusion program, it will be difficult to move aggressively on a program similar to that proposed by the 1980 fusion law and recommended in the various reviews

of the fusion program conducted during the Carter administration.

The most worrisome situation is in the Appropriations Subcommittee in the House, chaired by Congressman Tom Bevill (D-Ala.). There, staff members have rumored that the fusion budget might be cut back to $420 million, arguing that the money is needed instead for the nuclear programs and water development projects.

As of this writing, the Senate committees have taken no action on the fusion budget.

Concerned about the fusion budget, nine members of Congress, five Republicans and four Democrats, sent a letter to DOE Secretary James Edwards at the beginning of March, pointing out that "Congress has demonstrated strong support for an accelerated fusion energy program."

The group asked the secretary to consider "increased industrial participation in fusion research and development" and stated that support for fusion was "ideally suited" to the department's philosophy of support for long-term, high-risk technology development.

Pressure on the administration to go forward with fusion also came out of a meeting President Reagan had March 20 with former Japanese Prime Minister Takeo Fukuda, who restated his 1978 offer for closer U.S.-Japanese collaboration in fusion research.

On the nuclear front, the House authorizing subcommittee has restored $40 million to the High-Temperature Gas-Cooled Reactor program, which the Reagan budget had eliminated, and added $13 million for the Barnwell, South Carolina fuel reprocessing facility. It also allocated another $25.74 million to help with the cleanup of Three Mile Island.

NASA—Holding Options Open

The Space Science and Applications Subcommittee of the House Committee on Science and Technology has marked up its part of the NASA budget. Although the committee ended up with the same total dollars as the Reagan request, money was reshuffled to keep options open for programs that Office of Management and Budget Director David Stockman had killed.

Sixty million dollars, which was part of the contingency fund for the Space Shuttle should it run over projected costs, was redistributed to other programs. The subcommitee stated that if there is an overrun on the shuttle program in fiscal year 1982, NASA should come before Congress and ask for a supplemental budget request next year.

With the $60 million, the subcommittee, chaired by Congressman Ronnie Flippo (D-Ala.), kept alive some crucial projects. These include: $15 million for the International Solar Polar Mission, which is a joint project with the European Space Agency (ESA); $10 million to keep Spacelab on schedule. (This is being built by the European Space Agency for use in the Space Shuttle); $5 million to keep alive the option to fly a Halley's comet

THE CARTER AND REAGAN R&D BUDGETS
(in million $)

	Fiscal year 1981		Fiscal year 1982	
	Carter	Reagan	Carter	Reagan
Solar	598,836	503,688	575,960	193,300
Geothermal	156,021	142,521	91,575	48,375
Hydropower	21,800	−2,746	3,200	0
Nuclear—HTGR	40,000	17,824	0	0
Other nuclear	967,520	1,035,984	812,753	1,150,753
Magnetic fusion	394,117	383,314	506,170	460,000
Electric energy systems	39,923	35,041	38,900	9,900
Energy storage systems	71,800	51,867	59,500	39,000
Environment	235,794	226,815	280,100	230,800
Basic energy sciences	239,494	239,618	311,000	276,500
Technical assistance projects	12,500	9,500	19,800	3,000
Fossil energy	1,134,735	821,903	1,551,670	435,340
Advanced isotope separation	15,945	15,945	35,650	6,150
General science	504,415	504,415	607,320	567,460
Magnetohydrodynamics	66,500	60,533	60,000	0

This table compares selected budget lines from the proposed budgets of both administrations for fiscal years 1981 and 1982.

Although the Reagan administration has stressed the need to develop domestic energy production, the antiscience bias of the OMB and the administration's economic advisors has cut back the nuclear and advanced technology programs that would make this increased production possible.

Except for the Clinch River Breeder Reactor, the recommended Reagan budget for fiscal year 1982 is lower than the Carter budget in all advanced technology areas. Reagan is proposing the elimination of the High-Temperature Gas-Cooled Reactor (HTGR) nuclear R&D program and the elimination of the magnetohydrodynamics program, which would demonstrate technology to burn coal more efficiently.

The administration has made no commitment to have the government purchase the embattled Barnwell nuclear reprocessing plant in South Carolina, although it is admitted that industry cannot demonstrate reprocessing technology without direct government support.

mission, if NASA requests the funding; $5.7 million to life sciences, which will restore the program up to the Carter request level; $10 million to the previously eliminated geological applications program; $10 million for an upper atmospheric research satellite; $9 million for the technology transfer program, which had been eliminated; $4 million for materials processing in space; $5 million for a possible search and rescue satellite program; $8 million to continue the technology utilization program, and $13 million to solar propulsion and advanced programs.

It is unlikely that the Senate authorizing subcommittee, chaired by former astronaut and geologist Harrison Schmitt (R-N.M.) will let the Reagan cuts stand during their budget deliberations. Although Congress has not authorized the money required for an accelerated space program, no important projects will be canceled.

Education, Hydrogen, and MHD

The Reagan budget had proposed the elimination of the science education program of the National Science Foundation, the hydrogen program, and the magnetohydrodynamics advanced energy conversion program. The House is trying to restore these programs partially, so that there will not be irreparable damage in these areas.

According to the National Science Teachers Association, the House authorizing committee will put $75 million back into the science education directorate of the NSF, compared to the Carter request of $110 million. The NSTA has received supportive letters from Senator Schmitt and Senator Orrin Hatch (R-Utah) concerning the NSF program.

Sources in the Department of Energy report that Congress will attempt to restore the funding of thermochemical and related hydrogen production and storage research in the DOE to at least half of the fiscal year 1981 level. The MHD budget, sources said, recommended at $60 million under Carter and eliminated by Reagan, might have $20 million put back—if MHD supporters can influence the committee to save the program.

The OMB's Discount Rate: Writing Off Long-Term R&D

On what basis does the U.S. government decide which programs to fund and which to cut? The Office of Management and Budget employs a type of "cost-benefit" analysis that says, in effect, that no program is worthwhile unless it yields an immediate payoff.

This budget review practice has been in effect since June 1969, when the then Bureau of the Budget issued Circular A-94 on discount rates and procedures to be used in evaluating the deferred costs and benefits of long-term R&D spending. George Shultz was director of the bureau at the time, and James Rodney Schlesinger, fresh from his tenure as head of the Rand Corporation, was the number two man.

In essence, the OMB analysts argue that R&D spending on a long-range energy source like fusion has to show a positive incremental return on investment compared with investment in short-range energy alternatives on nonenergy investments. To determine this, they assume that fusion will not be a commercially available technology prior to 2010 and will not make a significant impact in the marketplace until 2030.

Then they discount the anticipated return, using a discount rate tied to the rate of inflation during the intervening period.

A number of studies have pointed up the inappropriateness of this method for evaluating the payoff of long-term R&D spending. George A. Hazelrigg, Jr., director of systems engineering for ECON, Inc. in Princeton, N.J., has shown that based on the OMB's cost-benefit analysis of fusion R&D, a dollar of return in 2030 is worth less than 1 cent today. Therefore, the OMB concludes that the funding of fusion is not worth the price.

Another study showed that under conditions of 20 percent inflation, any

Wide World

OMB Director David Stockman. According to his OMB procedures, long-term R&D is not cost-effective.

program with a payout beyond 4 to 5 years has a negative present value—according to the OMB method. With a low inflation rate of 7 percent, research with a payout longer than 10 years is valueless.

Schlesinger's Argument

In fact, a long list of vital government R&D programs have been axed over the last decade as a result of the OMB's Circular A-94, including the fast-breeder and high-temperature gas-cooled reactor technologies, adequate levels of fusion R&D, and various NASA programs. It was on the basis of the OMB's cost-benefit analysis that James Schlesinger, as Carter's energy secretary, could argue that the Clinch River breeder reactor project was not cost effective.

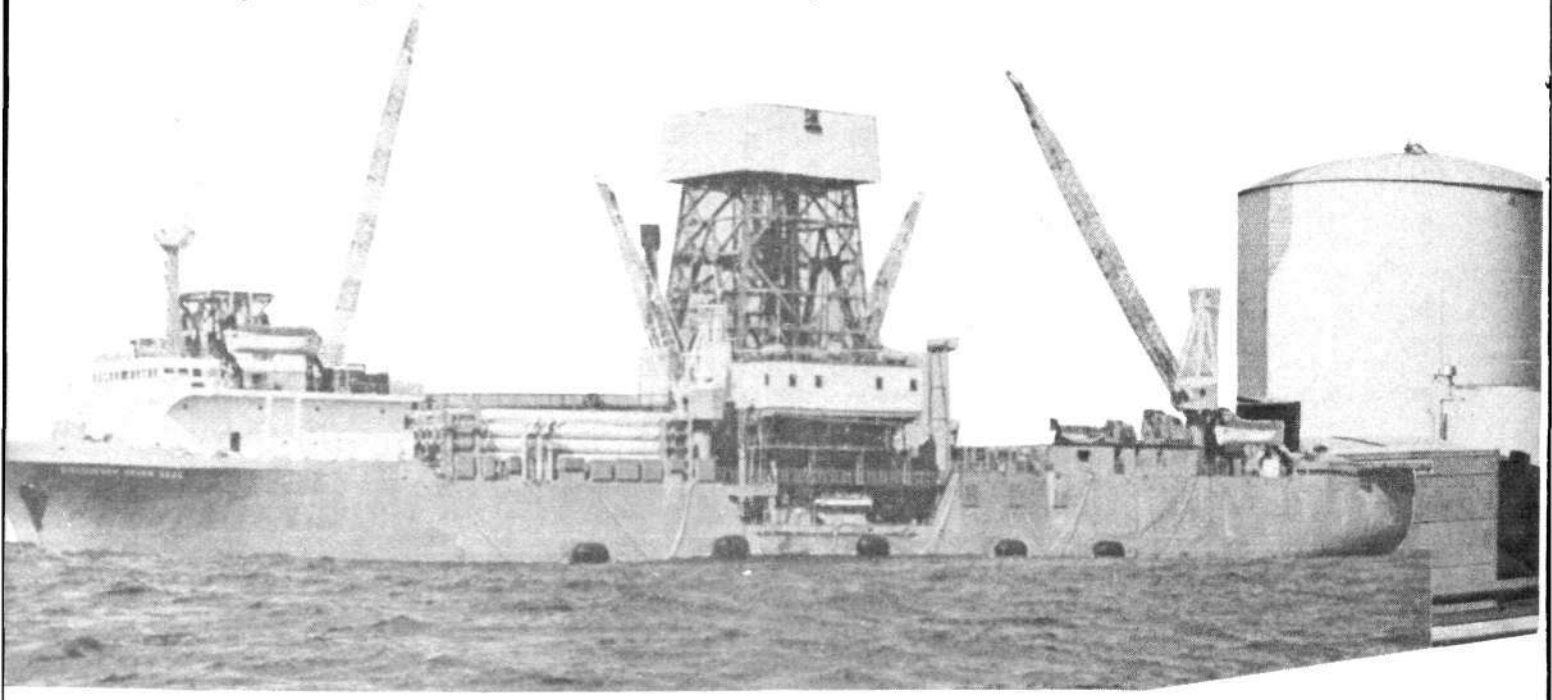
In an interview with *Fusion*, a scientist at one of the national fusion laboratories commented that the OMB budget review process is "just about the opposite of what it should be. Government should be the source of funding for longer range research, which, precisely because of its long-term nature, cannot be funded by private industry."

In addition, the OMB's cost-ac-

Continued on page 49

Oil for Technology

Blueprint for Mexico's Development



The Fusion Energy Foundation and the Mexican Association for Fusion Energy (AMEF) presented a 20-year program for Mexican development, "Energy and Economics: Mexico in the Year 2000," at a Feb. 19-20 conference sponsored by both organizations in Mexico City. Among the 150 participants at the conference were representatives of eight Mexican government ministries, leading private firms, and engineering, research, and educational institutions. (See Fusion, *June 1981, page 47.) For its development projections, the FEF-AMEF team used the LaRouche-Riemann computer model, the only econometric tool to make the rate of technological advance the key parameter of econometric forecasting and planning.*

Presented here is the introduction to the Mexico program by Uwe Parpart, director of research for the FEF, and a summary of the program's conclusions by Dr. Steven Bardwell, editor-in-chief of Fusion *magazine.*

Transcripts of the Mexico City seminar are available from the FEF in English for $250. They include the full FEF-AMEF program for Mexico by sector, plus an appendix on capital goods requirements by Dr. Steven Bardwell. The program will be published in full in Spanish in Fusión, *the bimonthly magazine of the AMEF, published by the FEF.*

THE DISCOVERY, STARTING IN the mid-1970s, that Mexico possesses much larger petroleum reserves (certainly in the 200-billion-barrel range) than had been previously realized, affords it a unique opportunity among the larger Third World sector countries to substantially reduce by four to five years the time that would "normally" be necessary—even with an ambitious development program—to become a modern industrial nation.

Our analysis demonstrates that by no later than the year 2000 the great majority of 115 to 120 million Mexicans should be able to enjoy a standard of living comparable to that of the average inhabitant of the Western European nations in the year 1980. Key to the success of a rapid development effort leading to such a result are extensive oil-for-technology deals between Mexico and several advanced sector countries, which could become a model for beneficial North-South relations in general and are essential to overcoming critical capital goods shortages.

Why Rapid Growth?

By 1990, oil revenues representing production for export of 3.5 million barrels per day of a total daily production of 10.5 million should be allocated to finance capital goods imports, to optimize the tempo of industrial development. At such a coupled oil export/capital goods import level, the Mexican economy can operate at a substantial growth rate in industry of 12 percent per year, powered by annual productivity increases whose lower boundary will at no point dip below 5 percent.

A "go slow" attitude in the exploitation of petroleum reserves represents the greatest threat to Mexico's future. The rapid conquest of underdevelopment must be based squarely on—for its tempo depends upon—continuation of the aggressive oil exploitation program of the past

One hundred billion dollars of capital goods imports, to be financed by increasing oil exports, can transform Mexico into a modern industrial state by the turn of the century. The Fusion Energy Foundation's Mexico program, discussed here by FEF director of research Uwe Parpart and Fusion editor-in-chief Dr. Steven Bardwell, shows how to get the job done.

several years. At an early point in the 1990s, reaching production levels of 10 million barrels per day would be desirable and guarantee Mexico the rates of capital formation in the economy that, in the course of the 1980s, will make the country less and less dependent on raw materials extraction.

It must be understood that these growth rates are not arbitrary, representing targets that would be "nice" to achieve. They are variables that depend on detailed time-phase investment decisions, estimates of when plant, equipment, and elements of infrastructure representing such investments will come on line, and how these will affect production and growth rates. They conform, on the other hand, to an absolutely essential structural requirement for the Mexican economy, without which large-scale social dislocations and the dreaded "Iranization" of the country may in fact become consequences of insufficient development.

Mexico, because of its anomalous population structure and oppressive rates of unemployment and underemployment, must between now and the year 2000 sustain annual rates of job creation and industry of 6 to 7 percent. It is the uniform evidence from both advanced and underdeveloped countries that underwent successful development since the end of World War II, and also analytically provable, that the combination of 12 percent industrial and 5 percent productivity growth rates is the minimum at which such rates of job creation are possible without hyperinflationary consequences.

The oil-for-technology strategy should be seen as the basis on which the principal existing bottlenecks can be eliminated. During the two-decade period ahead, Mexico must begin to make provisions for its energy future beyond the oil era. The 1985-1990 phase will be a crucial transition period in which a first series of nuclear power plants can come on line.

By the year 2000, more than 60 gigawatts of power must come from nuclear sources. This signifies more than simply a transition to a new mode of energy; it means a transition to a modern industrial economy as a whole, and is simultaneously one of the greatest challenges to Mexico's manpower development, if the country is to achieve the status of a truly independent republic.

To say that Mexico's economists—including those who operate the Diemex/Wharton Mexican econometric model at the Wharton School of the University of Pennsylvania in Philadelphia—are the principal obstacle to the country's successful economic development would clearly be to overstate the case. However, there can be little question that incessant talk of the dangers of "petrolization," association of the near 30 percent rate of inflation with the oil boom, lobbying for oil production ceilings to preserve the national patrimony, and so on, have gone far to inject doubt and uncertainty into government policy. It is necessary, in particular, to put to rest the "oil carries inflation" argument in order to permit an unobstructed view of the true dynamics of development.

There is much controversy over the extent to which

imported inflation contributes to the overall Mexican inflation rate. We shall not attempt to settle this matter here, except to say that we regard that contribution as significant. The domestic inflation component is said to be the result of excess demand—an excess of the oil revenues running up against limited productive capacity, production and distribution bottlenecks, and so forth.

Well, why not concentrate on rapid expansion of production capacities, instead of the omnipresent clamor for "cooling off" measures and currency devaluation? The very argument presented to demonstrate that the oil boom causes rising rates of inflation reveals that the true cause of the problem lies elsewhere: in certain profound structural weaknesses of the Mexican economy that can be cured only through an aggressive investment policy in the sectors in question.

Nor is there any difficulty in identifying the weak and inefficient sectors and structural imbalances in the economy that cause the inflationary drag on the economy as a whole. Before making that identification, let us concede the following: There is no question that even the best thought-out investment policy does not produce miracles overnight. And there will undoubtedly be a certain inflationary lag between today's spending and tomorrow's production capacity. However, such a shortage-causing time lag can be covered by a judicious import policy. It is the more profound structural problems and the political roadblocks to their elimination that cause all the trouble. To these problems we can now turn.

Major Bottlenecks

Subsistence farming. By far the largest problem for the Mexican economy is the tremendous inefficiency of the agricultural sector. While a clear distinction must be made between the significant, modern, import-oriented farm sector and the bulk of the agricultural sector, which consists of subsistence farming, the overall performance of the sector is so poor that in 1979 and in 1980 large quantities of food had to be imported. Oil revenues diverted for this purpose, of course, contributed nothing to economic development and became a pure source of inflation.

It is the 18 million rural poor who largely earn Mexico the title of underdeveloped nation. Only a program aiming for the most rapid, total elimination of subsistence farming will be able to secure for Mexico a solid economic future. We are fully cognizant that implementation of an agricultural development program on the U.S. side is not merely a technical problem, but is meeting and will continue to meet major political problems.

Skilled labor shortages. The second major problem in the Mexican economy is more difficult to pinpoint, and at present principally shows up in the initially seemingly unrelated problems of crucial weaknesses in the capital goods sector and extraordinary manpower shortages, principally in the highest skill categories.

The difficulty is as follows: Although Mexico has experienced impressive annual economic growth rates ranging between 6 and 8 percent in the entire 1955 to 1980 period, this economic growth has been entirely lopsided, favoring consumer goods industry to the almost total neglect of basic heavy industry. Until the recent period, the preferred areas for development were the easy profit, high-turnover, low-risk, low-technology areas. Under these circumstances, of course, there is no need to train a highly skilled labor force supported by a well-developed engineering and scientific manpower pool.

Past sins of omission have now turned into major bottlenecks, and the continued almost total lack of output of graduates with advanced degrees in the natural sciences,

A top priority in the FEF program for Mexico is to eliminate subsistence farming as quickly as possible, assimilating Mexico's 18 million rural poor into modern agriculture and industry.

United Nations

physics, and mathematics in particular, has reached the dimensions of a national scandal.

Transportation. The third major bottleneck in the Mexican economy is the transportation system. Transportation functions as a central determinant of productivity in any economy—to the extent that goods are reliably and rapidly transported, the economy has a "conveyor belt" that speeds up production. Without that ability, productivity decreases and, hence, inflation increases. Goods pile up at the border of Mexico; rail cars are used as warehouses while awaiting shipment; trucks are used for long-haul bulk shipments, and so forth. These problems impede the rate of production and the rate of absorption of investment—they cause inflation.

But these problems can be solved with investment in highly developed technologies. Mexico must put the sort of priority on investment in transport that the Koreans did in the early part of their economic "miracle." Almost half of the investment made in Korea in the early 1960s was in the development of a transport system, which paid off many times over in the 1970s. Extensive rail systems must be built that are electrified, rectified, and double tracked. A modern highway system must be built. Large ports must be constructed. In all these areas, technologies exist for rapid massive construction of transport facilities. Mexico has private sector companies internationally famous for their abilities in the sort of crash construction programs used by military forces. Mexico needs several Cam Rahn Bays!

Oil for Technology

All three of these problems can be solved with a forceful application of investment paid for by oil revenues. The potential exists in Mexico's oil reserves to solve the dependence on those reserves. Like any endowment, this oil will have been successfully used, if, at the end of a generation, it is no longer needed. The FEF program provides a strategy for the transformation of Mexico from a raw-material-producing country to a capital-goods-producing country.

The role of these oil exports is most dramatically shown in the way that they purchase the critical capital goods for Mexico. In 1982, we project that Mexico would use approximately 20 percent of its oil revenues for purchase of capital goods. This import of capital goods would represent about 75 percent of the capital goods needed in Mexico. However, by 1990, about 50 percent of the oil revenues would be used to purchase less than 60 percent of Mexico's capital goods needs—the other 40 percent would be produced domestically. By 1995, Mexico would be producing more than half of its capital goods requirements. And by the year 2000, Mexico would be producing 75 percent of its capital goods requirements.

The LaRouche-Riemann Model

The FEF program presented here is a "proof of principle" experiment—we have shown that Mexico can become an industrialized country by the mid-1990s. The FEF program is *not* a prediction of how that development will happen; nor is it a statement of how this industrial development must happen. But, it is a demonstration that Mexico need settle for nothing less than rates of growth of national product of 12 percent per year; and the transition to a modern, industrialized country in the lifetimes of most Mexican citizens today. Any claim of the impossibility of these goals is scientifically false.

As has been described in greater detail in published material, the LaRouche-Riemann model reproduces in numerical form the dominant cause-and-effect relations of an economy. This model shows how investments are generated, how their disposition affects future production. It gives the economic planner, industrial manager, or governmental economist the ability to derive impact evaluations for a given investment strategy. We have used the model to devise a specific investment strategy that shows without a doubt that Mexico can industrialize and lays bare the principal causal features of the process of development.

The motor for the Mexican economy, as for any economy, is the gross profit in tangible terms that it produces. Every economy that is growing does so first because it produces more tangible output than would be required to replace the inputs to the previous cycle of production. The difference between the total tangible output and the requirements for production at the same level is the gross tangible profit. This real surplus product is the source of monetary profit and is the driving force of an economy.

But, it is not enough merely to have produced this tangible profit; some portion of it must be reinvested in expanding the scale or quality of production if an economy is to progress. This portion of gross profit, called s' in our model, provides the fund for new capital investment, expansion of the labor force, and expansion of circulating capital inputs like energy and raw materials. These two aspects of real economic systems lead to the formulation of two corresponding parameters that quantify the most essential aspects of successful economics:

Productivity = gross profit divided by wages (in tangible terms). This ratio measures the effectiveness and efficiency of deployment of any economy's reason for existence—its population.

Free energy ratio = s' divided by equilibrium costs. This ratio measures the rate of directed investment in an economy and can be mathematically shown to give the instantaneous growth rate of the total tangible product.

Mexico's development depends on implementing a set of investments that increase these ratios as much as possible!

Agroindustrial Cities

The essential ingredient in any successful investment strategy for Mexico is a solution to the agricultural problem. Agriculture today in Mexico functions overall as a drag on the economy. Its productivity is about 65 percent of the average in the economy, meaning that the sector contributes less than its share to the total pool of tangible profit; it consumes 21 percent of total wages but produces only 11 percent of the profit.

But, more important, there is a part of agriculture, a subsector of subsistence agriculture, that is a net drain on the economy. In this subsistence sector, the productivity is lower than the rate of consumption of nonproductive

items (services and so forth) so that every peso invested in subsistence agriculture actually *decreases* the economy's ability to expand. There is a clear solution to the agricultural situation in Mexico: The subsistence fraction must be eliminated as quickly as possible, and the remaining fraction must have its productivity increased as rapidly as possible.

The Urgency of a Full Education Drive

From Part VII of the Fusion Energy Foundation's draft program for Mexico, "Education and Science: The Key to Mexico's Future."

The task of education in Mexico is twofold: to bring into existence a world-class scientific elite, and to imbue the population at large with elementary scientific literacy and an understanding of how science is the key to national sovereignty and development.

The problems we face in reaching these goals are also dual. First, the objective skill-level profile of the Mexican population; and second, the political or ideological antiscientific prejudices prevailing in much of Mexico's education system. The domination of education in Mexico by the enemies of industrial progess must be addressed. . . .

Despite almost 40 years of fairly steady economic growth, Mexico is practically a nullity in scientific achievement and number and quality of scientists, outside the field of petroleum. The list of annual PhDs awarded in Mexico is a disgrace. In ongoing basic research and development, Mexico has a pitiful 5,896 scientists actively engaged, one of the lowest in absolute numbers of significant countries in the world. . . .

Part of the problem is the cancerous expansion of "socially relevant" curricula at the expense of natural sciences. Compare Mexico to South Korea, a country that began less than 20 years ago as a very backward, nonindustrial nation, and that has now achieved a development level at least on a par with Mexico. Mexico had 112,942 students enrolled in the social sciences in 1975, compared to Korea's 37,247—while Korea, with half the total population of Mexico, had 17,022 students in natural sciences compared to Mexico's 14,042. And Korea had a far higher completion rate.

Mexico's enrollment in secondary education is also insufficient. In 1976, Korea, with half the potential student body of Mexico, enrolled 2,675,000 in secondary education, compared with Mexico's 2,142,800. In elementary education, while Mexico reports nearly universal attendance for three to six years of schooling, this has been achieved only with very large class sizes of 40 to 50 pupils, too large for efficient primary education.

Our program accomplishes the first goal within 10 years—after 1990 the subsistence sector of agriculture has decreased to less than 1 percent of the total economy. To raise productivity in agriculture requires massive investments *in industry,* most of all, and then a means of transferring those industrial products into agriculture.

We have formulated a unique strategy of "concentrated investment" in the construction of up to 10 agroindustrial complexes and ports—new cities based around advanced energy production and integrated industrial production, irrigation, and fertilizer production facilities. These new cities are the conveyor belt that moves the knowledge and capital to the countryside required to raise agricultural productivity.

Education and Urbanization

The second essential ingredient in a successful investment program is an aggressive education and urbanization program. Again, we have not proposed a broad-based, mass literacy campaign to train the labor force Mexico needs. Such a program may create a level of mediocre education suitable for the World Bank's "ruralism," but a different approach is demanded for industrial development.

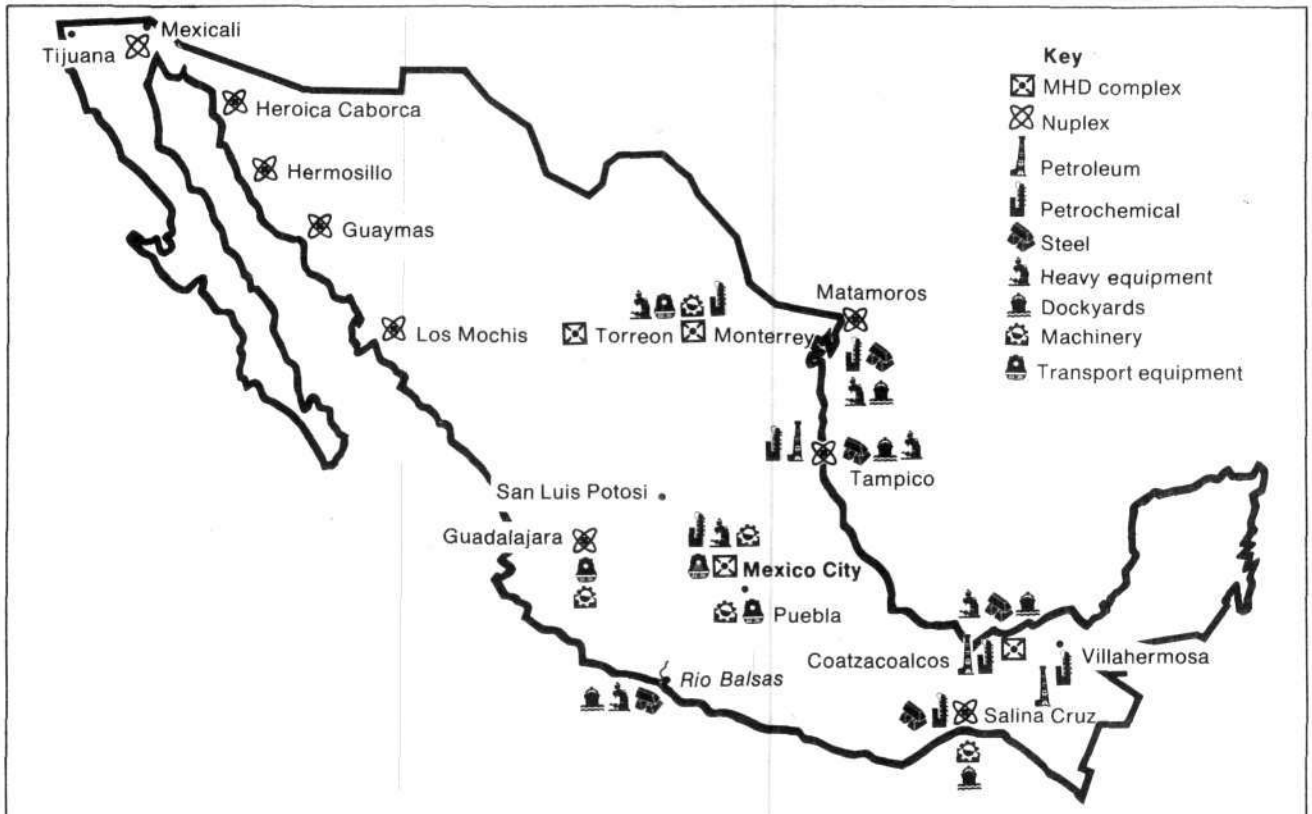
Rather, a top-down attack on the problem is necessary. Because of such a strategy, India is today favorably positioned for its own development. During the 1950s, every large regional center in India was equipped with a center for teaching and research. What more profound remembrance could be left of a national leader than that of Nehru's—almost all these institutions have above their entrance, "Established by Jawaharlal Nehru."

To raise productivity at 5 percent per year, to expand the industrial labor force at the rate of 8 percent per year, to urbanize Mexico with construction of 10 new cities, requires an initiating cadre force of engineers and scientists who can transmit their knowledge to expanding layers of the population, in the manner that the Ecole Polytechnique did in France in the early 1800s.

Mexico can use the construction of agroindustrial complexes to generate not only energy, food, and manufactured goods, but even more important, to educate "on the job" the citizenry of a modern industrial country.

Radiating out from these new urban centers will be engineering and scientific know-how, the tools of culture and the world view of a modern country, and the human side of the resolution of the problem of subsistence agriculture. Here are the jobs at high-skill levels and wages needed to build and maintain an urban labor force. With these new cities, the large economically inactive population of Mexico can be employed, the tragic underemployment of the labor force reversed, and educational and cultural resources built.

Finally, the Mexican economy must actually produce the industrial output required for its survival and growth. This can only be done by rapid and large-scale investment in industrial steel, cement, capital goods, and electricity. All must grow at rates in excess of 13 percent per year. Mexico is uniquely positioned to accomplish this goal using its oil revenues. South Korea, on the other hand, used labor-intensive investment in textiles to generate the



PROPOSED LOCATIONS OF SOME AGROINDUSTRIAL NUCLEAR COMPLEXES (NUPLEXES) BY THE YEAR 2000

Large agroindustrial complexes based on advanced energy sources are essential for Mexico's overall development. Nuclear reactors—optimally, high-temperature gas cooled reactors—and magnetohydrodynamic power generators will provide the base for chemical fertilizer plants, steel plants, desalination plants, and electricity grids. Three of these complexes are discussed in the program.

Northern plateau: *Half a million acres in the hot, arid, and thinly populated area are to become an agroindustrial center permitting the development of natural gas and mineral ores. Near Torreon, two high methane gas-fueled, 1,000-MWe magnetohydrodynamic generators coupled with steam turbines would be installed, providing energy for irrigation via subsurface pumping and for fertilizer production.*

Sonora region: *Near the extreme northwestern cities of Mexicali and Tijuana, 3 million acres can be developed, based on nuclear energy for copper refining, fertilizer production, and desalination.*

Central plains: *3 million acres near Guadalajara could be farmed, triple the present extent, with nuclear energy to expand irrigation and construction of reservoirs.*

Centered in areas of Mexico that most need manpower, infrastructure, and energy, the advantage of the nuplexes is to serve as central points of outward waves of education, urbanization, and industrialization.

surplus required for industrialization. Mexico can be spared this step with aggressive exploitation of its oil.

Our model shows that the revenues from this oil can more than adequately provide the margin of surplus needed to purchase capital goods in the critical first 12 to 15 years of industrialization. With a petroleum output growing at an average rate of 8 percent per year over the next two decades, and with the export of approximately 3 to 4 million barrels per day, Mexico can provide itself with the capacity for rapid industrial growth.

Mexico initially depends, in our program, on heavy investment in petroleum. But by 1988, only 24 percent of total investment goes to petroleum. The economy changes qualitatively, with larger and larger investments in industrial and capital goods sectors. By the end of our program, the capital goods sector itself is receiving 8 percent of the total investment per year and growing at an accelerating rate.

This strategy passes the acid test of our program—it transforms the Mexican economy from a raw materials producer, which it will continue to be for 8 to 10 years, into a capital-goods-producing country. The ratio of imported capital goods to domestically produced capital goods under our program begins at roughly 2.0 in 1980, but decreases by 1995 to less than 1.0. That is, Mexico is rapidly approaching the capability to produce its own requirements for continued industrialization.

At that point, which our study proves can be achieved in the early to mid-1990s, Mexico realizes its potential as a modern nation-state. The true source of national sovereignty will be within the grasp of the Mexican republic. There is no other path to true national independence.

Modeling Mexico's Industrial

ALEXANDER HAMILTON, one of the greatest American economists, rigorously identified the central concept of any industrial development program:

> The employment of machinery forms an item of great importance in the general mass of national industry. 'Tis an artificial force brought in aid of the natural force of man; and, to all the purposes of labour, is an increase of hands; an accession of strength, unencumbered too by the expense of maintaining the labourer.

"Artificial labor" solves the three essential paradoxes of development:

(1) Labor power development: A skilled labor force is required to run the machinery of a modern industrial plant, yet this labor requires the output from that industrial plant for an urbanized, modern standard of living. Without that standard of material culture, the labor force cannot function.

(2) Infrastructural development: A functioning industrial economy depends on an efficient transport and warehouse system, reliable and plentiful energy, and a dependable communications system. In proportion to the speed, reliability, and efficiency of this infrastructure, an industrial plant is productive. Yet, all the raw material of this infrastructure requires the output of industry—railroads require steel, and so forth.

(3) Machine tools and capital goods: Every aspect of industry depends on machinery, especially machine tools, the machinery that makes other machinery. Yet, these capital goods can be manufactured only by industry.

Application to Mexico

To address these "paradoxes" of development in Mexico, the FEF-AMEF program prescribes an aggressive use of oil revenues to purchase the capital goods necessary for industrial growth; a Korean-style infrastructural construction program to solve the bottlenecks in water availability and transport; and finally, a serious program to discourage growth of the subsistence agriculture sector, combined with incentives for urbanization and education of the peasant populations.

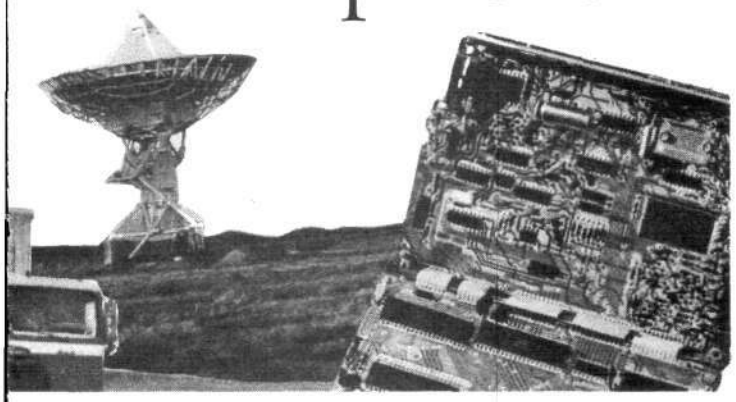
Based on historical examples provided by the industrial development of Europe and South Korea, it is clear that growth rates in excess of 10 percent per year (in tangible output) are not only possible, but, in fact, necessary if employment and productivity are to grow. In the experience of these countries, there is a direct correlation between periods of growth rates greater than 10 percent in industrial sectors and falling unemployment. South Korea, for example, experienced an average growth rate for almost 10 years of 13 percent per annum and urbanized a population that was, in 1960, more rural than India today.

Figures 1 and 2 show the total tangible output of the Mexican economy under the FEF-AMEF investment program. As Figure 2 shows, we have demonstrated the feasibility of an average growth rate in real terms of approximately 12 percent over 20 years. This growth rate results in a roughly 8.5-fold increase in the size of the Mexican economy over two decades.

The composition and efficiency of the economy changes both as a means and end of this growth. Figure 3 shows the rate of "economic energy" generation in the economy. The gross tangible profit generated by the economy is shown as a ratio of the equilibrium or replacement costs for production. This fundamental measure of productivity of the whole economy shows a rising tendency over the course of the 20 years of our program. But, as Figure 4 shows, the fact that this ratio rises at a decreasing rate is due to the decreasing role of petroleum and the conservative assumption made in our program of no qualitative new technology taking its place.

Figures 12 and 13 give a quantitative indication of the changing character of the Mexican economy as it industrializes. In spite of the last 15 years of economic growth, Mexico is, in 1980, a largely agrarian economy (in contrast, for example, to Korea). This agricultural sector is rapidly replaced, after 1980, by the petroleum sector and after 1990, by the industrial sectors. Agriculture's growth rate shrinks from 9 percent per year to 6 percent by the year 2000, while the industrial sectors increase from 11 percent to 15 percent per year. The most critical phase of this growing contribution of industry to the Mexican economy is in capital goods, which grow steadily from 1980 to 1990

Development



and then, from 1991 to 1995, in what is a turning point for the Mexican economy, they grow at an accelerating rate. By the year 2000, capital goods must be as large a part of the Mexican economy as agriculture.

To accomplish these goals, a unique strategy of "concentrated investment" has been developed: the construction of agroindustrial complexes—nuclear factories producing fertilizer, industrial raw materials, and energy—as the centerpoints for waves of rapid growth, education, and technological change. These new cities, and the industry they create, will be the stepping stone to countrywide industrialization—much as the textile industry was for Korea.

Rapid Rates of Industrialization

The driving force of this process of industrialization is defined by the rate at which reinvestment occurs—$s'/(c + v)$—shown in Figure 5. This "free energy ratio" expresses the ability and willingness of an economy to productively invest tangible surplus. As long as this ratio is rising, an economy is functioning in a mode where its current consumption is directed not merely to replacement of inputs, but also to preparation for succeeding modes of production.

In engineering terms, the success of rapid industrialization requires high rates of capital intensity, shown in Figures 6 and 7. The ratio of capital to productive employees' consumption shows the amount of "artificial labor" at the command of the workforce. This ratio rises in all sectors (see Figure 7), but rises about twice as fast in the industrial sectors as it does in agricultural sectors. This differential rate of capital intensity is the most important feature of the relative emphasis that must be given to industry. Figures 8 and 9 show the same feature in terms of new capital investment.

The key to Mexican industrialization is the surplus generated by the petroleum sector. This surplus comes from large rates of investment in that sector. However, as Figure 9 shows, the Mexican economy must rapidly change from a raw materials exporter to an industrial producer—a transition that occurs in an irreversible form during the early 1990s. This transition cannot take place earlier without seriously slowing the rate of growth of the economy and, perhaps, missing entirely the chance for industrialization.

Figure 10 shows the changing living standards of the Mexican workforce. While levels of consumption (of tangibles) increase rapidly (at about 8 to 9 percent per year) in all sectors, the relative portion by sector of consumption changes dramatically over the course of Mexico's industrialization. The dominant tendency is the decrease of agriculture from almost 25 percent of the consumption (higher in number of workers since the average wage is lower in agriculture) to about 14 percent by 2000. The industrial sectors account for two-thirds of the consumption by the year 1991, the beginning of the final transition period (see Figure 11).

As important as this general shift in composition of the workforce is, the more critical element is the rapid decline in the subsistence agriculture workforce after 1984. This sector, since its level of services and nonproductive consumption exceeds its productivity, is a net drain on the economy. That is, it is not only unproductive in a relative sense, it is actually parasitic on the rest of the economy. Without the most rapid possible disappearance of this sector—and the misery, poverty, and ignorance that it means—Mexico cannot develop. Figure 14 shows the rapid change in the composition of the agriculture sector required for industrialization. The subsistence sector, which accounts for more than one-quarter of agriculture in 1980, shrinks to less than 1 percent by 1990. This must occur not only for the productivity of the Mexican economy, but, even more, for the human potential that such a transition implies.

There are two dominant features of the Mexican development program described here: (1) the aggressive exploitation and export of petroleum; (2) the rapid destruction of the subsistence agriculture sector.

The Alternative

The advisability of both of these steps has been challenged by various representatives of the World Bank, the United Nations Institute for Training and Research (Unitar), and even some officials of the Mexican government. Two alternative simulations were prepared that contrast these options with the investment strategy proposed by the FEF-AMEF. In the first of these, we assume that oil output is held constant after 1984, at approximately 2.5 to 2.7 million barrels per day. The second of these invests the surplus that would have been used in petroleum's development, in the sector that "needs it most," subsistence agriculture.

The results of these differing investment strategies are contrasted in Figures 15 through 18. Even under very generous assumptions of the negative impact of the other investments, the total output of the Mexican economy is about 80 percent of its size with the slower petroleum investment (by 1999) and about 65 percent of its possible size if this investment is diverted to the subsistence agriculture sector. Consumption in agriculture (shown in Figure 16) suffers even more! As Figures 17 and 18 show, such a plan would doom the Mexican economy to the permanent status of an agrarian economy—productivity and capital intensity are so low that industrial development becomes impossible.

Figure 1
TOTAL TANGIBLE OUTPUT

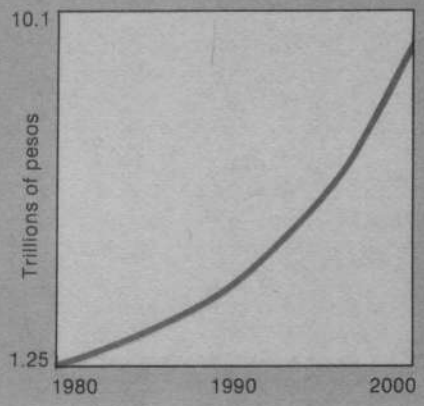


Figure 2
TOTAL TANGIBLE OUTPUT

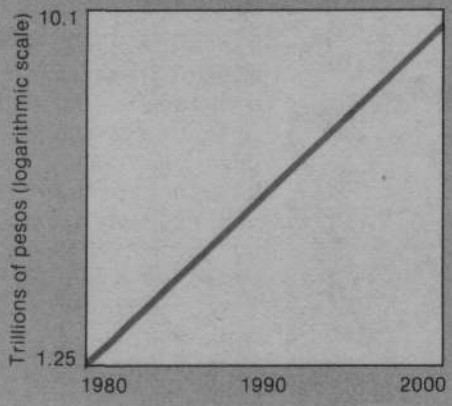


Figure 3
s/(c + v) TOTAL ECONOMY

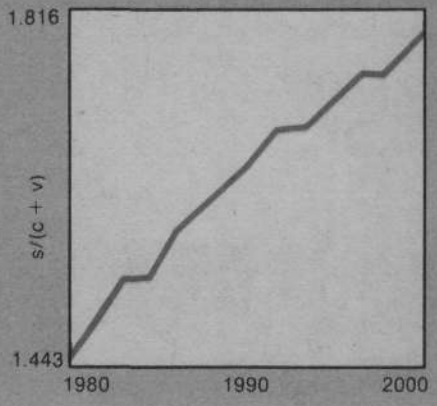


Figure 7
CAPITAL INTENSITY BY SECTOR

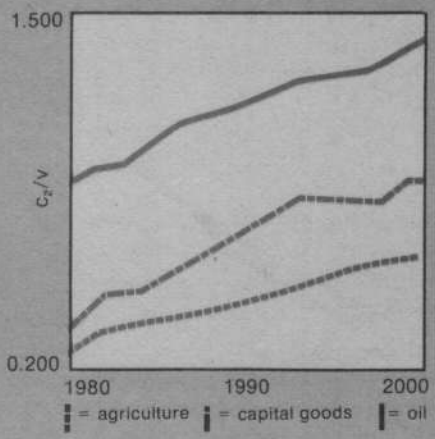


Figure 8
NEW CAPITAL INVESTMENT BY SECTOR

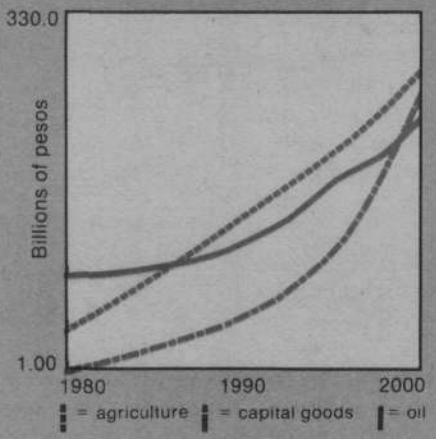


Figure 9
SECTORAL DISTRIBUTION NEW CAPITAL INVESTMENT

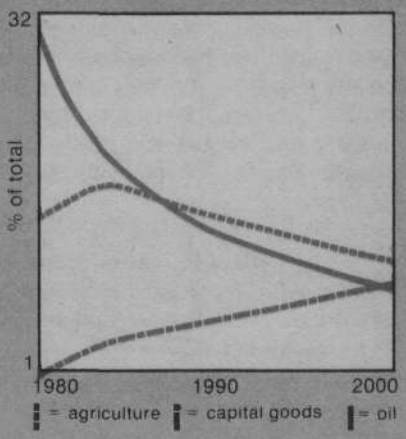


Figure 13
SECTORAL DISTRIBUTION TOTAL TANGIBLE OUTPUT

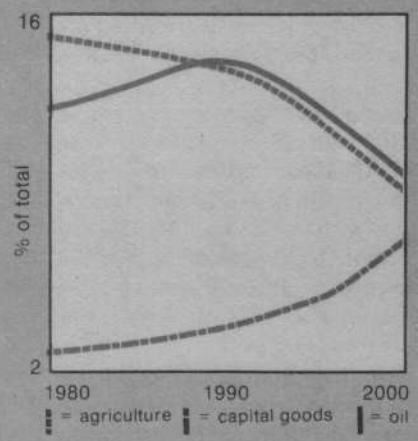


Figure 14
TANGIBLE CONSUMPTION IN TWO AGRICULTURAL SECTORS

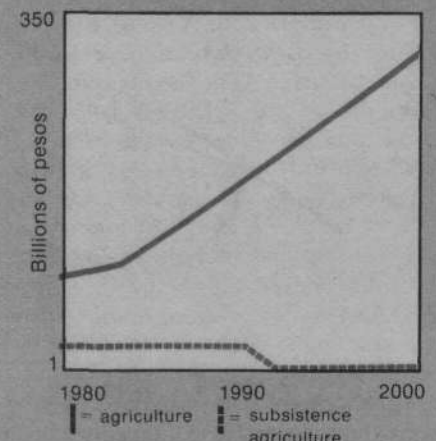


Figure 15
COMPARISON OF PLANS: TOTAL TANGIBLE OUTPUT

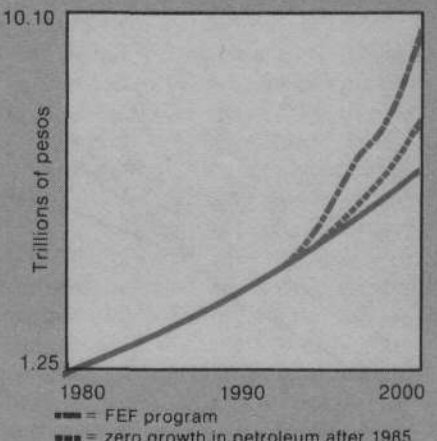


Figure 4
ANNUAL RATE OF GROWTH
s/(c + v)

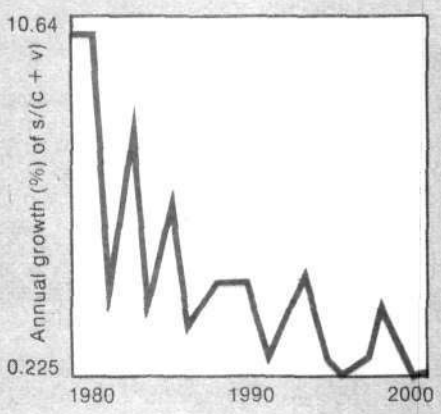


Figure 5
s'/(c + v) TOTAL ECONOMY

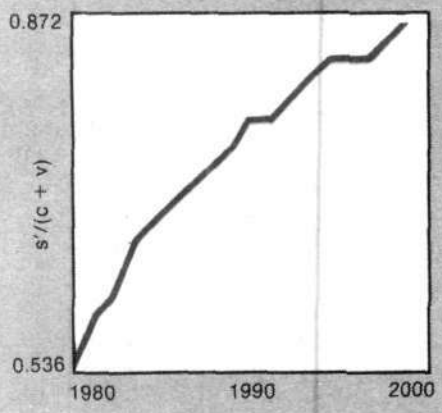


Figure 6
CAPITAL INTENSITY
OF THE ECONOMY

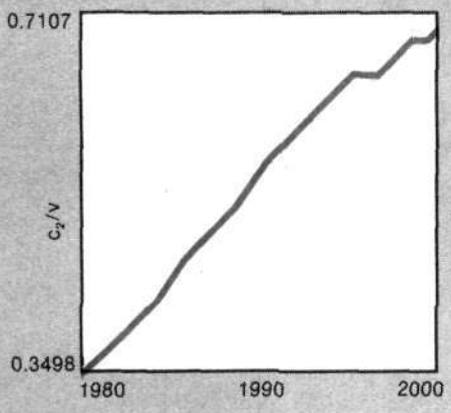


Figure 10
WORKFORCE CONSUMPTION
BY SECTOR

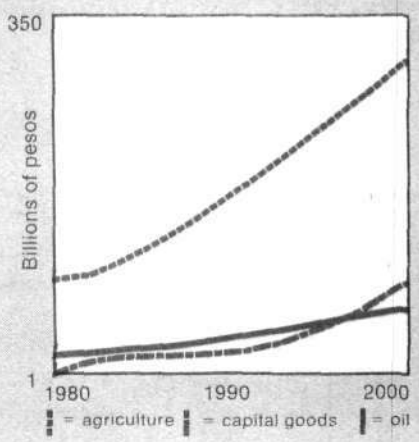


Figure 11
SECTORAL DISTRIBUTION
WORKFORCE CONSUMPTION

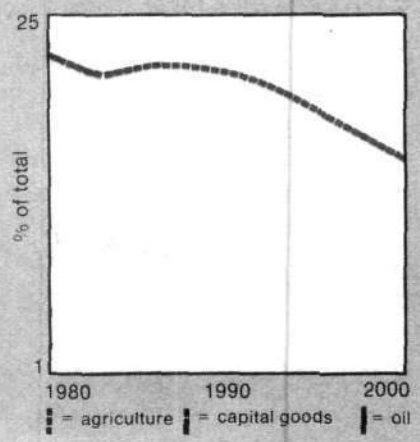


Figure 12
TOTAL TANGIBLE OUTPUT
BY SECTOR

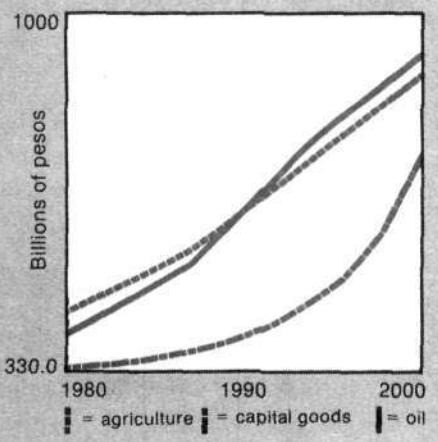


Figure 16
AGRICULTURAL WORKERS
CONSUMPTION

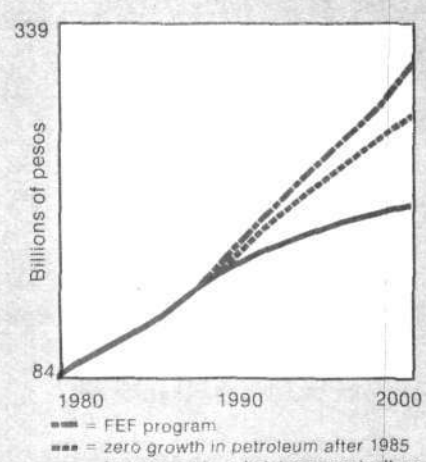


Figure 17
PRODUCTIVITY

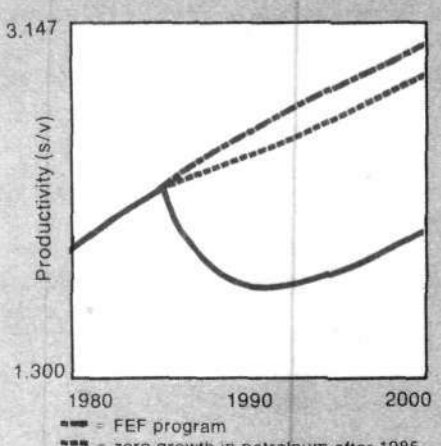
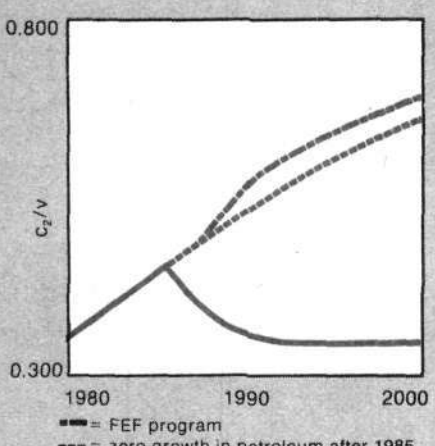
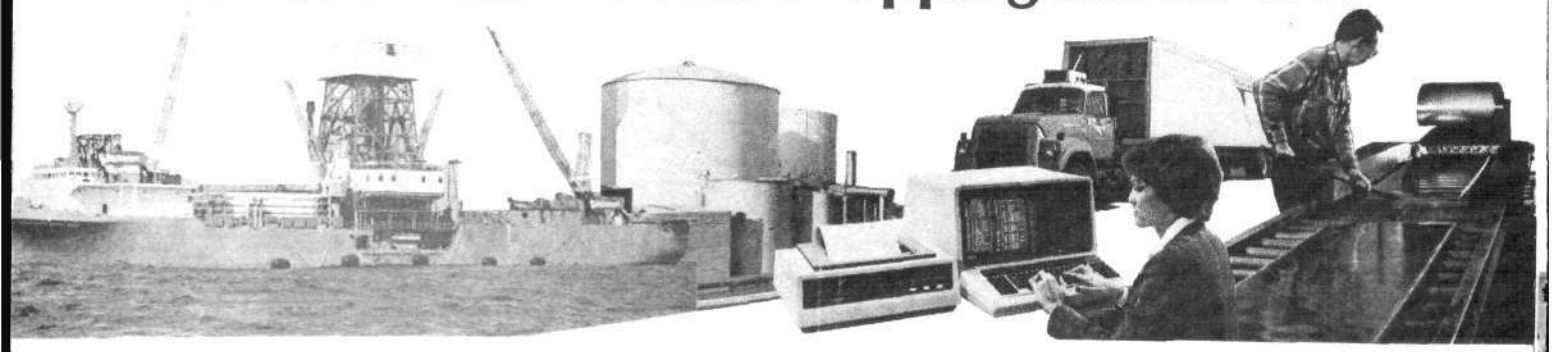


Figure 18
CAPITAL INTENSITY



Mexico's Billion-Dollar Shopping List for 1985

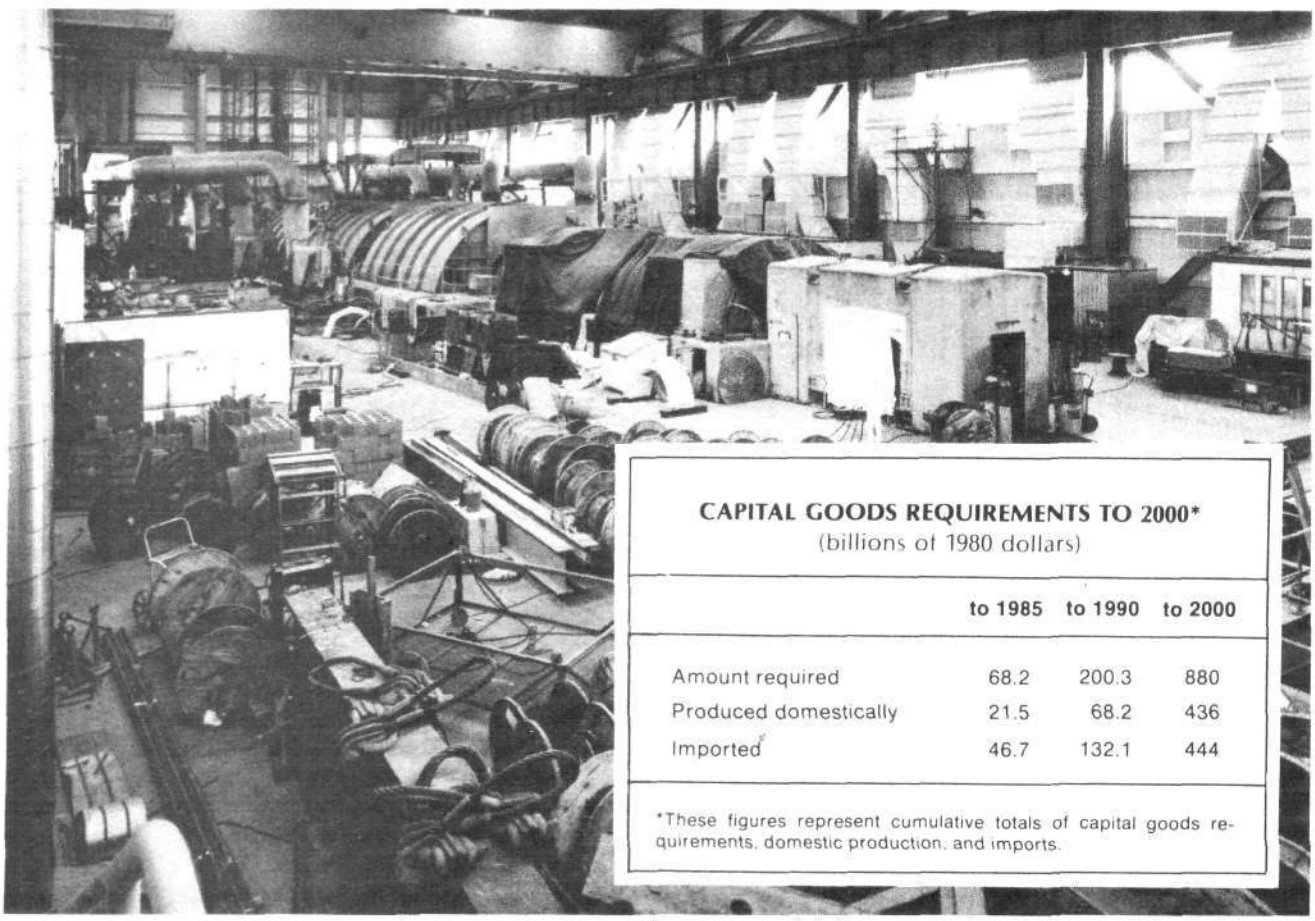


By 1985, the United States could be exporting $46.7 billion in capital goods to its southern neighbor.

The capital goods industry is crucial for Mexico's industrial development. However, because of the disproportionate development of light industries and import-substitution industries over the last three decades, Mexico's domestic capital goods-producing capacity is inadequate to meet the requirements of rapid industrialization. Correcting this deficiency is one of the major goals set by the FEF-AMEF development program for Mexico. In the meantime, Mexico's deficiency is a U.S. opportunity. The United States is Mexico's most natural supplier, and the present market pattern—in which the United States provides nearly two-thirds of Mexico's capital goods imports—gives U.S. firms a head start in providing an ever expanding array of capital goods to Mexico.

Under the FEF-AMEF program, in 1985 Mexico will be in the early phase of transforming itself into an industrial nation. However, the structure of the economy will still be strongly oriented to resource exploitation and agriculture; consequently, Mexico's "shopping list" for imports that year will reflect this orientation. Mexico's petroleum industry will require approximately $1.6 billion of capital goods imports in 1985—oil drilling equipment, specialty steel, and so forth. Agriculture will require $1.25 billion more for mechanizing and upgrading productivity in this critical—but now severely undercapitalized—area of the economy.

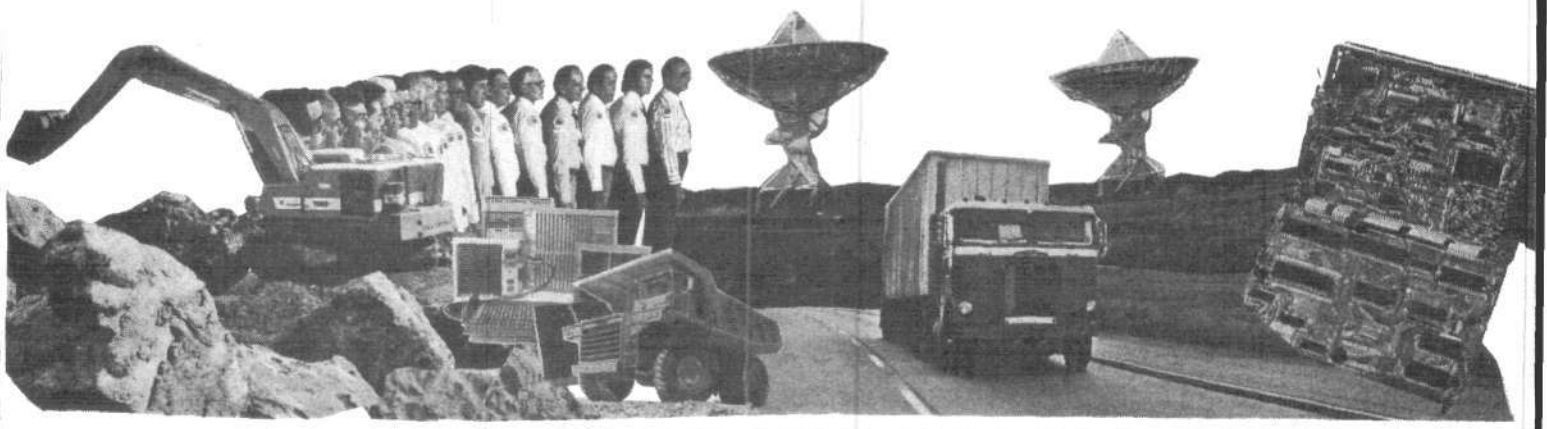
At the same time, Mexico's industrial managers must begin taking the



CAPITAL GOODS REQUIREMENTS TO 2000*
(billions of 1980 dollars)

	to 1985	to 1990	to 2000
Amount required	68.2	200.3	880
Produced domestically	21.5	68.2	436
Imported	46.7	132.1	444

*These figures represent cumulative totals of capital goods requirements, domestic production, and imports.



necessary steps to upgrade Mexico's domestic technological capability. The primary requirement here will be the construction and maintenance of industrial infrastructure. Of top importance is a series of modern port facilities, capable of handling 175 million tons of industrial imports in the year 2000 and prepared to accept 28.6 million tons of import cargo in 1985. Mexico's antiquated rail system, now a major bottleneck in expanding imports, will be embarking on a maintenance and expansion program aimed at increasing total trackage by 66 percent by the year 2000. Although the rail system will be carrying an increasing share of total freight, the highway network will also be growing, and Mexico will be making extensive purchases of trucks for short-haul and low-bulk transport. Total imports for these infrastructural improvements will amount to approximately $2.8 billion in 1985 and will include purchases of trucks and materials handling equipment, as well as construction equipment and materials.

Electric Power

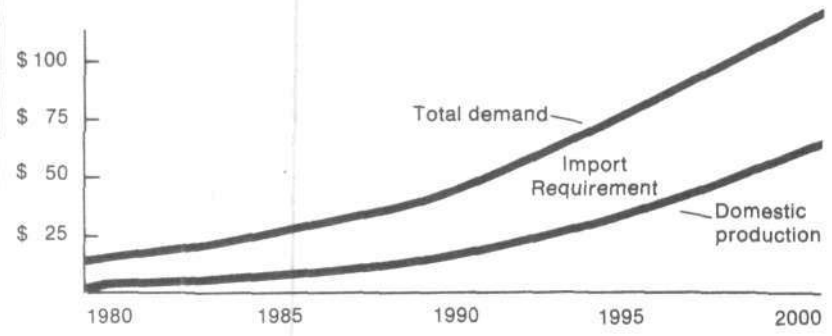
The other major area of import demand in 1985 will be to supply Mexico's need for increased electricity generation. The FEF-AMEF plan projects an additional 24 gigawatts of generating power in 1985 over the present, with one nuclear plant on line. The plan specifies a significant upgrading of capacity and quality of power over the next 15 years; by the year 2000, total generating capacity will be greater than 200 gigawatts, with 22 percent of that provided by 50 nuclear plants built at a total cost of more than $40 billion (in 1980 dollars).

—*Sylvia Barkley*

PARTIAL LIST OF MEXICO'S 1985 REQUIREMENTS

Item	Number*		Value* (millions of 1980 dollars)
Farm tractors, 50 to 99 hp	33,400		1,206
Other farm equipment, including trucks, combines and tillers	89,000		
Locomotives	288		894
Freight cars	15,000		
Material handling equipment for ports	34 110	cranes forklifts	100
Electric furnace steel plant (4 million ton/year capacity)	1 (Start negotiations for next blast furnace; find vendor for direct reduction plant.)		2,100
Oil refinery (200,000 bpd capacity)	1		652
Oil-fired power plants (750 MW each)	5		450
Nuclear plant (1 GW)	1		812
Trucks, tractor-trailer	22,000		1,800

*Amounts are for total requirements; an average of two-thirds will be imported.



MEXICO'S IMPORT REQUIREMENTS FOR CAPITAL GOODS, 1980-2000
U.S. $ (billions)

The fusion-fission hybrid is a sure path to commercial fusion and promises to halve the necessary time to get there.

The Molten Salt Hybrid

A 'Leisurely Walk' to a Fusion Economy

by C.P. Hager, Jr.

CONTROLLED THERMONUCLEAR FUSION will soon pass the milestone of breakeven—the demonstration of scientific feasibility. Breakeven, however, is but the first step along the road that ultimately leads to the realization of commercial fusion power. Past experience with the introduction of new technologies suggests that the road could prove to be a long one. Controlled fission, for example, was initially demonstrated in 1942, and the Shippingport, Pennsylvania nuclear plant was operating in 1957, yet nearly three decades elapsed before the technology achieved fairly widespread commercialization.

Fusion technology, if it conforms to this pattern, offers the industrialized world no surcease from its immediate energy problems. Fortunately, however, a way station on the road to fusion power exists in the form of the fusion-fission hybrid. With this system, the time needed to bring fusion power on line could be cut in half.

The crucial question is why can't a crash program bring fusion on line in 10 to 15 years? The answer lies in the fact that technological innovation moves through two distinct phases: a development phase and a deployment phase. The deployment phase is primarily a matter of logistics and economics and is influenced by such factors as the ease of capital formation, the availability of trained manpower, and even the efficiency with which the sub-subcontractor in Kankakee turns out widgets. Orchestrating a large enterprise such as the introduction of fusion power is very difficult, and bottlenecks are sure to develop. In contrast, the hybrid could readily plug into existing nuclear-power technology because the hybrid is first and foremost a source of fissile material. This, combined with the fact that a small number of hybrids can fuel a large number of fission reactors, results in a much more easily managed deployment.

Another point in favor of the hybrid is that it is already very nearly state-of-the-art. This is because it is in essence a plasma amplifier, using the rich flux of 14.1-MeV neutrons from the deuterium-tritium (DT) reaction to induce large numbers of fissions, each of which releases approximately 200 MeV. Usable power from a hybrid could be obtained with a very modest plasma performance, thus relaxing many of the stringent engineering requirements intrinsic to pure fusion systems.

To date, a multitude of different hybrid designs have been suggested. Some would use solid blankets of depleted uranium in which plutonium would be bred. Others would utilize solid blankets of thorium in order to breed uranium-233 (U-233), which is optimally efficient in thermal reactors. One design, intended to be compatible with the West German pebble-bed high temperature gas-cooled reactor (HTGR), would use unenriched fuel spheres as the breeding blanket, the idea being to enrich them in the hybrid and then transfer them directly, without reprocessing, to a waiting HTGR.

Perhaps the most promising design to emerge in recent years is of a hybrid with a fluid blanket composed of a molten fluoride salt. What is unique about this design is that the blanket material would be continuously reprocessed *in situ* by a small chemical plant integral to the reactor.

In situ reprocessing and a fluid blanket are spinoffs from the molten salt reactor program, which sought to develop a fluid-fuel thermal breeder reactor, the Molten Salt Breeder Reactor (MSBR). Oak Ridge National Laboratory's conceptual design for a 1,000-MWe MSBR[1] is shown in Figure 1 and described in Table 1.

A test-bed nonbreeding molten salt reactor, called the Molten Salt Reactor Experiment, was constructed and

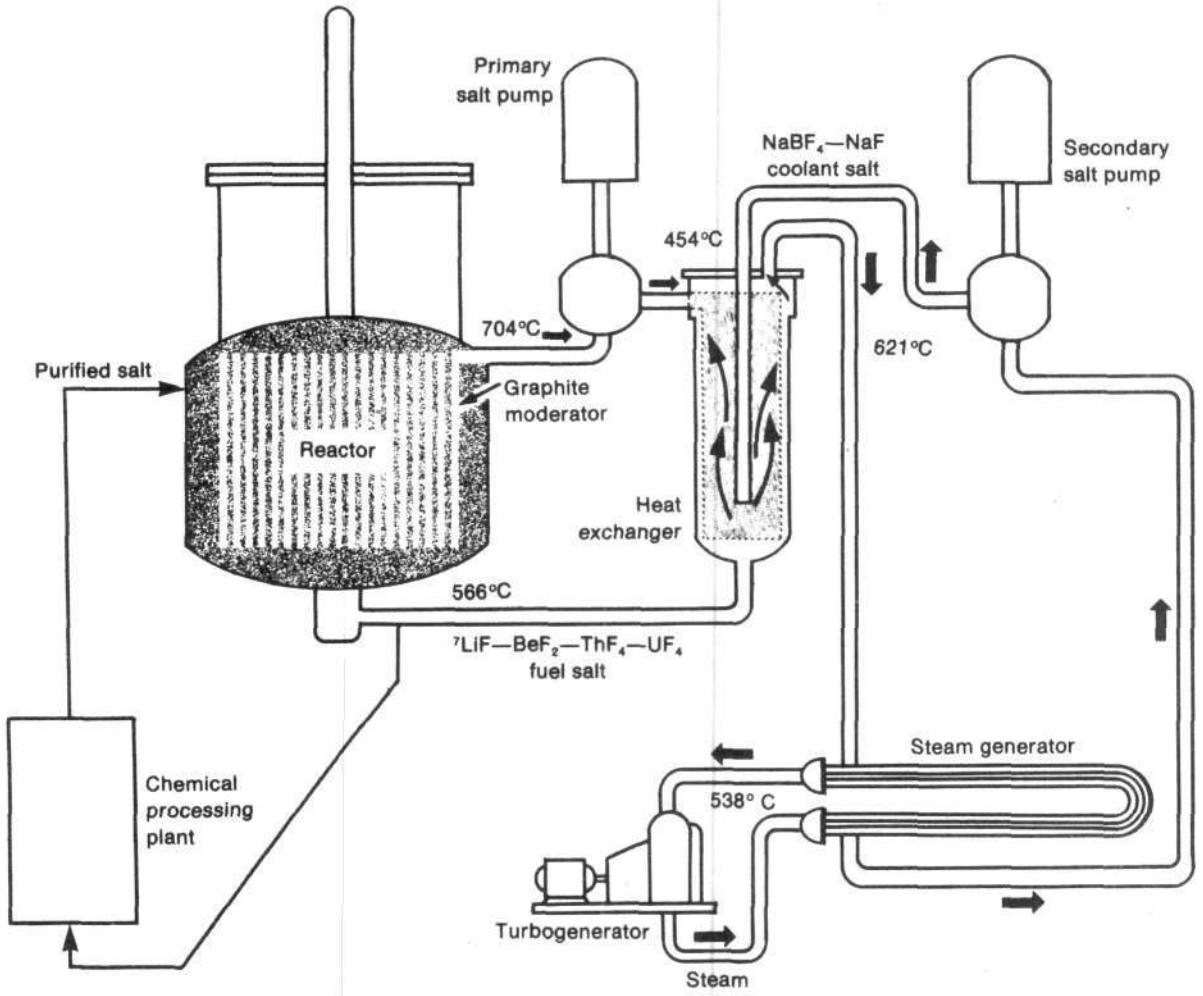


Figure 1
THE MOLTEN SALT BREEDER REACTOR

Unlike conventional reactors having solid core assemblies, the Molten Salt Reactor (MSR) is fueled by a circulating mixture of a liquid carrier salt and uranium fluoride. The initial motivation for the development of the MSR was to produce a small, high-performance power plant for an intercontinental nuclear-powered bomber. After the demonstration of such a power plant in 1954, the project was abandoned, and the focus shifted toward the MSR as a commercial electrical power plant.

The MSR has a number of potential advantages over solid-fueled reactors. The most important is that the fuel salt (which also acts as the heat-transfer medium) can be circulated through a processing unit where waste products can be removed. In solid fuel reactors, fission products accumulate in the fuel assemblies. Many of these products have high neutron absorption cross sections. Removal of these radioactive species allows a reactor to operate with a lower fissile loading, which has both economic and safety ramifications. The fuel utilization of the MSR can be further enhanced by sequestering the protactinium-233 produced from thorium-232 in the fuel salt, allowing it to decay into fissile uranium-233. This additional processing step allows the MSR to become a full-fledged breeder reactor.

Two problems, thought to be major impediments to the commercial development of the MSR, were essentially solved before the developmental program was terminated in 1976. The problem of corrosion of the structural material by the fuel and certain entrained fission by-product compounds (particularly tellurium compounds) was corrected by modifying the composition of the Hastelloy-N structural material. The second problem, the control of tritium produced by the neutron bombardment of the lithium constituent in the salt, was solved when it was discovered that the coolant salt, sodium fluoroborate, trapped nearly 98 percent of the tritium diffusing across the heat exchanger boundary. This discovery is particularly important for molten salt blankets in fusion hybrid reactor systems.

operated from 1965 to 1969, providing valuable information relating to systems engineering, reactor kinetics, and overall reliability. Although dropped by the government in order to focus effort on the Liquid Metal Fast Breeder Reactor (LMFBR), the program did record some important achievements before its termination: (1) the demonstration of the feasibility of the reprocessing system on a laboratory scale; (2) the development of a method of controlling the tritium produced by the neutron bombardment of the lithium component of the salt; and (3) the establishment of the validity of a modified Hastelloy-N as the primary system structural material. Each of these achievements bears directly on the functioning of the Molten Salt Hybrid Reactor (MSHR).

The on-site reprocessing system would function in the MSHR in a manner analogous to a kidney in a human being. The system designed for the MSBR was to perform three tasks: first, continuous removal of fission product noble gases (xenon and krypton) as well as some tritium (mostly as tritium fluoride); second, continuous removal of fission-product rare earths and alkali earths; and, third, removal for subsequent decay of the uranium-233 precursor, protactinium-233.

The MSHR on-site reprocessing system would be similar, although certain modifications might be required depending upon blanket multiplication factors. On-site reprocessing would confer a number of advantages on the MSHR compared to other hybrid systems that rely on conventional reprocessing alternatives (for example, PUREX or THOREX). Projections of MSBR fuel-cycle economics in comparison with other reactor systems ranging from the Light Water Breeder Reactor and CANDU to the LMFBR and Gas-Cooled Fast Breeder Reactor show the MSBR to be superior to all but the advanced oxide LMFBR.

Table 1
OPERATING PARAMETERS OF A 1,000-MWe MOLTEN SALT BREEDER REACTOR

Thermal power	2,250 MW
Electric power	1,000 MW
Plant lifetime	30 years
Fuel processing	On-line, continuous
Fissile inventory	1,500 kg
Breeding ratio	1.065
Plant doubling time	20 years
Thermal efficiency	44%
Fuel salt composition (primary circuit)	$^{7}LiF—BeF_2—ThF_4—UF_4$ (71.7 — 16.0—12.0—0.3 mole%)
Moderator	Unclad, sealed graphite
Reactor vessel material	Modified Hastelloy-N
Power density	22 kW/liter
Vessel design pressure	517 kPa (75 psia)
Peak thermal neutron flux	8.3×10^{14} neutrons/cm²-sec
Coolant salt composition (secondary circuit)	Eutectic sodium fluoroborate $NaBF_4—NaF$ (92—8.0 mole%)

The reasons for the MSBR's low fuel cycle costs would apply with equal force to the MSHR. Solid blanket hybrids would have to shut down to replace their blanket elements; the MSHR would not, thereby attaining a higher capacity factor. Blanket elements for typical hybrid designs would require complex engineering; the MSHR's salt blanket would not. The lifetime high-level waste produced by MSHR operation could be stored on site to be removed at final plant shutdown. This would simplify and lower the costs of waste handling.

Figures 2 and 3 show the blanket designs envisioned for typical hybrids[2] and molten salt hybrids,[3] respectively. In the typical hybrid design, the part of the blanket located just behind the first wall is the converter region (generally made of depleted uranium). It is here that primary neutron multiplication occurs with the energetic DT neutrons causing $(n,2n)$, $(n,3n)$, and fast fission reactions in the uranium. All these additional neutrons can be put to work both to provide criticality in a fission blanket and breeding in a fertile blanket. Excess neutrons would be captured in an outer lithium blanket to produce the tritium needed to sustain hybrid operation. In the MSHR the salt, which is composed of 71 percent lithium fluoride, 2 percent beryllium fluoride, and 27 percent thorium fluoride (as measured in moles), would perform all of these functions.

It should also be noted that, broadly speaking, blanket design is not greatly affected by the type of fusion machine acting as the ultimate source. Hence, one could assume a mirror, tokamak, laser, light-ion, or heavy-ion fusion machine producing the plasma in the diagrams.

Hybrids: Fuel and Power

All hybrids can be divided into two main types, fuel factories and power hybrids. Fuel factories emphasize fissile production at the expense of power multiplication, whereas power hybrids can generate considerable usable energy. Lawrence Livermore National Laboratory has designed a molten salt blanket system for a fuel factory driven by a mirror machine. The LLNL design maximizes fissile production in three ways.

First, blanket fissions are suppressed by rapid removal of both protactinium-233 and uranium-233. This would greatly reduce the amount of fission products present in the blanket, thereby simplifying the reprocessing system in comparison with the MSBR's system mentioned previously. This, in turn, would mean that the blanket would be relatively "clean." In fact, LLNL projects that the radioactivity in the blanket would be less than that of the activated structural materials.

Second, tritium produced by bombardment of the lithium constituent of the salt would be removed for use as fuel in fusion reactors. The chemical composition of the salt would be such that tritium production would balance fuel requirements. The application of the MSBR's proven tritium-handling technique to the hybrid's reprocessing system would greatly simplify the problem of tritium control.

Third, neutron multiplication would be assisted by using rods containing powdered beryllium located in the salt blanket. The additional neutrons would enhance U-233 production.

It is estimated that this system would be able to achieve a support ratio of 50 or more thermal reactors fueled by each hybrid reactor.

A power hybrid would be similar to a fuel factory except that substantially more fissioning would take place in the blanket. The role of the power hybrid within the energy economy would be the same as that of the LMFBR—to feed electricity into the grid and to produce fissile material in excess of needs. Oak Ridge has designed a power-producing MSHR in a 1,000-MWe system. This MSHR would produce enough U-233 to support approximately eight standard light water reactors (LWR) operating on a once-through fuel cycle. The LMFBR, for comparison, could support less than one-half LWR per breeder. All things being equal, continuous reprocessing would tend to favor the MSHR over the LMFBR in terms of overall capacity factor.

Taking the comparison a step further, an MSHR would also offer safety benefits over the LMFBR. A number of accident scenarios that are considered quite serious with the LMFBR are either impossible or relatively minor affairs with the MSHR, for several reasons. The MSHR is significantly subcritical because it depends on the neutron flux from the plasma to sustain operation. An LMFBR-style transient overpower accident would thus be impossible in the molten-salt hybrid. The MSHR is also immune to core-melt-type accidents and fuel rod failures. In addition, a loss-of-coolant accident is essentially impossible in the MSHR; under extreme situations the blanket salt could actually be drained to a storage tank integral to the system. Finally, the blanket salt does not react chemically with air or water.

The MSHR's safety attributes must, of course, be assessed in terms of relative costs and benefits. It should be noted that the results of in-reactor tests conducted in both England and France showed the LMFBR to be intrinsically safe because of the large sodium heat sink's ability to remove after-heat by natural convection if pumps failed. The caveat, therefore, is that the "real" safety margin between the MSHR and LMFBR may not be as large as might first appear.

An intriguing approach to fusion-fission systems, based upon initial studies conducted at Oak Ridge National Laboratory, has been suggested by V.L. Blinkin and V.M. Novikov of the I.V. Kurchatov Institute of Atomic Energy.[4] Their idea is to introduce fuel factories as small units connected "symbiotically" to molten salt converter reactors (MSRs). The linkage is symbiotic in that the MSR is the source of all tritium used by the hybrid while the hybrid is the source of all U-233 used by the MSR. A glance at Figure 4 and Table 2 shows that the method by which this is achieved involves altering the salt composition of the fuel and blanket, eliminating fertile thorium from the former and lithium from the latter. Blinkin and Novikov's arguments in favor of the symbiotic arrangement are as follows:

First, given the MSR's proven tritium-handling method and the reduced fuel needs of a small hybrid, the so-called tritium problem in fusion power would be reduced to easily manageable proportions. Second, the full reprocessing system of the MSBR has never been demon-

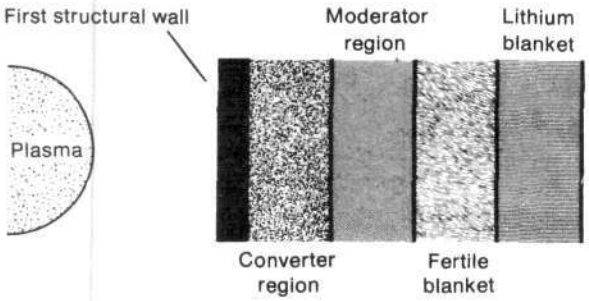


Figure 2
TYPICAL HYBRID BLANKET ARRANGEMENT

This schematic shows a cross section of a possible blanket configuration for a hybrid reactor. The goal of a blanket design is twofold: first, to maximize neutron production and, second, to optimize neutron utilization. The converter region (generally assumed to consist of depleted U-238), in line with the first goal, multiplies the number of neutrons available. These neutrons are then moderated and put to work to breed fissile plutonium or U-233 as well as to support fission in some of the fissile material produced in the blanket.

It should be noted that a hybrid would produce approximately 4 neutrons per 14-MeV fusion neutron versus about 2.5 neutrons produced per fission in a fast breeder. Virtually all the hybrid neutrons, however, would be available for fissile production, whereas the breeder must use one of the fission-produced neutrons to sustain criticality. With proper blanket design, commercially feasible hybrids are possible with plasma-power multiplication factors at or slightly above unity. In other words, the hybrid is a near-certain possibility.

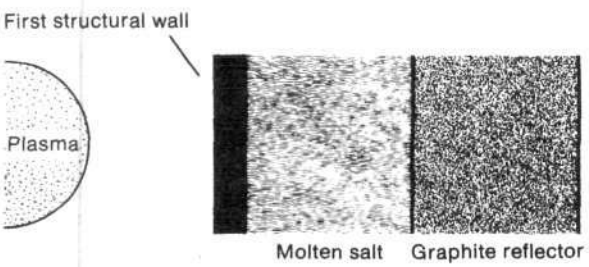


Figure 3
POSSIBLE MOLTEN SALT HYBRID BLANKET ARRANGEMENT

The fluid blanket is suggested as an alternative to a solid blanket in order to adapt the molten salt breeder reactor reprocessing system to a hybrid, thereby allowing U-233 and Pa-233 to be removed almost as rapidly as it is produced. This would increase the net fissile production because fewer neutrons would be wasted fissioning the U-233 or converting the Pa-233 into useless U-234. Secondary considerations would include the perceived economic advantage of a continuous reprocessing system as well as possible safety benefits.

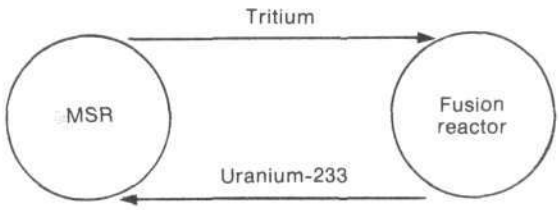


Figure 4
SYMBIOTIC MOLTEN SALT HYBRID SYSTEM

Blinkin and Novikov's suggestion is essentially to build a fission reactor with a fusion appendix. The advantage claimed for this "symbiotic" arrangement is that a nonbreeding MSR and a small, low-power tokamak are feasible with current technology. The tritium-getter properties of the MSR's sodium fluoroborate coolant would eliminate the tritium headache that so often besets designers of fusion systems. Blinkin and Novikov claim that there is a further benefit in dividing the processing system between two reactors, because of the complexities involved in removal of both fission-product rare earths and protactinium at the same time. Fission product removal would take place in the MSR, and protactinium and uranium removal would take place in the fusion reactor.

Table 2

OPERATING PARAMETERS OF MOLTEN SALT SYMBIOTIC SYSTEM

MSR fuel salt composition	$LiF—BeF_2—^{233}UF_4$ (50.0—50.0—<0.1 mole%)
Fusion reactor molten salt blanket composition	$NaF—BeF_2—ThF_4$ (71.0—2.0—27.0 mole%)
Thermal power ratio of MSR to fusion reactor	11:1

strated on the scale of an operating commercial reactor. By splitting the tasks (fission product removal and protactinium or uranium isolation) between two reactors, reprocessing is greatly simplified. This would keep capital costs down and shorten the engineering lead time.

Third, breeding systems with short doubling times are needed to sustain a rapid penetration of nuclear power into the energy economy. The MSBR's doubling time of 20 years is far too long. With the LMFBR a potential plutonium bottleneck could occur. Each LMFBR requires approximately 23 LWR-years of operation to provide its fuel inventory; hence, a more than modest growth in demand could find insufficient plutonium to bring needed LMFBR capacity on line. [This, however, represents a first-generation LMFBR, using uranium-plutonium oxide fuel. The second-generation LMFBR, using advanced fuels such as uranium-plutonium carbides, will have doubling times in the range of 7 to 15 years—*Ed.*] The symbiotic system would have a much smaller fissile inventory than the LMFBR, which with a doubling time of 4 to 5 years could grow at a rate sufficient to keep pace with any foreseeable energy demand.

Fourth, the intrinsic superiority of on-site reprocessing over conventional reprocessing in lowered fuel cycle costs, simplified waste handling, and elevated capacity factors makes fluid fuel systems particularly attractive.

One interesting aspect of Blinkin and Novikov's scheme is that the MSR could be installed as an independent system with linkage to the hybrid to follow later. This means that if, as is likely, the deployment of the hybrid lags behind that of the MSR, MSRs would still be able to contribute to energy needs.

Which of the above systems holds the greatest promise is a matter of conjecture, although there are some persuasive arguments being made in favor of the fuel factory approach. From the economic standpoint, so the main argument runs, the fissile fuel produced in a hybrid is more valuable than the electricity generated. Hence, the support ratio becomes the controlling factor. For a power hybrid to compete, it would need a support ratio roughly equivalent to that of the fuel factory. Another argument is that a fuel factory should be a less complex installation. Fission suppression makes the engineering of the reprocessing system more tractable in a fuel factory, and, of course, there is no need for all the ancillary plant (steam generators, turbines, and so on) that would be a part of any power hybrid. Only time will tell whether these arguments prove to be correct.

It should be remembered that the hybrid is closely linked to a large fission power economy.[5] A commitment to the development of the hybrid is, therefore, ipso facto a strong endorsement of nuclear power. It is also an equally strong endorsement of pure fusion. Edward Teller has likened the direct approach to pure fusion to scaling a mountain in one giant leap, while he views the development of the hybrid as a leisurely walk to the top. Although this probably exaggerates the difficulty of achieving pure fusion, it points up the importance of the pedestrian approach, via the hybrid, as a sure way of getting where we want to go.

C.P. Hager is a systems programmer at the Indiana University Cyclotron Facility, and he is involved in research on topics related to energy and nuclear power.

Notes

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The use and further development of artificial kidney treatments, including research into new, more advanced technology in the field, are being seriously threatened by a shortsighted, cost-accounting approach to advanced medical technology and by the right-to-die ethic.

Renal Dialysis

High Technology Medical Care Under Attack

by Ned Rosinsky, M.D.

THE FEDERAL PROGRAM that provides life-sustaining artificial kidney treatments and kidney transplants to more than 50,000 people in the United States is in jeopardy.

A handful of vocal, well-publicized critics is charging that the kidney dialysis program's annual budget of $1.2 billion is excessive and far beyond anything foreseen when its enabling legislation was passed in 1972; that the program is wasteful because many patients are being unnecessarily treated in expensive kidney dialysis centers rather than being given less costly home dialysis; that a significant portion of alleged cost overruns stem from the inflation of costs by allegedly profiteering private dialysis centers; and that other nations, in particular Great Britain, operate more efficient dialysis programs at a lower cost per patient.

A serious review of the federal dialysis program in the United States, however, shows that all these charges are false: The End Stage Renal Disease program or ESRD, as it is known, is one of the most efficient medical programs in the country. Its costs were accurately predicted in 1972, and the entry of private companies into the field has brought down costs. Furthermore, if the British model were followed in the United States, three-quarters of the 50,000 U.S. dialysis patients would be ordered off treatment and "allowed to die" of renal failure, for in Great Britain, budgetary and other constraints limit the number of ESRD patients allowed on dialysis and favor younger patients.

Clearly, there are other motivations for the attack on renal dialysis besides the list of indefensible charges that have been leveled against the ESRD program. Renal dialysis and other forms of high-technology medical care, which would be pursued with vigor and without debate in a period of economic growth, are falling victim to a

Carlos de Hoyos

The author talks with a patient with end stage renal disease, who is receiving one of his three-times-a-week dialysis treatments.

"No incompetent person should be put on renal dialysis in the first place."

Richard McCormick, S.J., director of the Kennedy Institute for Bioethics

The argument of the bioethics community would condemn to an early grave a large number of the country's nursing home patients, one-third of whom have been declared incompetent and many of whom have renal disease.

Ulanowsky

misapplied, cost-accounting mentality bred by economic depression. The Health Care Financing Administration in the Department of Health and Human Services, formerly Health, Education, and Welfare, is formulating new reimbursement rates for dialysis that may reduce payments to for-profit providers and wreak havoc in the industry. Not only renal dialysis, but the whole concept of health care provided by for-profit private companies is under attack in this revision of the reimbursement rate structure.

Even more pernicious than the threatened rate revisions, however, are the rationalizations that are being offered to justify large-scale cutbacks in life-saving medical technology. Among the most prominent criticisms of the ESRD program is the charge from the "right-to-die" advocates that many of the patients treated in the program are incompetent, elderly persons who should be allowed to die without interference. For example, Richard McCormick, S.J., director of the Kennedy Institute for Bioethics at Georgetown University in Washington, D.C., has stated categorically: "No incompetent person should be put on renal dialysis in the first place" (Rosinsky 1980a).

Since one-third of the approximately 1.3 million nursing home residents in the United States have been declared incompetent, and since these 430,000 people have a high incidence of renal failure because of their age, the stance of McCormick and others in the bioethics community is tantamount to condemning a sizable number of senior citizens to an early grave.

And though home dialysis may be useful in certain circumstances, the most vocal proponents of home dialysis are proposing it as a less expensive alternative to dialysis center treatments and raising the same complaints about the "ethics" of providing costly medical treatment to the elderly as the bioethics community.

End Stage Renal Disease

The term *end stage renal disease* (ESRD) is a catchall category covering a large number of diseases that adversely affect kidney function, including diabetes, hypertension, arteriosclerosis, a variety of autoimmune diseases (in which the body's own immune system turns against its tissues), and chronic inflammation of the kidneys, or glomerulonephritis. ESRD occurs in 75 persons per million annually; there are approximately 15,000 new cases in the United States every year. In all varieties of ESRD, kidney functioning is reduced to minimal or zero levels, and life is threatened.

In normal functioning, the kidney eliminates a variety of toxins from the blood and also corrects for water and salt imbalances through a process loosely termed "selective filtration." This complex process occurs within the functional modules of the kidney, termed nephrons, of which each kidney has approximately one million (see figure).

In a 24-hour period, the normal pair of kidneys will filter the equivalent of about 200 liters of blood (during this period the blood will pass through the kidneys many times) and produce about 2 liters of urine containing the filtered toxins, water, and salts to be excreted.

The normal pair of kidneys has a large surplus capacity; even if one kidney is removed, the remaining kidney will be sufficient to perform the necessary functions. This fact helps explain why a long-time diabetic or hypertensive may never experience problems from kidney failure, or may experience them only after decades of other underlying disease symptoms. Thus, many kidney patients become symptomatic only in the sixth or seventh decade of life.

Renal Dialysis: The State of the Art

Once kidney function falls below a critical level, there is a progressive buildup of toxins, water retention, and abnormal salt balance. With a complete loss of kidney function, this abnormal metabolic state, known as uremia, rapidly leads to coma and death within several weeks.

The basic principle underlying dialysis is simple: Molecules in a solution tend to move from areas of greater concentration to areas of lesser concentration. In dialysis, excess toxins or other substances are removed from the blood by cycling the blood outside of the body, placing

it in proximity to another fluid dialysate that contains a lower concentration of the excess substances. The two fluids, the blood and the dialysate, are separated by a semipermeable membrane, a thin sheet of material that allows certain small and medium-size molecules to pass through but keeps the blood cells and large protein molecules within the blood.

The major problems to be surmounted in this process are avoiding blood clotting and contamination of the blood resulting in infection and meeting a set of delicate conditions: proper membrane permeability characteristics, an adequate amount of membranal surface area to dialyze the blood sufficiently, proper constituents of the dialysate fluid, and suitable access to blood vessels to allow a schedule of several dialysis treatments per week for many years.

The first partially successful attempt to create an artificial kidney was in 1913 by Dr. John J. Abel. Abel tested his apparatus on animals, and he succeeded in cycling the blood outside the animal and removing some of the toxins. His effort was limited, however, by an inefficient membrane (actually collodium tubes, through which the blood flowed and which were, in turn, bathed in the dialysate) and by the use of a fairly toxic anticoagulant—hirudin, derived from leach heads. Because of the toxicity of hirudin, Abel never tested the apparatus on human beings.

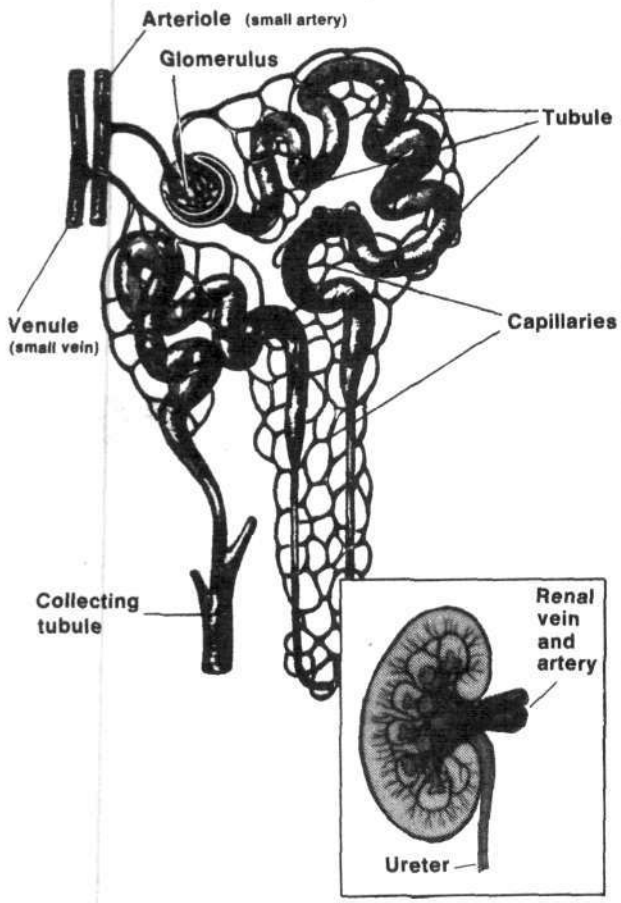
A nontoxic anticoagulant, heparin, was later isolated in 1918 by Howell and Holt and was tested from 1926 to 1928 by G. Haas in several short trials on human beings. Haas also introduced the use of a blood pump for the first time; previous experiments had depended on the high pressure of arterial blood to drive the flow.

It was Dr. Willem J. Kolff of the Netherlands who developed the first clinically effective application of an artificial kidney apparatus in the late 1930s and early 1940s. Kolff's apparatus increased the rate of dialysis by placing the fluids in a rotating drum and subjecting them to motion.

Additional improvements enlarging the membranal surface area and refining the dialysate constituents occurred in the 1950s. And the last remaining problem, the need for repeated access to the arterial blood supply, was solved in 1960 by W. Quinton, D. Dillard, and B.H. Scribner with the development of a permanent indwelling catheter, or rubber tube, inserted in a forearm artery and vein. When not being used for dialysis, the catheter simply shunts blood from the artery to the vein with which it is connected. Access to the shunt for dialysis is by needle puncture. The advantage of this method over the direct use of an artery and vein is that repeated needle puncture obliterates the artery, whereas a rubber shunt will last for years.

Today, the rubber shunt method is no longer used. Instead, the forearm artery is surgically connected to one of the many veins in the forearm, creating a physiological shunt that raises the blood pressure in the forearm veins to arterial pressure. This process greatly enlarges the number of vessels that can be tapped for arterial blood and thus solves the problem of repeated access.

Improved engineering of the flow system to prevent



THE NEPRHON—
THE KIDNEY'S FUNCTIONAL UNIT

The inset is a cross section of the entire kidney, indicating the renal artery, which carries blood into the kidney; the renal vein, which carries the blood out; and the ureter, which carries the produced urine to the bladder.

The main figure is an enlargement of the microscopic functional unit of the kidney—the nephron. Each kidney contains approximately 1 million nephrons, consisting of a small branch of the renal artery, which brings blood into a receptacle called the glomerulus. The blood is forced through a network of small vessels in the glomerulus, removing most of the volume of the blood plasma. This fluid is then carried through the tubule, which is surrounded by a network of small blood vessels (capillaries). These vessels selectively reabsorb most of the filtered liquid and empty into the renal vein. The remaining filtered fluid is gathered by the collecting tubule and carried to the bladder as urine.

The end result of the filtration and partial reabsorption processes is that excess water, salts, and many different toxins are removed from the blood. Both kidneys together filter 200 liters of blood daily and produce 2 liters of urine.

contamination and the development of antibiotics during the 1940s and 1950s have greatly reduced the problem of infection. Theoretically, dialysis can now maintain an ESRD patient until he dies of another condition, eliminating kidney failure as a cause of death.

Further Developments: Peritoneal Dialysis

A second type of dialysis has been developed during the past decade called peritoneal dialysis (PD), which is distinguished from the earlier developed hemodialysis or blood dialysis. In peritoneal dialysis, the dialysis is performed internally, using the lining of the abdominal cavity, or peritoneum, as the dialyzing membrane. This technique involves surgically placing a permanent indwelling catheter tube in the abdominal wall through which the dialysate fluid is introduced into the abdominal cavity (though it remains outside of the abdominal organs themselves). Over a period of hours, the fluid absorbs toxins and other wastes through the peritoneum from the blood circulating in the abdominal wall. After a certain period of time, the fluid is withdrawn from the abdomen, and the process is repeated as needed. The rate of dialysis is approximately half as fast as that for hemodialysis, taking eight to twelve hours per treatment instead of four to six hours, and it entails a higher risk of serious infection (peritonitis, or infection of the peritoneum).

Recent developments in fluid packaging have made possible a new approach to peritoneal dialysis by allowing the patient to use smaller amounts of fluid, keep the fluid bag attached and rolled up under his clothing, and go about a daily routine without confinement, except for the changing of the fluid every three or four hours. This routine includes one eight-hour dialysis at night while the patient sleeps. This new approach, termed continuous ambulatory peritoneal dialysis, CAPD, is now used in only a few ESRD patients. It may become more popular, however, because the main drawback of peritoneal dialysis, the rate of infection, has been decreased to approximately one case of peritonitis per 10 patient-months and can be expected to decrease further in the future.

Other technologies under development include various types of portable dialysis units, some recently available ones that can be carried in a suitcase, and others not as yet generally available that can be worn on the wrist. The advantages of the smaller units are increased patient mobility and enormous savings in cost.

Application of the Technology

The development of the indwelling shunt in 1960 solved the last remaining technical problem of the artificial kidney, the first artificial organ, but the actual application of the technology to save the lives of the thousands of patients with ESRD lagged over the next 10 years. The main problem was money, both for the initial capital costs of dialysis machines and for paying personnel to administer the several-times-per-week, four to eight hour treatments.

Toward the end of the 1960s, most dialysis was being administered in several small centers, such as the Northwest Kidney Center in Seattle and the renal unit at Peter Bent Brigham Hospital in Boston. The shortage of treatment facilities at the time, a general problem during the early phase of development of any new medical technology, resulted in the preferential treatment of younger ESRD patients. However, the Seattle and Boston centers adopted different tactics for dealing with the funding shortage.

At the point when more dialysis machines were becoming available but the process was still expensive because of labor costs, the Seattle group, headed by Dr. Christopher Blagg, tended to have patients keep a machine at home and dialyze themselves with the help of a trained family member. The dialysis technique used involved inserting needles into the shunt, putting dialysate fluid into the machine, monitoring flow rates, and maintaining aseptic conditions to prevent infection.

Drs. Constantine Hampers and Edward Hager of the Boston group took a different approach. They secured $1.5 million in venture capital in 1968 and founded a for-profit corporation, National Medical Care or NMC, to provide dialysis services outside the hospital setting in specialized dialysis centers. By maximizing manpower efficiency through patient scheduling techniques and buying supplies in bulk, NMC proved to be the most efficient provider of dialysis-center services in the country. NMC quickly spread to other cities by securing the cooperation of the leading kidney specialists (nephrologists) in an area to run the local NMC dialysis center. Since Hampers and Hager were themselves highly regarded in the field, they already had numerous personal contacts in the major academic medical centers across the country; and the strategy of enlisting the best local nephrologists to run their centers ensured that the local medical establishment would use their services and that the highest quality of care would be provided.

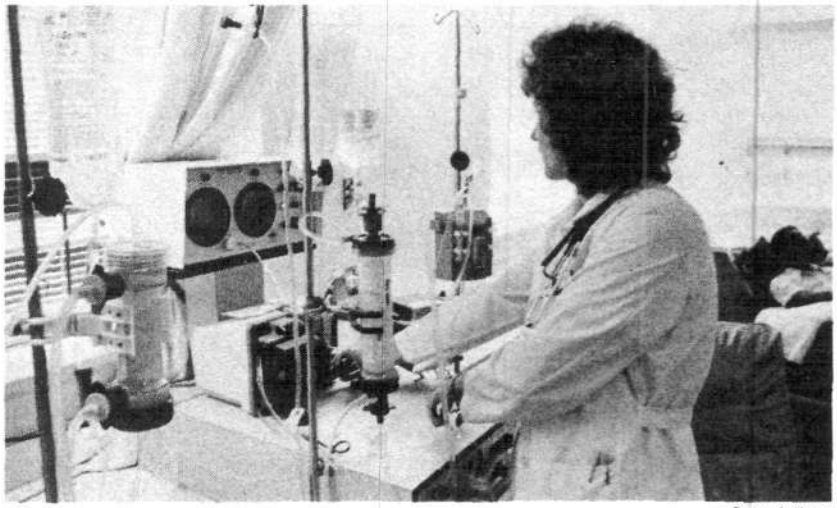
Congress Acts

By the early 1970s, dialysis was recognized as standard medical practice instead of an experimental procedure, and Congress moved to cover the expense of the treatments for all Americans in the Social Security Amendments of 1972. Although Medicare, passed in 1965, would have soon picked up the tab for those over 65, the new law covered those persons of any age afflicted with ESRD and set up a special End Stage Renal Disease program under Medicare. The legislation established a reimbursement rate ceiling of $150 per treatment (including a physician's fee) for 156 treatments per year—a ceiling of $23,400 annually per patient.

At the time of the passage of the 1972 law, PL 92-603, 5,000 patients were being maintained on dialysis, 40 percent of them at home. During the same year, the alternate form of therapy, kidney transplants—which had also been developed during the 1960s, was performed on 2,800.

After the passage of the ESRD legislation, the number of patients on dialysis increased dramatically, reaching an estimated 50,000 patients in 1980. Transplants have also increased, but not nearly as rapidly, because the number of promising transplants is limited by the availability of live donors related to the patient; transplants other than these have produced poor results at a high rate.

The current federal budget for the ESRD program is



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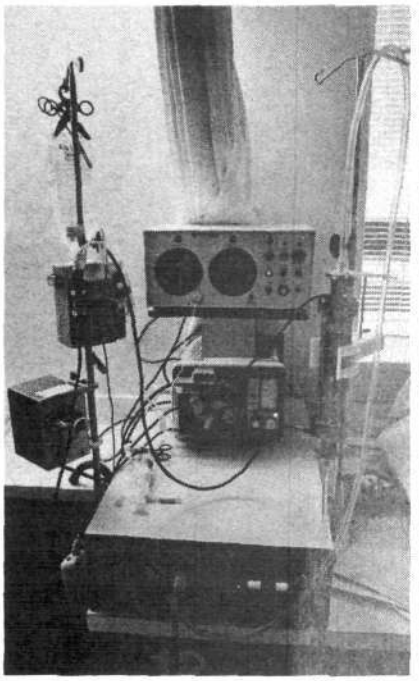


Carlos de Hoyos

The dialysis machine shown here performs the kidneys' function for end stage renal disease patients. The blood is cycled outside the body, permitting the removal of toxins, excess water, and salts. Dialysis has been perfected over a period of decades to avoid the problems of blood clotting and contamination, as well as to achieve proper filtering.

about $1.2 billion annually. The budget has increased substantially each year since 1972, when it was about one-fourth this size, prompting cries of "cost overruns" from the program's vociferous critics. Opponents of the program claim that the budget will climb as high as $6.3 billion by 1992 or, in a more cautious estimate, to $4.6 billion (Rettig 1980, Vanik 1977).

These estimates, used to rationalize cutbacks in the program, are flawed by several obvious errors. First, they are not adjusted for inflation; second, they are not adjusted for the anticipated tapering off of the yearly increase in total patients served by the ESRD program. Statisticians estimate that by the mid-1990s, the total number of patients in the program will level off to 90,000: 15,000 new patients will be added per year, but the average patient will die of other causes six years after starting dialysis, removing 15,000 patients from the program per year (many dialysis patients are elderly or have other diseases such as diabetes, which shorten life span). Therefore, the number of patients on dialysis will be roughly constant once the ESRD population stabilizes (Rettig 1980).

The computed cost of this program will be $1.8 billion in constant dollars, not much higher than the current figure (Rettig 1980). Concerning the cost per patient, the government's original reimbursement ceiling of $150 per treatment has not changed since 1972, a unique example of cost control not only in the medical area but in the entire economy.

The reason for the fourfold increase in the ESRD budget since 1972 is simply that the patient load has increased from 5,000 to 50,000—a tenfold increase, in fact. The patient load increased so rapidly during the initial phase of the program because the starting number was so small; there were only 5,000 ESRD patients living in 1972 because tens of thousands had died during the 1960s when dialysis was not available. The staff of the congressional committees that held hearings on the ESRD legislation in 1972, in fact, accurately predicted this tenfold increase, which was simply a matter of population statistics (Klar 1972).

The Role of Private Enterprise

Much of the published debate on the ESRD program centers on the role of private enterprise, in particular the role of National Medical Care (NMC), in providing dialysis. Notably, in April and May 1980, *Science*, the weekly magazine of the American Association for the Advancement of Science, published a two-part series titled "NMC Thrives Selling Dialysis," which purported to review the "politics, economics and sociology of dialysis" (Kolata 1980a,b). After briefly describing the phenomenal growth of NMC, the article painted a picture of the company's founders as self-interested money grubbers—"a nephrologist formerly associated with an NMC unit in suburban Washington, says the director of that unit, makes on the order of $400,000 a year," *Science* reported; a doctor who declined to work for NMC was quoted as saying, "I felt I would have a conflict of interest in prescribing and delivering health care"; and Dr. Christopher Blagg of the Northwest Kidney Center was held up as warning that NMC will soon have a monopoly on dialysis in the country.

These charges have little merit. The $400,000 figure actually represents the income shared by four physicians in the Washington unit; doctors usually deliver the health care they prescribe in most areas of medicine as a matter of course (should doctors be prohibited from advising patients to return for further treatment because of "conflict of interest"?); and NMC now treats only 17 percent of ESRD patients, hardly a monopoly.

Science stated further that although NMC might provide high-quality service in dialyzing patients in their centers, a "conflict of interest charge is often made by proponents of home dialysis, who say that NMC does not encourage

this form of treatment. A home dialysis debate has arisen and has become symbolic of all the critics fear and dislike about the company." Home dialysis costs "only about half as much" as dialysis in a center, *Science* continued, "in part, because the family members or friends are unpaid" for their services in assisting the dialysis treatment. Blagg's group sends home about 70 percent of their patients, whereas NMC sends home only about 15 percent, *Science* reported.

The 15 percent figure is also roughly the average for dialysis centers as a whole. Therefore, if NMC is forcing patients to accept center dialysis, as Blagg charges, then so are the vast majority of dialysis centers in the United States, most of which are nonprofit. *Science* had to admit that Blagg's support for home dialysis is "evangelical," noting that his 70 percent figure is far and away the highest in the country.

Again, what are the facts? NMC does earn a greater profit from treating patients in its centers, but the company is also the largest manufacturer of home dialysis equipment and supplies in the country; it also makes money if the patient goes home. The profit differential for center versus home dialysis is on the order of 50 percent, significant but not extraordinary.

Second, Blagg and *Science* magazine maintain that home dialysis is half as expensive as center dialysis. But according to an independent evaluation of the costs of home versus center dialysis by statisticians from the U.S. Center for Disease Control (Stange and Sumner 1978), the cost of home dialysis is $15,400 per year if the home aide is not paid, and $20,392 if the aide is paid. By comparison, NMC's charge to the government for a year of dialysis treatment is $19,188 ($133 per treatment, less $10 in taxes per treatment, times 156 treatments per year). Thus, if the home aide is paid, the costs are comparable; if free labor is used (which, in fact, represents a tax on the time and potential earnings of family members), then the cost of home dialysis is reduced to the $15,400 figure—cheaper than center dialysis, but only by about 25 percent, not 50 percent as charged by Blagg.

Third, if it is true as Blagg alleges that NMC inflates the cost of dialysis, then its charges to the government should be higher than those of other suppliers of dialysis services. In fact, the opposite is true. The government pays more to nonprofit and government dialysis centers than to for-profit centers on a per-patient basis. For example, in fiscal 1976-77, the number of centers of different types requesting exemptions from the government reimbursement ceiling were: 2 for-profit centers out of 171, 51 nonprofit centers out of 458, and 26 nonfederal government centers out of 146 (ESRD-M15 1979). The average amounts awarded were $160 to the for-profit centers, $187 to the nonprofit centers, and $186 to the government providers.

Dr. Hampers of NMC further points out that NMC regularly charges the government $25 less per treatment than nonprofit centers (NMC charges $133 less $10 returned to the government in taxes, or $123, compared with an average of $148 per treatment for the nonprofit centers). If this figure is multiplied by the approximately 1 million dialysis treatments performed by NMC during 1978, then it is clear that NMC actually saved the government $25 million that year (Hampers 1979). In fact, NMC treats 17 percent of the country's ESRD patients on only 8 percent of the federal ESRD budget (Hampers 1979).

Concerning the quality of care of home versus center dialysis treatment, Blagg testified in congressional hearings on the ESRD legislation that the percentage of his patients surviving three years or more was 58 percent (Blagg 1977). By contrast, the three-year survival rate for patients in NMC's Boston unit was 76 percent at that time, and the national average was 67 percent. The three-year survival rate in Blagg's program was 27 percent below the national average, while the Boston group's was 27 percent above the national average (Hampers 1979).

(European countries, exclusive of Britain, have a policy on home dialysis similar to the average U.S. center and also have a 67 percent three-year survival rate.)

When Blagg was asked by this author to explain the discrepancies in survival rates, he stated, "The patient mix was different. If you have more diabetics, for example, you will have a lower survival rate" (Rosinsky 1980b). Asked if he had any statistics to demonstrate that the thousands of patients he has treated differ significantly from the national average, he said he did not. Asked if he had any indication whatsoever that his patient mix differed from the national average, he said again that he did not.

Why should a person on home dialysis have less of a chance of surviving than one on center dialysis? The factors are complex and are influenced by the underlying diseases the patient may have. However, the quality of the dialysis treatment may also be a factor; for example, there is the possibility that a home dialysis patient may not dialyze himself long or frequently enough. In that case he will experience large swings in blood pressure (blood pressure rises several days after the last treatment), which may accelerate the development of arteriosclerosis, heart disease, and stroke—major causes of death in the ESRD population, as well as the general population. More research needs to be done in this area, but the survival statistics speak for themselves until more answers are forthcoming.

Why the Debate?

If NMC provides cheaper and more competent dialysis, why the attacks? The debate over center dialysis intensified in 1978, when the House of Representatives passed a bill that would have mandated that 50 percent of all new dialysis patients be treated at home. Hampers, Blagg, and many other doctors testified in Senate hearings on the bill. The result was a significant weakening of the disputed home treatment provision and merely the removal of some of the minor financial disincentives to home dialysis. NMC was generally given the major credit for toning down the House bill.

In the course of this testimony, the issues of private enterprise, home dialysis, cost overruns, and conflict of interest were raised again and again. These issues were also debated in the pages of medical journals, and in one of these journal debates, Hampers and Blagg wrote consecutive guest editorials. Hampers discussed the cost data, the home-versus-center data, and the fallacy of the conflict-of-interest charge (Hampers 1979). Blagg replied sim-

ply by asking, "cui bono?" (who benefits?) and did not directly address the issues (Blagg 1979).

Who in fact benefits—from Blagg's attacks? Hampers pointed out in his guest editorial that conflict of interest can take many forms besides desired monetary gain: ". . . influence-seeking and rank-conscious individuals or committees of a number of sacrosanct academic and nonprofit institutions . . . one professor's ego or another's blind 'pride of authorship' in one form of medical care (such as the evangelistic support of home dialysis by the Seattle group) may result in a far more serious conflict of interest than another man's pocketbook."

If only egos were involved that would be bad enough. But the matter goes further. Blagg, who is a British national, was asked by this author to comment on the British practice of treating only 25 percent of ESRD patients and letting the rest die. He replied: "They go too far, but we must have limits after all. We cannot go on providing services to anyone who asks for them."

This is the crux of the matter. Blagg would put a limit on the kinds of persons allowed to benefit from medical technology. NMC, on the other hand, is a high-technology company providing high-quality service in the tradition of the American system, a tradition that holds progress and scientific development as capable of solving virtually any problem. An integral part of that tradition is society's moral commitment to provide for citizens who have worked a full life and are facing retirement and old age.

If the country is on the path of scientific and technological development, the economy can easily support whatever services the elderly may require. It is only in a depression economy that the debate over dialysis would occur at all.

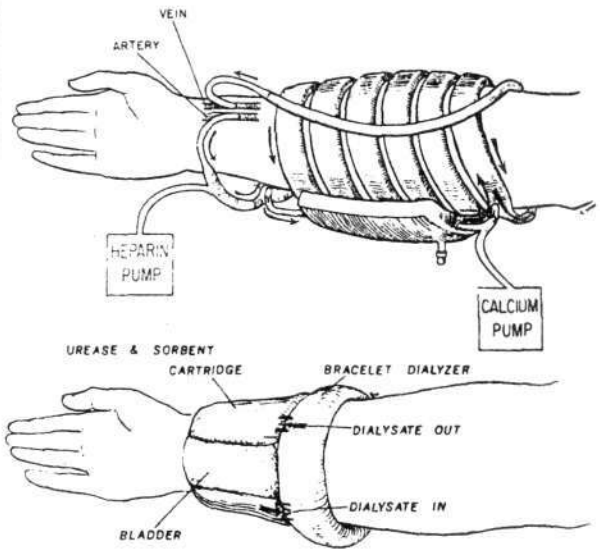
The *Science* magazine series made this point clear. *Science* recalled that in 1972 former Senator Vance Hartke, the sponsor of the ESRD legislation, stated that most of the renal patients then facing death would be able to return to work and lead productive jobs if dialysis were generally available. But now we have a patient load of predominantly elderly people who cannot be "rehabilitated" to go back to work, *Science* lamented. "In other countries, England in particular, doctors do not refer such patients [the terminally ill or incompetent] for dialysis. But in this country, where Congress intended that dialysis be available to all those who need it, it has become legally and morally difficult to refuse patients."

It is worth noting that one-third of nursing home residents in the United States have been declared incompetent, approximately 430,000 persons. The average cost of a nursing home bed is $18,000 per year, approximately the same as the cost of dialysis. The argument that elderly incompetent people should be denied dialysis because of

"If the country is on the path of scientific and technological development, the economy can easily support whatever services the elderly may require. It is only in a depression economy that the debate over dialysis would occur at all."

The Department of Health and Human Services is threatening to lower reimbursement rates of for-profit centers like the modern facility shown here.

Carlos de Hoyos



One of the new developments in dialysis technology is miniaturization. The Houston Medical Center has devised a filtration unit that can be worn on the wrist, for minimal interruption of the patient's normal mobility. Dialysis is continuous like normal kidney functioning.

the high cost could logically be extended to a denial of nursing home care, since the costs are comparable—and indeed, some right-to-die advocates would agree with this.

In a related argument, Blagg noted in his testimony that the ESRD program consumes 5 percent of Medicare funds, but the ESRD population comprises only 0.2 percent of the Medicare population; therefore, ESRD patients are getting more than their fair share of the funds. However, this logic violates the basic notion of insurance, since the point of shared risk is to cover the minority of people who are catastrophically affected. This is gladly agreed to by the majority of persons in shared risk relationships, because no one can predict whether he or she will be one of the unfortunate ones in great need. By Blagg's reasoning, the small minority of auto collision policy-holders who are involved in expensive accidents are taking advantage of the majority who do not have accidents and should therefore be denied payments.

Future of the Science

At present we have only halfway measures to treat ESRD, and they are cumbersome and time-consuming. But this is not unusual in the early phase of development of a field of medical science. Tuberculosis, for example, was treated by collapsing the lung surgically followed by a long hospital stay, prior to the discovery of antibiotics specific to the disease. In the case of polio, immunization has now virtually wiped out the disease in the United States, but in the 1950s, a great deal of money went into iron lungs to keep alive children struck by the infection, particularly during the acute phase. Should these provisional treatments have been forbidden because they were too costly? In the case of dialysis, the decades of experience with large machine dialysis are now being used to miniaturize the apparatus, a development that will ultimately cheapen the cost of the treatment.

Looking to the future, of prime importance is a better understanding of the pathological changes involved in the various forms of ESRD. Many researchers believe that the majority of cases of ESRD result from the abnormal creation of antigen-antibody complexes: attachment of molecules of the immune system (antibodies) to their molecular "targets" (antigens) and the subsequent deposition of these complexes within the tissues of the kidney. In some cases, the body's immune system apparently comes to regard certain components of the kidney tissue as foreign and forms immune complexes with these components. The result is damage to the kidney functioning.

In order to understand how and why these antibody-antigen complexes are formed, it is necessary to have a general understanding of how the immune system functions as a whole, and this question is still largely unanswered. The ESRD question thus leads back to some very basic questions in biology.

As for the further development of dialysis technology, miniaturization has already produced a dialysis unit that can be carried in a suitcase, and the surgery department at Houston Medical Center has devised a filtration unit that can be worn on the wrist, allowing continual dialysis with minimal physical constraint. Neither device is generally available to the public, mainly because of the absence of funding for large-scale development. Once developed, however, these refinements would greatly cut the cost of dialysis.

The question is whether the United States will reverse the shortsighted, cost-accounting mentality that keeps these lines of research underfunded or whether the nation will go the way of Britain, limiting access to the benefits of medical technology.

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OMB Discount Rate

Continued from page 23

counting methodology is riddled with elementary fallacies. It completely ignores the spinoffs on productivity of high-technology energy R&D investment for all of industry, and their deflationary effects. Conversely, in calculating its discount rate, the OMB projects a more or less constant rate of inflation forward into the future. However, the effect of not funding the development of advanced nuclear technologies and fusion will be an increasing scarcity of energy resources and runaway energy prices.

—William Engdahl

Stockman Lowers The Boom on U.S. Agriculture

The proposed cuts in the Department of Agriculture's budget, totaling $1.7 billion in fiscal year 1981 and $7.6 billion in fiscal 1982, follow the same pattern imposed by Office of Management and Budget Director Stockman in other critical areas of the federal budget: short-term savings at the expense of giving up long-term benefits. Moreover, the revised budget for fiscal 1982, which amounts to $47.1 billion, will entail serious long-term economic damage.

The planned cuts in the rural development budget exemplify this wrongheaded approach. The bulk of the cuts involve raising the cost of borrowing under the Farmers Home Administration (FmHA) and Rural Electric Administration (REA) to "market levels" and constricting access to these programs. FmHA farm ownership lending will be reduced by half, and emergency lending by 25 percent. Rates will be raised and Federal Financing Board guarantees eliminated for REA loans. The intention is to reduce FmHA outlays by more than $1 billion in fiscal 1981 and nearly $3 billion in fiscal 1982, and to reduce lending by more than $500 million over the next two years.

In the short and long term, both of these government programs have acted to promote viable rural economies. Recently, it has been the FmHA programs that have prevented the wholesale bankruptcy of American agriculture by shielding the farm sector from the worst effects of Federal Reserve interest rate policy.

Food and Nutrition Cuts

The second area slated for major cutbacks is domestic food and nutrition programs, with cuts totaling $3.7 billion proposed in the food stamp, school lunch, and smaller programs in fiscal 1982. These cuts are another reflection of the OMB's incompetence in basic economics.

It is widely recognized that participation in and dollar outlays for these programs did not explode until the last five years, as tight credit policies and unemployment threw more Americans out of work. The growth of these programs is a symptom of the economic crisis, not the cause, and cutting them back will not solve inflation or other chronic problems.

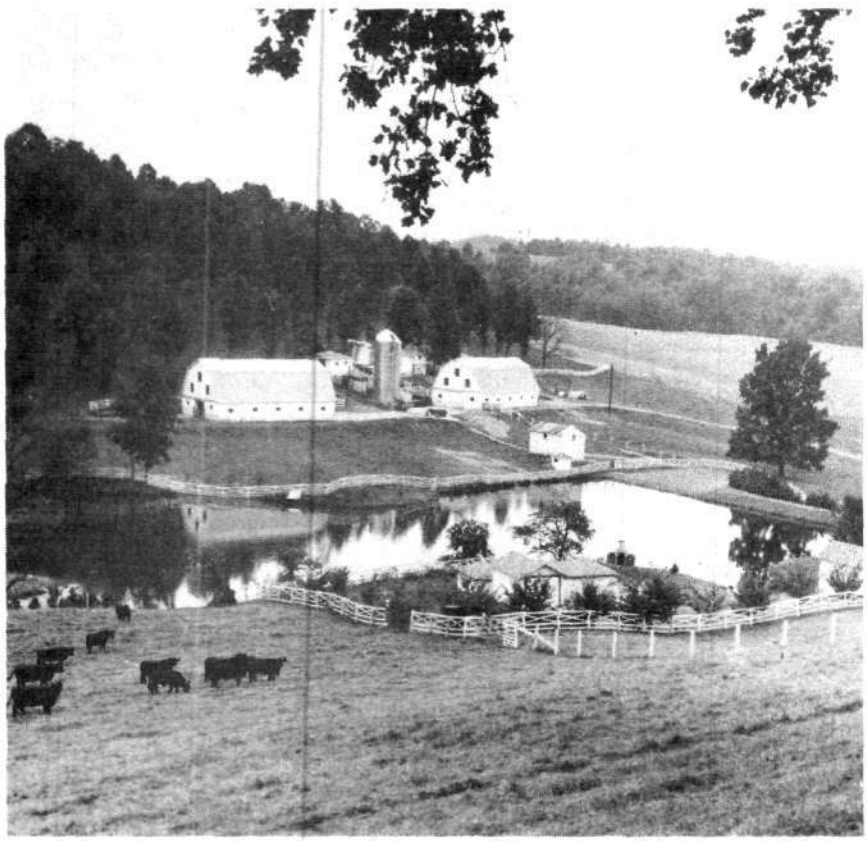
Smaller, though qualitatively significant cuts, are being proposed in the USDA's conservation, watershed planning, construction, and forestry programs.

Planned reductions in the PL-480 program for food aid and market development will make the new administration's commitment to the expansion of farm exports difficult to fulfill.

Cuts in other areas of the budget will also hit agriculture, such as the $10 million cut in the joint NASA-USDA AgRISTARS satellite sensing project, and cuts and the imposition of user fees in water resource development and transportation.

The sole increase in the USDA budget—a $14 million rise in research funding in fiscal 1982—will merely allow this long underfunded area to keep pace with inflation.

—Susan Cohen



USDA

An owner-operator farm in Taylor County, W.Va. More than 100,000 such farms went out of business in 1980—but it would have been worse without the cushion of the government's FmHA and REA loan programs.

Budget Cutters Aim at Cutting U.S. Population

A Fusion Energy Foundation policy statement in the June issue of Fusion *warned that the proposed cuts in the federal science budget would de facto bring about the scenario predicted in the* Global 2000 Report: *the collapse of life-supporting ecological systems and massive depopulation.*

Further evidence indicates that the actual aim of the threatened budget cuts is to enforce the policy of global population control recommended by Global 2000, *a report on population and the environment commissioned by President Carter and coordinated by the State Department and the Council on Environmental Quality. Articles on* Global 2000 *appeared in the May and June issues of* Fusion.

* * *

The most outspoken proponents of economic austerity in the administration—including Office of Management and Budget Director David Stockman, Vice President George H. Bush, and William Draper III, President Reagan's nominee to head the U.S. Export-Import Bank—have been leading supporters of U.S. and global population stabilization for more than a decade.

Stockman and Bush, in fact, worked closely with a group called the Population Crisis Committee (PCC) in introducing the theory of population control in the United States and attempting to make it palatable to a population accustomed to continuous scientific progress and its concomitant—population growth. The PCC was launched in 1965 as an offshoot of the Draper Fund (formerly the Victor Bostrom Fund) by the late General William Draper, Jr. Draper was the father of the new Eximbank head.

Stockman's Record

OMB Director Stockman's remark on CBS-TV's "Face the Nation" program March 22 that tax-paying Americans have no right to expect services from the government should be seen in the context of his record of opposition to federal spending that supports population expansion.

As a freshman congressman from Michigan, Stockman was one of the leaders of the House Select Committee on Population—a fact that he has had deleted from his recent biographies in *Who's Who* and other biographical sources. This committee was formed in 1977 at the instigation of the PCC/Draper Fund and Vietnam War General Maxwell Taylor with the mandate to "investigate world population growth and the U.S. role in meeting this challenge, as well as assess population trends in the U.S. and the need for additional policies" to stabilize population growth here and internationally.

In a reversal of 200 years of U.S. legislative history, the committee's starting premise was that technological development and economic growth had reached their limits and that U.S. population growth had to be halted accordingly.

Stockman was cochairman of the committee's taskforce on the Domestic Consequences of U.S. Population Change, which made long-range proposals for reshaping U.S. budget policy to encourage a slowdown in population growth.

The attempted cancellation of critical water projects in the western states by former President Carter, which galvanized Congress against him in 1978, was lifted directly from Stockman's study for the Select Committee, according to a former aide. The final report that Stockman's taskforce issued in March 1979 concluded that the construction of water and other infrastructural projects "creates much more population than was originally in the area, and leads to dislocations and internal migrations."

As OMB director, Stockman has proposed cutting back federal water project funding by 20 percent.

Stockman's taskforce also warned of budgetary problems arising from the shift in the age-distribution of the U.S. population in the direction of a growing proportion of elderly retired people; it recommended that Social Security benefits be reduced and the retirement age raised.

Gen. Draper on 'Culling' Human Surplus

Writing in the spring 1971 newsletter of the Victor Bostrom Fund (the predecessor of Population Crisis Committee/Draper Fund), General William Draper, Jr. likened the developing nations to the "world famous animal reserve—the Kruger Park in South Africa."

"There the elephants were getting too numerous, pushing over and killing too many trees, and thereby threatening the food supply of other animals. . . . So the park rangers will act as judge and jury. They will arbitrarily reduce one or another species as necessary to preserve the balanced environment for all other animals.

"But who will be **Park** Ranger for the **Human Race?**

"Who will cull out the surplus in this country or that country when the pressure of too many people and too few resources increases beyond endurance?

"Will the death-dealing Horsemen of the Apocalypse—war in its modern nuclear dress, hunger haunting half the human race, and disease—will the gaunt and forbidding Horsemen become Park Rangers for that two-legged animal called **Man?"**

As OMB director, Stockman has proposed the taxation of Social Security payments, lowering total payments to senior citizens by more than $11 billion in the next budget.

Bush's Record

Vice President Bush has an even longer record than Stockman in the field of population control. Bush's father, Senator Prescott Bush of Connecticut, was a close personal friend of the PCC's General Draper. As ambassador to China in 1974-75, George Bush and his wife Barbara helped the Peking regime work on its population control program—a program that had been drafted with input from the PCC/Draper Fund and International Planned Parenthood.

The 1979 annual report issued by the Draper Fund termed Bush one of the "most conspicuous activists, proposing all of the major or controversial recommendations" on population in the U.S. Congress in the 1960s. Bush's work culminated in his sponsorship in 1970 of the Family Planning Services and Population Research Act, which authorized $382 million for the establishment of a "comprehensive family planning program for the U.S."

U.S. foreign economic policy is now also being guided by the aim of enforcing population stabilization. According to Sharon Camp of the PCC/Draper Fund, under William Draper III the U.S. Eximbank will halt the financing of heavy industrial goods exports to the developing sector—"because industrialization means a buildup of population"—in favor of raw materials extraction projects.

William Draper III, a California investment banker, has served as a leader of the Population Crisis Committee founded by his father. In a recent report prepared for the PCC titled "World Population Growth and U.S. Security Interests," Draper and General Maxwell Taylor argue that the greatest strategic threat to the United States stems from uncontrolled population growth and resulting political instability in the Third World nations that are the source of strategic materials.

This linkage of population and strategic materials is critical.

Because the environmentalist movement has been discredited over the last four years, the current strategy of the Malthusians is to recast zero population growth as a national strategic issue.

Pennsylvanians Say 'Yes' To TMI 1

Pennsylvania labor and business groups responded to the March 28 antinuclear demonstration in Harrisburg, Pa. by coming out publicly in favor of reopening the undamaged Unit 1 reactor at Three Mile Island.

On the day of the demonstration, which drew only 5,000 out of a predicted 20,000 protesters, state Building and Construction Trades Council president Tom Miller issued a statement calling for the reopening of TMI's Unit 1 reactor. Miller cited estimates that the loss of power from the plant is costing state ratepayers an additional $14 million a month in electricity costs.

Other state union officials also echoed the evaluation of the AFL-CIO's national Building and Construction Trades chief, Robert Georgine, that the antinuclear rally did not have the backing of organized labor. The day before the demonstration, the national union placed full-page advertisements in the Harrisburg papers with the banner headline: "Anti-TMI Demo Does Not Represent Organized Labor."

"Three Mile Island proves that nuclear is safer than ever," one of the ads stated. "Despite headlines, the nuclear industry can take pride in a flawless safety record. The American public has nothing to fear from TMI or nuclear power. It has everything to fear from those who would shut down the nuclear industry and cause us to lose thousands of jobs."

The organizers of the antinuclear rally had claimed the backing of 10 major unions, including the International Association of Machinists, the United Auto Workers, and the United Mine Workers. Although IAM presi-

Continued on page 61

Yippie Leader: 'We Have to Stop Science'

"We have got to stop science, and scientific progress. This is not what America needs," Abbie Hoffman, the Youth International Party (Yippie) leader, told a Washington, D.C. conference on water policy March 21 sponsored by the Environmental Policy Center. The Policy Center is now leading the fight to get Congress to halt the half-completed Tennessee-Tombigbee waterway project.

At the conference, Hoffman described his own campaign against the St. Lawrence Seaway and the efforts of the Army Corps of Engineers to open up the St. Lawrence for year-round navigation. "We made winter navigation synonymous with the devil," Hoffman said. "The Army Corps of Engineers started saying they were against winter navigation, but for seasonal extension. . . . This is a war. The Army Corps of Engineers sits on the other side of the trenches as far as I'm concerned. . . . They are the enemy. . . . They have an engineering mentality."

"I learned a lot from [Saul] Alinsky," he said, referring to the community organizer who trained Cesar Chavez and the leaders of Chicago's street gangs. "We think a beautiful river is progress. We think we can do light industry with alternative energy," Hoffman said. "Complicated facts and issues—ignore them," Hoffman advised. "Facts separate people. The enemy has facts and science. You can't fall into their trap by using the same language. It's not what moves people to action. An expert is someone from out of town."

China's Birth Control Edicts Lead to Infanticide

Nan Fang Ribao, the leading newspaper of southern China, reported in March that "during 1980 in Jieyang [a small town in Canton's Guagndong province] eight female infants were found dead, abandoned in front of the local party headquarters. . . . Most had been suffocated."

Female infanticide has appeared before in China in earlier periods of grave social and economic crisis—most recently in the 1958-60 famine during the "Great Leap Forward." Today, China's runaway inflation, its political instability, and the recent cutbacks ordered by Peking in flood control and irrigation projects are signs of another dynastic breakdown in the eyes of China's peasant masses.

The additional factor in the reappearance of infanticide is a new government rule limiting couples to one child only, as a means of achieving zero population growth in China.

If a couple persists in having a second child, "one of the parents is forced to buy all grain rations at twice the regulation prices for the next seven years," a Western diplomat told Reuters news service in March. The third child does not get the identity card that entitles him to food rations.

Under this coercion, China's most populous province, Sichuan, cut its annual net population growth from 0.67 percent in 1979 to 0.45 percent in 1980. The population growth rate for the entire country is now about 1 percent per annum, and the goal is zero population growth by the year 2000.

Should a couple's first child be a girl, many parents fear that they will be left without an heir or source of support in their declining years. Thus, in certain areas some parents have begun murdering their first-born female offspring.

Chinese officials pontificate that the dictum of "equality of the sexes" advises against the murder of female infants; however, they maintain that the one-child-only edict must be preserved.

As early as 1971, it should be noted, the Draper Fund's Population Crisis Committee endorsed Mao Zedong's goal of replacement-only population growth for importation to the United States.

James Andanson/Sygma

The new government ruling in China that limits couples to one child only is being praised by groups like the Draper Fund/Population Crisis Committee as a model for the advanced sector. Here, Chinese youngsters pose with skateboards in Peking. Will they have any brothers or sisters?

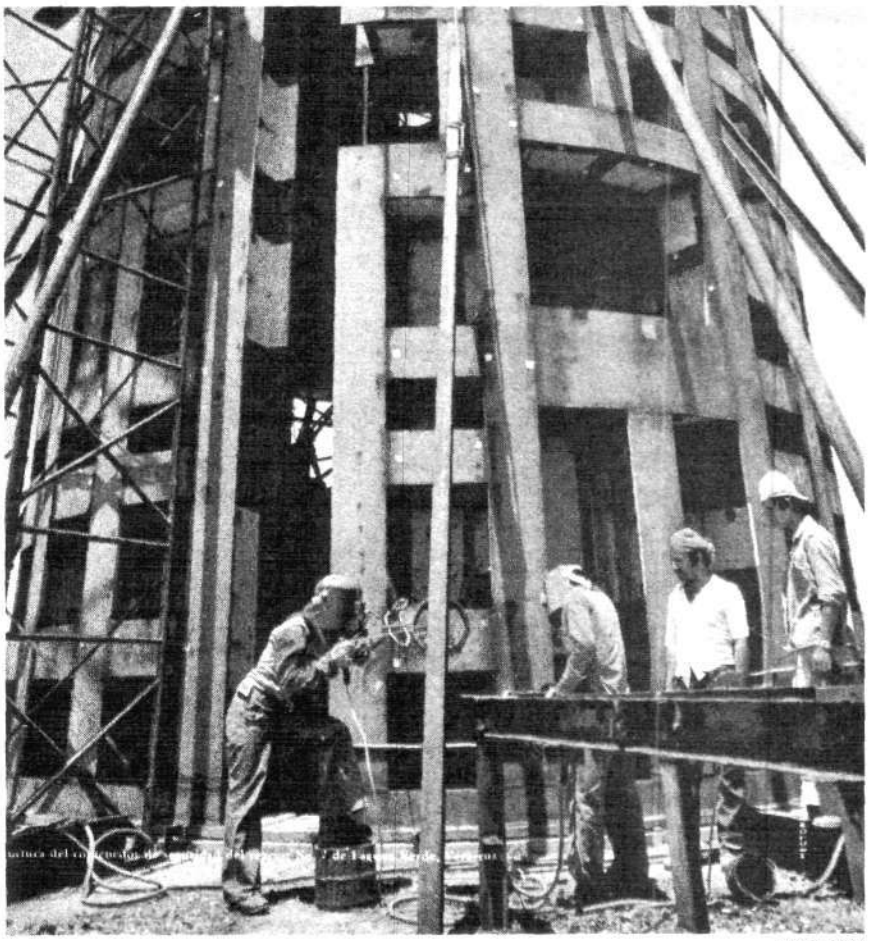
Mexico Debates Nuclear Energy

Jorge Díaz Serrano, the director of Mexico's state oil company (Pemex), visited the country's nuclear research center at Salazar for the first time March 23 and announced there that Mexico will combine scientific and technological expertise in the oil and nuclear fields "to prepare the country in its transit from the era of hydrocarbons to the nuclear era."

The same idea had appeared the day before in an editorial in the Mexican daily *Novedades*, which declared, "In order to move on to the technology that nuclear energy permits us to use, we must carry out a great national effort to prepare technicians and professionals in this area."

Earlier in the month, in a speech March 9 before an international economics symposium at the Monterrey Institute of Technology, economist Lyndon H. LaRouche, Jr., who was recently elected to the Fusion Energy Foundation board of directors, stressed the importance of nuclear energy for the successful industrialization of Mexico over the coming two decades. LaRouche's remarks were carried prominently in newspapers throughout Mexico.

As Mexico's national energy plan now stands, the country will have 20 nuclear plants by the year 2000. Its first commercial reactors—the twin 650-megawatt plants at Laguna Verde



Hector García

The containment vessel of the No. 2 reactor under construction at Laguna Verde, Veracruz.

on the Veracruz coast—are due to come on line by 1983.

As in other countries that have gone nuclear, however, just as Mexico's nuclear program is getting off the ground, an environmentalist movement has popped up to oppose nuclear construction plans. Mexico's greenies suddenly gained national attention in March with a series of advertisements in the press demanding a halt in the construction of a nuclear research center at Lake Pátzcuaro in Michoácan. The greenies claim that the nuclear facility will endanger the lake's rare white fish, and they are attempting to organize the Indians who live in the area to block the facility.

Among the supporters of these native environmentalists are the Friends of the Earth, Mexico's newly formed branch of the international Social Democracy, and the United Nations Environmental Program based in Mexico City—the same supranational bodies that control the antinuclear movement elsewhere.

The prime target is Mexico's nuclear workers union—the SUTIN. In an article in the leftist paper *Uno Mas Uno* in early March, environmentalist leader Mauricio Schoijet tried to "prove how industrial unions in the advanced countries are irreversibly turning against nuclear power." The next day a spokesman for the SUTIN answered in the same paper that "Schoijet's ecstasy of antinuclear delirium . . . is a really romantic idea. But we are 4.5 billion people living on this planet. . . . Preindustrial society (feudal, primitive, patriarchal, or what?) may seem attractive to some people, but it won't provide for the population!"

On March 24 the SUTIN took out an advertisement in the Mexico City press charging that the groups opposing the Patzcuaro nuclear research center "not only misinform, but lie and create alarm. In their extreme thesis—the 'return to nature'—they propose to stop technological and industrial development, and the right of the nation to access and to master the most advanced technologies, progress."

—Elsa Ennis

French Socialists Cautious on Nuclear Program

François Mitterrand, the French Socialist Party leader, was understandably cautious about sounding too antinuclear in his presidential campaign speeches this past spring; the French population by and large is strongly pronuclear and hundreds of thousands of jobs are tied up with nuclear plant construction. Mitterrand's Socialists officially support the completion of the 40 or so nuclear facilities in various stages of construction in France, though they favor a moratorium on all new nuclear plant starts. The CFDT, the Socialist Party-linked trade union confederation, on the other hand, is calling for an immediate halt on construction on all nuclear plants.

The debate over the future of France's nuclear program comes at a time when the program has reached a new benchmark in its progress. As of January 1981, nuclear-generated electricity reached a record 34 percent of total electricity production in the country, according to Electricité de France, the large state-owned utility. The percentage of nuclear-produced electricity is up from 23.5 percent in 1980 and 13 percent in 1978. The cost of nuclear electricity in 1980 was down to 10.5 centimes (about 0.2 cents) per kilowatt-hour, compared with three times that for oil and 19.3 centimes per kilowatt-hour for coal.

Evolution: In Search of Causality

The most surprising thing about the new debate over evolution is that the Creationists, the Darwinians, and their scientific opponents are actually in agreement about the fundamental basis of the theory of evolution—the idea that biological history is determined by the second law of thermodynamics and its statement of the necessity of eventual decay.

The much-publicized case in California, where Creationists challenged the Darwinian view of evolution, and the equally well-publicized Chicago conference on macroevolution, where the new anti-Darwinian scientific community challenged the accepted dogma of Darwinian natural selection, are both examples of an agreement on fundamental principles. In both cases, the supposed adversaries are arguing over relatively trivial parts of biological theory. The important question of what guides evolution—change and resultant decay or a global, directed, qualitative set of increasingly complex laws—is never asked by any of the contestants.

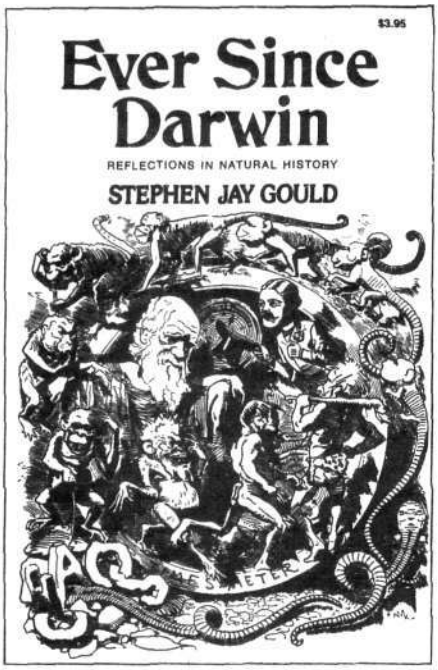
The Creationists, although claiming to challenge the atheistic theories of Darwin's theory of the descent of man from animals, have concocted one of the most pagan views of the world and its creation imaginable.

Dr. Henry Morris, a leading spokesman for the Creationists, has stated that "the descent from order to disorder eliminates the possibility of a basic law of increasing organization which develops existing systems into higher systems." This restatement of a bowdlerized version of the second law of thermodynamics portrays a universe created by a God who was then incapable of continuing the process of creation as perfection.

The idea of continued creation as perfection has been the crux of Christian theology since the time of St. Augustine and his teachers. To claim the mantle of Christianity for a doctrine that so manifestly denies the possibility of productive intervention into the world is paganism of the worst sort.

The ultimate logic of the Creationist belief system is neatly demonstrated by the Creationist movement's widespread endorsement of *Entropy: The New World View*, a recent book by Jeremy Rifkin. Rifkin, a board member of the Institute for Policy Studies and a leading participant in the prototerrorist People's Bicentennial movement in 1976, draws the only possible conclusion that can follow from the application of the second law of thermodynamics to biology: There are too many people alive today; some must die, and the rest must return to a New Dark Ages of rural existence.

Perhaps the most surprising aspect of the Darwin debate is the role of Stephen Jay Gould, the well-known Harvard University paleontologist: Gould has been the most vocal of the paleontologists who have documented extensive evidence for what is called punctuated equilibrium evolution. In this view, there are long periods of virtually no change in speciation followed by changes that appear "overnight," in terms of the vast time scale of the fossil record.



The cover to Ever Since Darwin, *one of Stephen Jay Gould's popular books on evolution, shows man evolving in stages out of chaos. Chaos evolves into the evil serpent, which gradually turns into monkeys, which, in turn, evolve into the devil, which further changes to become primitive man. Finally, primitive man becomes civilized man, represented by Darwin sitting in a Godlike throne.*

Gould's Punctuation

Gould takes such "punctuation" one step further, however, stating that such quick changes occur through chance catastrophes.

"Randomness may not act only in generating variation; it may be an important agent of evolutionary change as well. The specter of chance is now truly intruding where Darwin's critics had falsely detected it before. . . . Randomness is challenging the determinism of natural selection as a cause of change at all three levels," Gould wrote in the *New Scientist* Feb. 5, 1981.

The modern version of Darwinian theory, called the Modern Synthesis, is already problematic as a scientific hypothesis, even without Gould's additional burden of three-level randomness.

In brief, the neo-Darwinian view states that scarcity of available resources enables only what is called the most fit to survive and procreate. Random point mutation at the gene level creates genetic variation within a species population, and gradual shifts in the frequency of various genes in the population allow select individuals to survive most fitfully in new environmental circumstances and produce a new group of individuals that are reproductively isolated. This is called speciation.

The accumulated ecological evidence not only indicates that new species do *not* fight over a limited supply of environmental niches (comfortable circumstances), but also indicates the direction research should take in order to define causality.

New, rapidly evolving species actively modify and create the environmental niches they occupy; they use their transformed physiology to actively change nature. Survival-of-the-fittest battles over scarce resources,

therefore, emerge only in the special case of population pressure generated by failure of a species to continue evolving in a way that collectively opens up further environmental opportunities.

The study of the causality behind evolution must begin to examine the interaction of rapidly evolving species and the global boundary conditions imposed by the larger global changes in the biosphere. Recent evolutionary debates have shifted the focus away from such studies, which would have to take into consideration global climatological and geological biospheric changes.

This shift in the evolution debate is not generated simply by scientific inquiry; it is a political shift by the neo-Malthusian ideologues promoting zero growth and depopulation. Such forces have a heavy vested interest in maintaining the Malthusian premises of the Darwinian Modern Synthesis against any kind of experimental evidence.

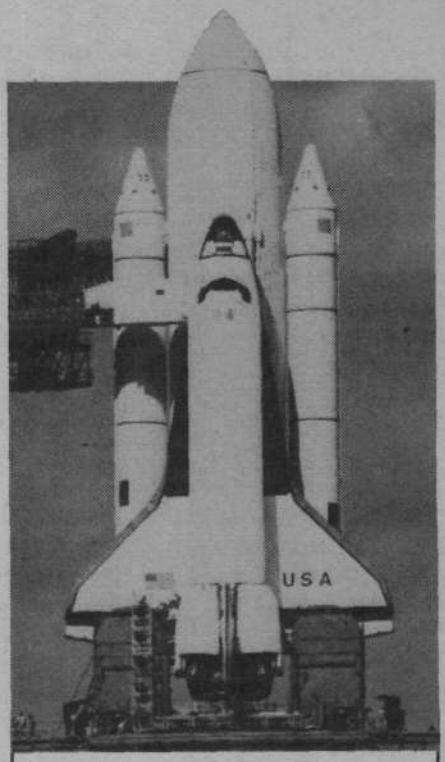
The Malthusian Link

This link between Darwin and Malthus is a historical one: Sir Charles Darwin's mechanism for evolution was funded and directed by the same groupings in the British East India Company and British Admiralty who had earlier funded Parson Malthus's work. These circles founded Statistical Societies all over England for the purpose of working out a more exact mathematical and political scheme for controlling population growth.

At the same time, Darwin's cousin, Sir Francis Galton, took the Malthusian precepts of Darwinian evolution even one step further to found eugenics, the pseudoscientific racist rationalization for separating out "fit" from "unfit" human beings.

"Race improvement or Eugenics," wrote Galton, ". . . ought to be exerted to prevent the free propagation of the stock of those who are seriously afflicted by lunacy, feeble-mindedness, habitual criminality, and pauperism. I cannot doubt that our democracy will ultimately refuse consent to that liberty of propagating children which is now allowed to the undesirable classes."

—Carol Cleary



Jupiter, Saturn, Earth in Triple Conjunction July 24

Over recent months, the night sky has provided quite a spectacle—a lineup of the planets that are now being visited by the Voyager spacecraft. Looking up in the region of the Constellation Virgo, two giant planets, Jupiter and Saturn, can be seen very close to each other.

On three separate occasions, Dec. 31, 1980, March 4, 1981, and July 24, 1981, the two planets appear to make a close approach to each other, as seen from the Earth. This event, a triple conjunction, is a rare occurrence and will not be seen again until sometime in the 23rd century.

To add to the spectacle, on Aug. 30 this year, Venus will line up with Saturn and Jupiter, bringing this period of celestial display to a fitting close.

It is because Jupiter and Saturn, as well as the less visible (from Earth) Uranus and Neptune, are in the same general area of the sky that the current Grand Tour of the planets by the Voyager spacecrafts can take place. This Grand Tour program was cut back in the 1970s from its original plan that would have launched four spacecraft to explore all the planets from Jupiter to Neptune. The result is that a rare opportunity for efficient planetary exploration has been largely lost for the immediate generations, since the planets will not line up this way again for well over a century.

At first it may seem strange that Jupiter and Saturn appear to dance back and forth close to each other in the space of a few months. The reason is that the Earth is not the ideal platform from which to observe planetary motions. Not only does it rotate on its axis once every 24 hours, but it is orbiting the Sun at about 18.5 miles per second.

The other planets revolve about the Sun in much the same way the Earth does, except that the length of the year on each of them is different from the Earth year. As a result, when viewed from the Earth, Jupiter, for instance, will appear to move forward through the background of stars. Then its progress will seem to slow. It will seem to move backward for a while and, finally, it will go forward again. This motion, called *retrograde motion*, is the result of the Earth's motion in relation to Jupiter and does not represent any actual vagaries in Jupiter's progress around the Sun.

It is easy to build a model of the solar system to help visualize the retrograde motion. You can construct a good approximation of the triple conjunction using a model that includes the Sun as a pivot point, the Earth, Jupiter, and Saturn.

These planets can simply be lengths of wire or cardboard indicating successive distances from the Sun in proportion to the planets' actual distance. (See accompanying table.) You move the planets in their orbits by distances proportional to their years. After each motion, sight along the line between Earth and each of the planets. Mark on some sort of fixed background the succession of sightings.

You will be able to re-create a triple conjunction if you start out with Jupiter and Saturn near each other and nearly on the opposite side of the Sun from the Earth.

—Dr. John Schoonover

Planet	Distance from Sun (million miles)	Length of year (days)
Earth	92.9	365.26
Jupiter	483.4	4,332.59
Saturn	886.1	10,759.20

New Vacuum Process Upgrades Foundry Methods

A new technique for making specialized casting molds known as the V-Process because it uses a vacuum to set the mold represents a major advance in iron and steel foundry practices. The process, which was invented and developed by the Herman-Sinto V-Process Company, a firm jointly owned by Americans and Japanese, has been introduced in the United States over the past three years in several foundries, and it is expected eventually to replace the current no-bake chemical bond method of producing molds.

Adirondack Steel Casting Co., Inc. of Watervliet, N.Y., one of the U.S. foundries using the new technique, reports that the process has resulted in major savings. It also is much cleaner and easier to work with and produces a far superior mold surface than the old technique.

Traditionally, molds for making specialized items like power plant valve casings, automobile engine blocks, locomotive frames, and tank turrets have been produced by first making a model in wood or epoxy of the inside and outside surfaces of the item to be cast. These models, in turn, are used to make an image of the surfaces in a mold made of fine sand.

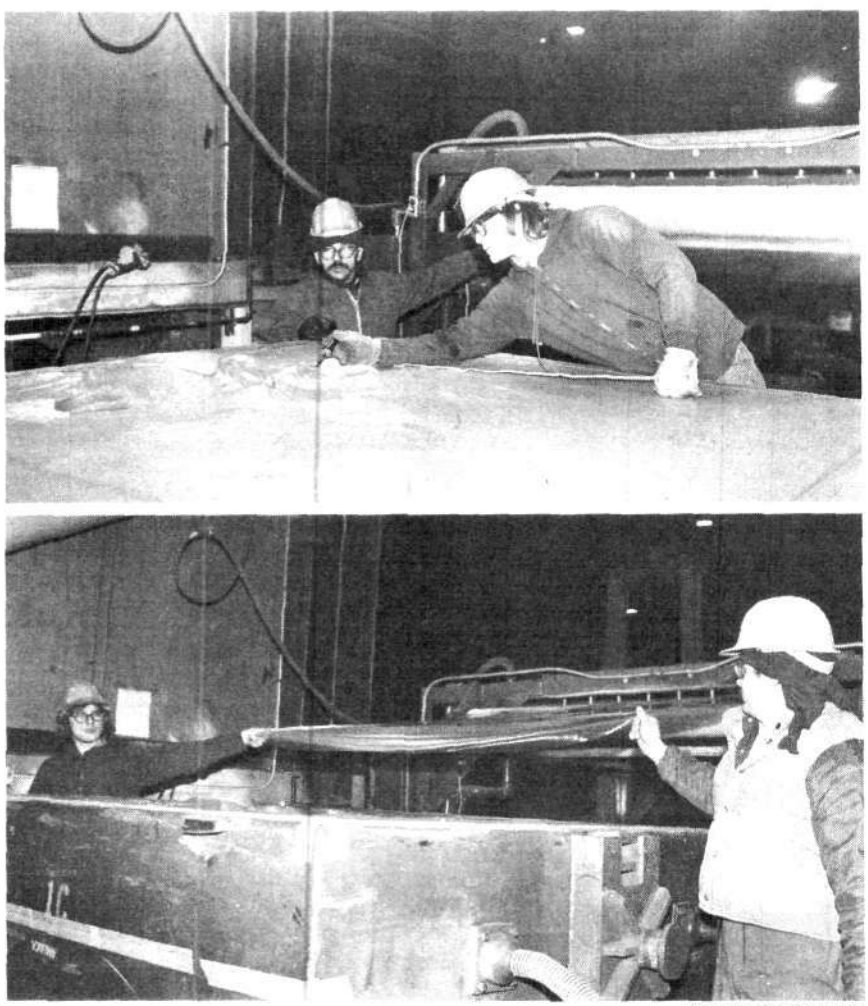
Under current methods, the sand is mixed with a chemical binder, vibrated, and packed around the model. When the sand and chemicals set, the model is removed, leaving the outside of the mold. The inside or core of the mold is formed in the same way, except the sand is placed inside the model and removed when set. The core and outside molds are then sealed together.

The new V-Process uses no chemical binders but instead holds the sand in the proper shape by pulling a vacuum on it. A thin plastic sheet, which has been heated to make it pliable, is fitted over the wood or epoxy model. A rectangular form, or flask, is then placed around the plastic-coated model. A second sheet of plastic is spread over the top of the flask, and a vacuum is pulled on the sand and plastic sheets, drawing the air out of the sand and forming a rock-hard mold sealed with plastic.

One of the advantages of this method is that the plastic makes the casting surface much smoother. After the hot metal is poured into the mold to make the casting, the mold can be easily disassembled by simply releasing the vacuum and collapsing the sand into a loose pile, ready for reuse.

The fact that the sand has no chemical binders added to it and can be reused results in significant cost savings in the production process. Adirondack Steel Casting Co. plans to expand its current pilot project into a permanent facility over the next three years, completely replacing its chemical binding operations and realizing projected savings of $500,000 per annum.

Editor's note: Fusion *encourages readers to submit items on new technologies and products of general interest for this column. Submissions should be addressed to Jon Gilbertson at the FEF office in New York.*



Adirondack Steel Casting Co.

The V-process casting method in action. Two employees at Adirondack Steel Casting Co. check the molding sand and spread the second plastic sheet over the top of the flask, before pulling a vacuum on the sand between the plastic sheets and forming it into a rock-hard mold.

FEF Annual Meeting Features Ebasco's Reichle

The FEF held its annual national members meeting at New York's Statler Hilton Hotel March 30 to assess the foundation's work over the past year and plan the direction of its current science alert mobilization. The highlight of the meeting was a presentation by Leonard F. C. Reichle, executive president of Ebasco Services, Inc.

The first item on the agenda was the election of a new director to fill the vacant seat on the foundation's board. The FEF board of directors and members present, in person and by proxy, elected Lyndon H. LaRouche, Jr. to the position. In announcing the board's proposal to elect LaRouche, Jon Gilbertson, the FEF's secretary treasurer, described LaRouche as one of the individuals who had founded the FEF nearly seven years ago and the developer of the LaRouche-Riemann econometric model on which the foundation's recent work in economics has been based.

In addition to the election of LaRouche, the board announced the appointment of Dr. Steven Bardwell as the editor-in-chief of the FEF's publications and Paul Gallagher as FEF executive director.

After the close of the business meeting, Steven Bardwell gave a brief presentation of the FEF's new "Solving the Energy Crisis" slide show, which is now available for use by members.

The Energy Question

Leonard Reichle, who is the director of Ebasco's prime contract work on the Princeton PLT and TFTR fusion machines, then gave the FEF members a preview of his upcoming testimony before the House Subcommittee on Energy Research and Production.

"The main question today is energy," Reichle began. He compared the situation with fusion to that of nuclear energy 34 years ago when he started his career at the Atomic Energy Commission. "After the war," Reichle said, "nuclear work was classified, but a few people started to talk about a civilian nuclear program. Gradually, pressure built up for the Atomic Energy Act of 1954."

"At first there were snickers," he recalled. "When Admiral Rickover announced that the first nuclear plant would produce electric power for 64 mills per kilowatt-hour, people laughed and said that coal would produce power at 8 mills per kilowatt-hour. Today, you hear the same kind of cries about fusion."

Reichle criticized what he called the "technological-development-for-its-own-sake approach" that says you can get to fusion by developing one piece of technology at a time. "This would be like Henry Ford deciding that he was going to build a Model T first by perfecting a carburetor, then a steering mechanism, and so forth. In my view, the way we can really get fusion going is to do it the way industry does things: Pick the leading technology and support it with dollars, and support all the back-up technologies at the same time, with all working toward the main objective."

"If we get our priorities straight," Reichle said, "we can achieve a demonstration engineering reactor by 1990 and a commercial demonstration electric power-producing reactor by the year 2000."

"Ebasco is pushing for the full funding of the fusion program," Reichle said, "because of its real value in terms of all mankind. What the world needs now is more and more energy, not less and less. You can't cut up the pie and make it go around. You have to make more pie. The only way to increase the standard of living is to provide more energy per capita."

"We have two options for the future, the breeder reactor and fusion. We have to move ahead vigorously with both," he continued.

"Some critics say 'no, it's too early,' but a broader range of people think it's time—the International Atomic Energy Agency and the Buchsbaum committee, for example."

Reichle said that he thought the best way to proceed on setting up the Center for Fusion Engineering mandated in the fusion law was to have a project team of an experienced industrial company and a university laboratory.

As for the manpower question, Reichle noted that the problem would be solved if we launched a national program to do what the 1980 fusion legislation mandates and if President Reagan endorsed the program the way France's President Giscard has endorsed his country's nuclear program.

Stuart Lewis

"You can't cut up the pie and make it go around. You have to make more pie." Here Leonard Reichle, executive vice president of Ebasco Services, Inc. addresses annual FEF meeting.

FEF Presents Energy Technology Awards at TechEx

The Fusion Energy Foundation presented its first annual Energy Technology Awards at the TechEx '81, 9th Annual World Fair for Technology Exchange held in Atlanta March 10 through 13. Presented in cooperation with Dr. Dvorkovitz & Associates, the awards are to recognize new inventions and discoveries in the area of energy technology that offer the greatest potential improvement in productivity for energy production and use for advanced or underdeveloped nations.

The 1981 winners, selected by an international panel of judges headed by FEF director of nuclear engineering Jon Gilbertson, were the Institut Fur Allgemeine Physik of Vienna, Austria, First Place; the Alfred University Research Foundation of Alfred, N.Y., Second Place; and ISTECH, Inc., of Livonia, Mich., Third Place. The awards were presented at a luncheon March 12 by Chris Winslow, FEF regional coordinator.

The winners of the TechExcellence Awards sponsored by Dr. Dvorkovitz & Associates also received their awards at this luncheon.

The Institut Fur Allgemeine Physik received a first place award for its continuing development and use of a Doppler-shift laser spectrometer to identify impurities in fusion plasmas. Since plasma impurities are a major problem in sustaining fusion reactions long enough to produce a net energy gain, the Institut's spectrometer is an important diagnostic tool to aid in overcoming the engineering problems in building a commercial fusion power reactor.

The Second Place award to the Alfred University Research Foundation recognized its development of a new coal slurry mixture, which is about 80 percent coal and only about 20 percent water with minimal chemical additives. Formerly, coal slurries contained as much as 50 percent water, which had to be removed before the coal could be burned as fuel. The new coal slurry resembles heavy oil and can be transported and stored as such. Since it can be burned directly without de-watering, a costly step is eliminated.

The potential effect of this new coal slurry, called Co-Al, on the world's energy requirements over the next few decades is expected to be quite significant.

The Third Place award to ISTECH, Inc. illustrates the FEF award criteria for increasing the overall profitability of an economy by increasing the energy density of industrial processes. ISTECH has developed and designed what it calls Integrated Construction Technologies in which a unique design of preinsulated, reinforced concrete walls with story-high prefabricated panels results in a building needing 40 to 50 percent less energy for heating and cooling.

In addition, the ISTECH techniques result in a much more efficient and productive construction process: three Integrated Construction buildings can be constructed and operated with the same input energy as two similar buildings of standard construction.

The FEF Energy Technology Awards are open to corporate, government, academic, and private inventors who exhibit at the annual TechEx world fairs. For further information, contact Jon Gilbertson at the Fusion Energy Foundation in New York.

FEF southern regional coordinator Chris Winslow (left) presents Energy Technology awards to Second Place winner William B. Crandall, director of the Alfred University Research Foundation (above), and Third Place winner Melvin H. Sachs, president of ISTECH, Inc. (below).

Reversing the Budget Cuts

FEF Organizes 'Science Alert'

The FEF's national "science alert," announced March 1 in response to the threatened budget cuts in American basic science programs, reached 15,000 FEF members in mid-March through a special members bulletin. The bulletin featured a call from former congressman Mike McCormack to defend his milestone 1980 fusion legislation and a list of upcoming FEF members meetings on the science alert.

The FEF call has generated a membership debate, raised the level of member activity around the issue of U.S. basic science policy, and brought FEF members attending the meetings into discussion and collaboration with building trades representatives concerned to revive nuclear power.

Developments in March included:

Three hundred FEF members attended seven members meetings in New England and the Mid-Atlantic states. Building trades representatives attended all but one of these meetings and the FEF science alert statement was mailed out by the national *Labor Beacon* monthly to its subscribers. At this writing, seven more meetings are scheduled for April. This round will be concentrated in the West and Southwest but will include an April 29 strategy session in Harrisburg, Pa. in the campaign to bring the undamaged Unit 1 reactor at Three Mile Island on line.

After the announcement of the FEF's national campaign to bring down electricity rates by reopening closed nuclear plants, one FEF member held a well-covered press conference on the campaign in Harrisburg; a second member organized a 70-person town meeting in New Jersey to discuss the reopening of TMI 1.

Five student chapters were formed over the month, one in New York, two in New Jersey, and two on the West Coast. More than 10,000 back issues of *Fusion* were given out on campuses where science alert meetings were being held.

Twelve FEF members raised their status to lifetime members with $1,000 contributions to help meet the costs of conducting the science alert and restabilize the finances of *Fusion* and *The Young Scientist*. An additional $16,000 was raised in special contributions and loans of more than $1,000 each.

The donation of paper by a member enabled the FEF to issue 15,000 copies of a dossier on bringing down electricity rates with nuclear power, which

Stuart Lewis

FEF organizers Sylvia Barkley and Roger Calvin at the Fusion *and* Young Scientist *booth at the annual meeting of the National Science Teachers Association in New York April 4-5. "It's about time" was a frequent response from serious teachers, who said that proscience materials for use in the classroom are almost impossible to find.*

Member Launches TMI Campaign

The FEF's campaign to lower electricity rates by bringing stalled nuclear power plants on line started with Scott Morrison of Dorwood Industries in New Jersey, who commissioned an FEF dossier on the subject for his own testimony at electric rate hearings. Morrison later advised the FEF to "get going on this practical issue," made more practical by the election of a president who favors nuclear power expansion. His advice was taken, and the FEF reissued the dossier in 15,000 copies to service a national campaign for the reopening of nuclear power plants.

"Electric rates are the number one issue in our area, and the only reason they're increasing as fast as they are is the closing of TMI," Morrison said. Jersey Central Power & Light formerly charged the lowest electric rates in the state and among the lowest in the Northeast, even though the utility serves a large area with many separated towns. Then it lost the use of power from both TMI Unit 1 and its own Oyster Creek reactor.

The FEF campaign initiated by Morrison has caught on with consumer groups formed to protest rising electricity rates, and their members are now attending FEF-sponsored meetings on the nuclear solution to the problem.

focused on the Pennsylvania-New Jersey power grid.

Investments by several members in the notes of our publisher, New Benjamin Franklin House, for the FEF science books series allowed the scheduling of the first book, *Fusion Power: The Ultimate Energy Source*, for June publication.

State Chapters Formed

The FEF is initiating the formation of official state chapters in seven states, with more to come later this summer. These state chapters will have affiliated city and campus chapters. The new state chapters will hold regular members meetings monthly or every six weeks in as many cities as possible. Where such meetings are already being held, they are becoming forums for discussing FEF campaigns in science and education policy, as well as fundraising efforts to support the goals of the FEF.

—Paul Gallagher

'Yes' to TMI 1

Continued from page 51

dent William Winpisinger and a scattering of representatives of other unions made an appearance, the bulk of those who showed up were professional antinuclear demonstrators from the drug-rock counterculture.

Pennsylvania business spokesmen were as emphatic as the unionists about their support for TMI. The week of the rally, the Pennsylvania Chamber of Commerce released a report calling for the reopening of TMI's Unit 1 and charging that the Nuclear Regulatory Commission had "dragged its feet" on the utility's request for a license to start up the reactor.

Earlier in the month the Fusion Energy Foundation decided to make the reopening of Unit 1 the focus of a national campaign to lower electricity rates by getting on line nuclear plants that were shut down or stalled in construction. At a press conference in Harrisburg March 27, FEF spokesman Ira Seybold announced an April 29 organizing meeting in that city to officially launch the drive.

Young Scientist Sponsorship Gets Corporate Boost

Several corporations have contributed to the Fusion Energy Foundation specifically to sponsor bulk subscriptions of The Young Scientist *magazine in schools of their choice, and one executive is actively recruiting other companies to match his contribution.*

Frank B. Hewes, treasurer of Adirondack Steel Casting Co., Inc. in Watervliet, N.Y. wrote to three dozen New York State businessmen urging them to help put the magazine into area classrooms. Here are excerpts from his letter:

I want to introduce you to a children's science magazine called *The Young Scientist*. I would like your company to consider giving financial support to this magazine as has Adirondack.

The magazine is being introduced by a nonprofit, tax-exempt scientific organization called the Fusion Energy Foundation. I have worked with them for the past 3½ years and know many individuals on their staff. They are a group committed to the industrial development and economic growth of America and they believe, as I do, that this can only be done by educating our youth in science and technology. I think you probably feel this way too.

After the last 15 years of the antiscience environmentalist curriculum that has infested our schools, I think that it's about time that our youngsters were exposed to real science again. That is the purpose of *The Young Scientist*.

The Fusion Energy Foundation has initiated a program that is designed to raise the necessary capital to introduce this magazine into primary and secondary schools throughout the United States—those schools who request it. That program is called The Young Scientist Sponsorship Program. . . .

Adirondack Steel Casting Co. has already participated in this program with a contribution of $1,000 to be used for bulk subscriptions of the magazine to help service science classes in the schools in our area. Board of Education members and educators, as well as parents with whom I've talked, have already expressed their desire to have such a magazine available to schools. . . ."

Corporations, trade unions, schools, and other organizations interested in the sponsorship program should contact Judy Acheson at the FEF New York office.

FEF in the News

The Clive Thomas show, WKIS Radio, Orlando, Fla., March 24

FEF spokesman Ira Seybold and Fay Sober were invited to this popular statewide program to discuss "The Media Role in Creating the Harrisburg Hoax," an article Sober authored in the April issue of *Fusion*. Both the show's listeners and host concurred that the media had manufactured the scare around Three Mile Island, and there was a lively discussion on the role of the Federal Emergency Management Agency and the Pennsylvania state government in allowing sensation-mongering instead of news. Seybold and Sober are members of the Independent Commission to Investigate Media Corruption, whose reports on TMI were the basis for the *Fusion* article.

Aleksandrov

Continued from page 17

efficient utilization of oil, and taking other resources into account, it will be possible to extend the time taken to restructure the fuel and energy complex to 40 to 50 years, which will appreciably lessen the strain in the transition period.

Unlimited Power with Nuclear

However, even this longer period of change in the structure of the power industry cannot allow a postponement of the commencement of work on creating a nuclear power industry suitable for the long term and on developing the means of using such energy in all spheres of consumption of traditional energy sources.

The point is that the power industry has a high degree of inertia—its highly capital-intensive and materials-intensive nature as well as the length of time taken to develop new, economically acceptable techniques make it necessary to begin the development of all aspects of the new energy structure now.

The main task is to create a nuclear power industry structure such that the industry will be supplied with fuel indefinitely. The thermal neutron reactors now being used can utilize about 1 percent of the raw uranium. And they cannot provide for the nuclear power industry in the long term.

Science has found a radical method—it is possible to create fast breeder reactors that make it possible to utilize uranium reserves more fully.

Commercial reactors of this type have been created in our country. One of them, the BN-350, has been in operation for a long time, and the BN-600 was started up in 1980. There is still complex work ahead, however, on increasing the speed of production of plutonium and its return to the fuel cycle, since only then will it be possible to move toward a nuclear power industry providing itself with fuel for an unlimited time and developing at the pace the country needs.

The possibility is not excluded that it will be difficult to ensure the necessary rate of growth in the power industry in the distant future by producing plutonium in fast breeder reactors and through the extraction of natural uranium. In this event science is also preparing a solution: The merging of the nuclei of light elements—thermonuclear fusion—is accompanied by the release of neutrons. Some of them could be captured by uranium-238 to yield plutonium.

The possible speed of production of plutonium in these hybrid fission-fusion reactors is very great and will ensure any necessary rate of development of the nuclear power industry. As yet there are no such reactors, but they will be created by the end of the century. They will most likely be created sooner than pure fusion reactors. Therefore, in a couple of centuries' time, when the coal shortage begins to make itself felt, nuclear power of all kinds will be able to supply all spheres of energy consumption for an indefinite period. Thus the structure of the infinitely developing nuclear power industry will be as follows: Thermal neutron reactors will be joined by fast breeder reactors, and they may be joined by hybrid reactors. In parallel, large capacity fusion reactors will be created.

Thus the future development of the power industry will not be restricted by a shortage of energy resources if the appropriate reorganization of its structure is carried out in good time. This is entirely realistic in our country.

Bring the space age home.

Eight stunning NASA photographs, color enhanced by a special process, are now available from FEF. You'll want several of these classic space-age photographs for yourself and for gifts.

These unique photographs are printed on Kodak paper by Maxtron Industries, and each photo is ferrotyped to give it a brilliant glossy surface.

The photographs can be purchased unmounted, with bevel-cut matboard, or matted and framed in silver anodized section frame.

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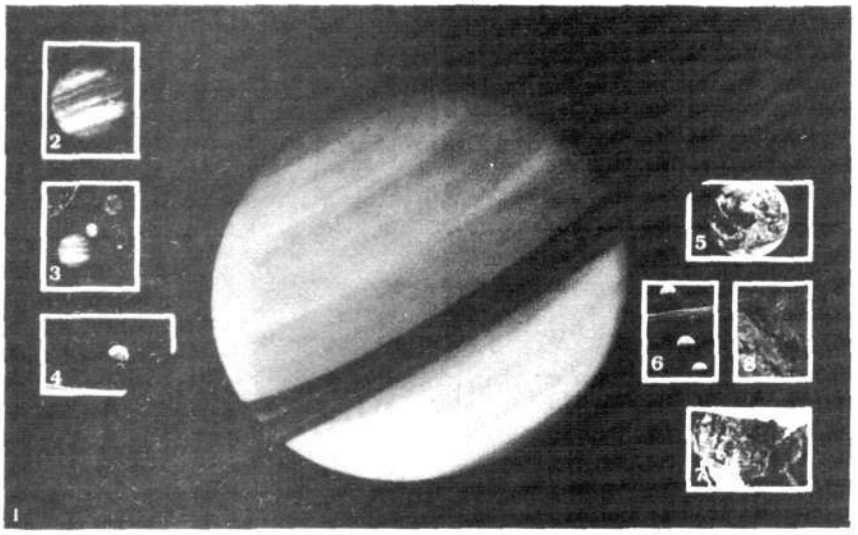

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The Young Scientist is making history!

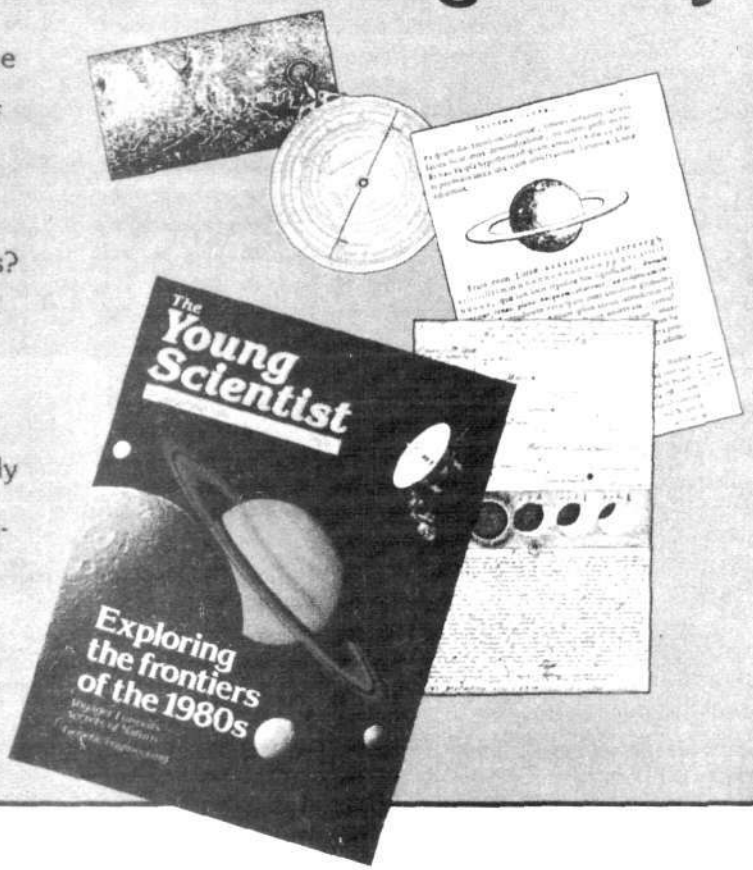
Each issue of *The Young Scientist* magazine tells readers about the scientists, experiments, and discoveries on the frontiers of science today—and yesterday.

Why are the Saturn results important?
How does genetic engineering work?
Why are soap bubbles shaped like spheres?

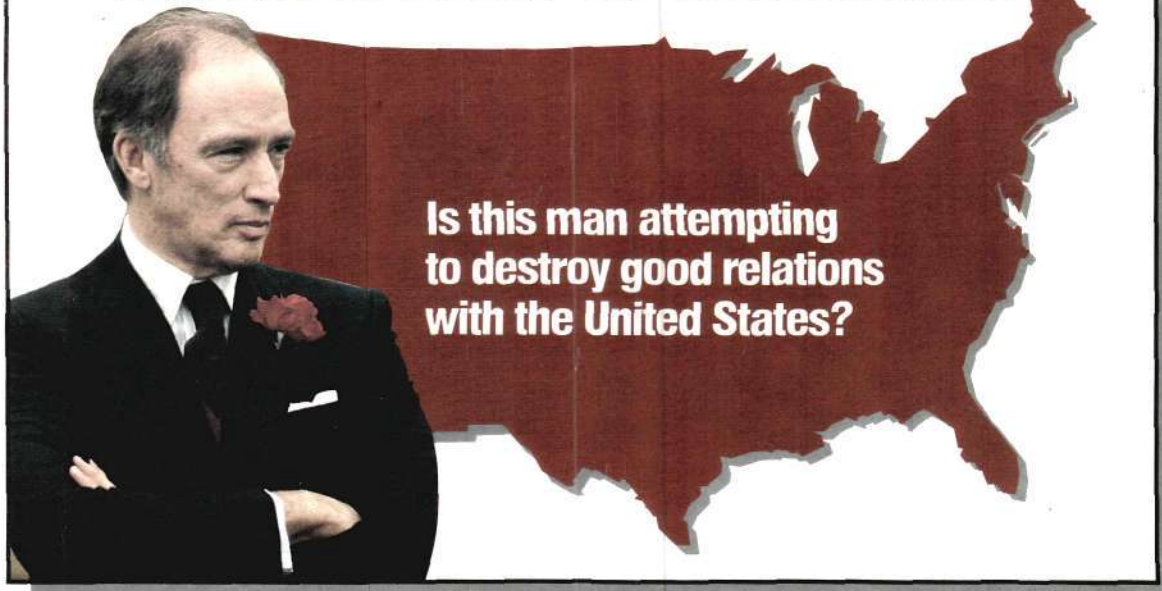
The Young Scientist answers questions like this in every issue—and has puzzles and experiments, interviews, news, and photographic tours of the nation's leading scientific labs, museums, and high-technology industries. Published bimonthly by the Fusion Energy Foundation, *The Young Scientist* is part of a nationwide campaign to reverse the collapse of American science education.

Subscribe now. Give your children today's science... to make them the history makers of tomorrow.

Fill out the insert card opposite this page.



Will Canada remain America's friend?



Startling facts about Canada all Americans must know

Pierre Elliot Trudeau is forcing a new constitution on the Canadian people.

■ The constitution denies the right of habeus corpus. This means that a person does not have to be *charged with any crime* to be picked up and held *indefinitely*.

■ The constitution *does not* guarantee the right of *private property*.

■ Trudeau is imposing a British constitution on Canada which 8 out of 10 provinces have already rejected. If passed, the Trudeau formula would destroy the provincial autonomies and legislative powers over human rights and natural resources.

Who Is Pierre Elliot Trudeau?

■ Trudeau's philosophy is the "Third Way" of the Socialist International. This group held a meeting in Washington, D.C. December 5-7, 1980, in which a destabilization of President Reagan through labor confrontations was openly discussed.

■ Trudeau is a card-carrying member of the Club of Rome, and has promoted the Brandt Commission program: that the world population must be reduced by two billion people and that nuclear energy must be abandoned and replaced by what they call *appropriate technology* (environmentalism).

■ Trudeau is promoting the legalization of marijuana in Canada. This is not surprising since some of the most "drug-connected" banks in the world are in Canada.

Direct attacks on the United States:

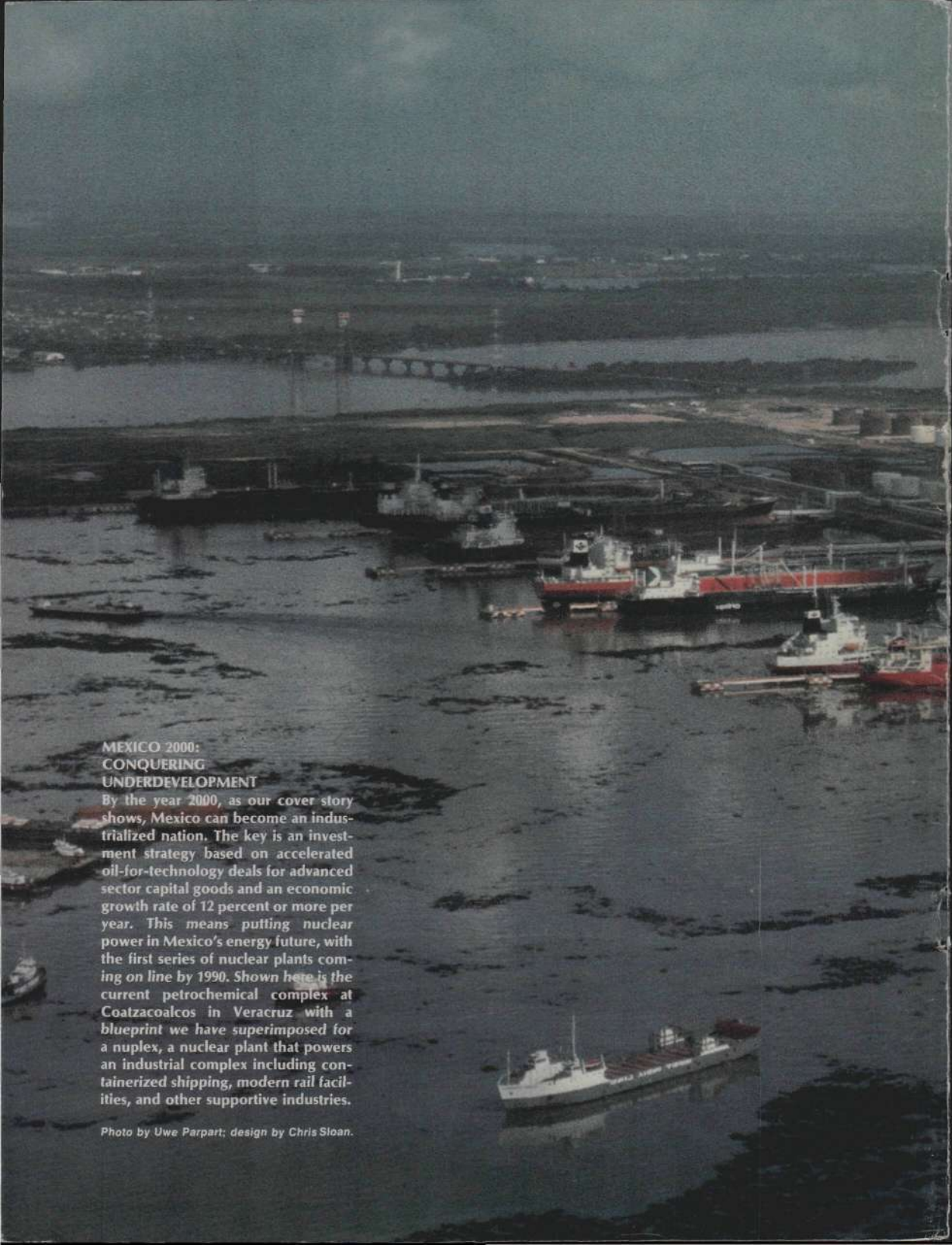
■ In the fall of 1980, the Canadian wheat board proposed a policy of wheat dumping on the U.S. to *undercut American farmers* while destroying Canadian agriculture.

■ Two to three billion dollars of Canadian capital, needed for resource development at home, is going into the American real estate market to fuel a speculative boom. At the same time, American firms are effectively *banned* from buying into Canada.

There are many people throughout Canada who find Trudeau's policy wrong and unfair. We wanted to inform our friends in America of what is going on and ask for your help to protest these policies in the U.S. Congress and the White House.

Are you concerned? We are. Write your congressman. Tell the President.

American Friends of Canada, P.O. Box 1883, Loop Station, Chicago, Ill. 60690



MEXICO 2000: CONQUERING UNDERDEVELOPMENT

By the year 2000, as our cover story shows, Mexico can become an industrialized nation. The key is an investment strategy based on accelerated oil-for-technology deals for advanced sector capital goods and an economic growth rate of 12 percent or more per year. This means putting nuclear power in Mexico's energy future, with the first series of nuclear plants coming on line by 1990. Shown here is the current petrochemical complex at Coatzacoalcos in Veracruz with a blueprint we have superimposed for a nuplex, a nuclear plant that powers an industrial complex including containerized shipping, modern rail facilities, and other supportive industries.

Photo by Uwe Parpart; design by Chris Sloan.